

Moran Lake Monarch Butterfly Habitat Management Plan Update

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1 Introduction

Rincon Consultants, Inc. (Rincon) has prepared this report in conjunction with Park Planning staff from the Santa Cruz County Department of Parks, Open Space & Cultural Services (County Parks) as an update to the 2010 Moran Lake Monarch Butterfly Habitat Management Plan (MBHMP). The 2010 MBHMP integrated previous reports and studies regarding monarch butterfly overwintering habitat surrounding Moran Lake in Santa Cruz County, California. This updated MBHMP details the most recent monarch population data, describes current monarch overwintering conditions at Moran Lake, and provides updated monarch habitat management recommendations. This plan includes content that is consistent with the 2022 Monarch Overwintering Grove Management Plan Template. The template was developed for land managers of overwintering sites by the following agencies and organizations: Xerces Society for Invertebrate Conservation,[1] Groundswell Coastal Ecology,[2] California Department of Parks and Recreation, and the U.S. Fish and Wildlife Service (USFWS).

The 2010 MBHMP integrated the Management Plan for the Monarch Habitat at Moran Lake County Park (Joni L. Janecki & Associates 2004), the Management Plan for the Monarch Habitat at the D.A. Porath [Lode Street] Sanitation Facility of the Santa Cruz County Sanitation District (Joni L. Janecki & Associates, Inc. 2006), and portions of the Moran Lake Water Quality Study & Conceptual Restoration Plan prepared for the Santa Cruz County Redevelopment Agency (John Gilchrist & Associates and Fall Creek Engineering 2005). This plan, unlike the 2010 plan, does not address improvements to County Parks' facilities (trails, amenities, etc.) or to the structure of the lake (bank stabilization). A separate project addressing those elements is being developed presently.

Land ownership of the overwintering habitat surrounding Moran Lake is shared between County Parks and the Santa Cruz County Sanitation District (Sanitation District). The overwintering habitat includes the eucalyptus groves within Moran Lake County Park and surrounding the Sanitation District's D.A. Porath Sanitation Facility. Under the terms of a memorandum of understanding between the Sanitation District and County Parks that was approved by the Board of Supervisors on September 30, 2025, County Parks is responsible for managing the entirety of the monarch habitat.

County Parks was awarded a grant from the USFWS Coastal Program for Central California Coast. The USFWS agreement contains two objectives for County Parks to meet:

- Objective 1 – Create an updated site assessment and set of management recommendations, based on monitoring of the overwintering monarch site, to be referenced and considered in a future Monarch Butterfly Habitat Management Plan
- Objective 2 – With stakeholder and community input, prepare an updated Monarch Butterfly Habitat Management Plan for Moran Lake County Park, prepare environmental review document in accordance with the California Environmental Quality Act, and present

[1] The Xerces Society for Invertebrate Conservation is an international nonprofit organization that protects the natural world through the conservation of invertebrates and their habitats. As a science-based organization, they both conduct their own research and rely upon the most up-to-date information to guide their conservation work. Key program areas include pollinator conservation, endangered species conservation, and reducing pesticide use and impacts (Xerces 2023a).

[2] Groundswell Coastal Ecology is a 501(c)(3) dedicated to building healthy coastal ecosystems through education and community-based ecological restoration and research. The organization partners with land managers, agencies, stakeholder groups, and the public to identify, prioritize, plan, and implement projects that enhance biodiversity and the long-term health of coastal habitats (Groundswell Coastal Ecology 2023).

to the County Board of Supervisors for review and adoption, allowing subsequent objectives to be completed.

To meet these objectives, County Parks contracted a qualified entomologist specializing in migratory monarchs to assess the site, complete an updated report, and provide a set of recommendations for monarch habitat management at Moran Lake County Park. Entomologist Dr. Stu Weiss's findings and recommendations are presented in the 2022 Moran Lake Monarch Butterfly Habitat Existing Conditions Report (Appendix A). Recommendations were modified in 2024 based on additional available information and written as an addendum to the Moran Lake Monarch Butterfly Overwintering Habitat Existing Conditions Report prepared in 2022. Data and management recommendations from the 2024 Addendum have been incorporated into this plan, and are in Appendix A. Recommendations were further modified in 2025 based on a wind study conducted by Althouse and Meade and Dr. Stu Weiss. Data and management recommendations from the 2025 wind study have been incorporated into this plan, and are included as a 2025 Addendum to the Moran Lake Monarch Butterfly Overwintering Habitat Existing Conditions Report in Appendix A.

County Parks orchestrated stakeholder and community input over a three-year period that was used to complete this Monarch Butterfly Habitat Management Plan for Moran Lake County Park. In addition, County Parks has contracted with consultants to prepare an environmental document in accordance with the California Environmental Quality Act. The final Habitat Management Plan and environmental document will be presented to the County Board of Supervisors for review and adoption, which would facilitate completion of the USFWS grant objectives.

2 Background and Purpose

Available reports regarding the origin of the blue gum eucalyptus forest that provides the monarch butterfly overwintering habitat include the 1980 Environmental Baseline Study for the Moran Lake Enhancement Plan Santa Cruz, California, and the 2005 Santa Cruz County Redevelopment Agency's Moran Lake Water Quality Study & Conceptual Restoration Plan, and the 2010 Moran Lake Monarch Butterfly Habitat Management Report (MBHMP) The consensus is that the blue gum eucalyptus growing around Moran Lake were likely planted as windbreak trees in the late 1800's or early 1900's. An analysis of aerial photos showed that the trees were well-established by 1929. Two adjacent woodlots were planted north of the lake. The main eucalyptus grove is likely the remains of one of the woodlots and now surrounds the Sanitation District's D.A. Porath Sanitation Facility, which was constructed in 1953.

The 1980 Environmental Baseline Study (Study) was prepared for the first phase of the Moran Lake Enhancement Plan. The Study notes that surveys were conducted that year for water quality in relation to biological abundance and diversity. Biological inventories included vegetation, birds, aquatic invertebrates (benthic and planktonic), fish and mammals. The stated intent of the Study was for the baseline information to be used for comparison, with post-restoration monitoring at Moran Lake. No known monitoring reports are available at the time of the drafting of this document. The Study notes that Moran Lake supported an extremely impoverished fauna of estuarine organisms at that time. No data regarding monarch butterflies is provided.

The Redevelopment Agency's Restoration Plan discusses Moran Lake historically as a pocket beach heavily influenced by seasonal tides that was filled with soil and materials in the early 1960s when Wood's Lagoon was expanded and converted into the Santa Cruz Yacht Harbor. The 2005 Plan describes the area being colonized primarily by non-native plants at that time, including by the dominant trees of blue gums (*Eucalyptus globulus*) and Monterey cypress (*Cupressus macrocarpa*).

In 1997, the Xerces Society, a volunteer citizen scientist group, began recording monarch butterfly overwintering counts in the State. In 1997, the organization recorded approximately 70,000 overwintering monarchs at the Moran Lake site. In 2016, the Xerces Society listed the Moran Lake site as one of the top 10 highest priority overwintering sites in the region. The western population of monarch butterflies has fluctuated greatly in recent years. An annual count of monarchs at Moran Lake in 2020 recorded just 50 overwintering monarchs; 7,050 were recorded in 2023 (Xerces Society 2023b).

In 2010, Moran Lake County Park's MBHMP was prepared to include the most recent monarch population use and habitat information and provide County Parks with an updated, comprehensive, and certified monarch management plan. The MBHMP provided goals and management recommendations for all monarch overwintering habitat surrounding Moran Lake. Since that time, County Parks has struggled with the funding to implement such a plan, and thus, management actions were constrained.

Over the past decade much of the monarch overwintering habitat at Moran Lake, comprised of eucalyptus groves, has been altered by drought. The long-term drought has negatively affected monarch overwintering habitat along the California coast as it has at the Moran Lake site. The drought, plus permitted and non-permitted tree removals, non-holistic tree maintenance, and poorly draining soil resulting in multiple tree failures of windbreak trees are contributing to the declining habitat.

The purpose of this updated MBHMP is to describe the current habitat conditions on-site and provide updated management recommendations based on current monarch overwintering observations and existing habitat conditions that will aid in the restoration, preservation, and future enhancement of monarch overwintering habitat at Moran Lake.

2.1 Monarch Butterfly Habitat Listing Status

2.1.1 Federal

In 2014, the Center for Biological Diversity petitioned the USFWS to list the monarch butterfly as a threatened species under section 4(d) of the federal Endangered Species Act (ESA; Center for Biological Diversity 2014). The USFWS updated their status assessment on December 15, 2020 (USFWS 2020), finding that listing of the western monarch population was warranted but precluded. The finding stated that the USFWS could not identify Evolutionary Significant Units (ESU) for monarchs, because, as defined in the ESA, when invertebrates, including butterflies, are evaluated, they are evaluated across the entire range. The evaluation was based on the global population that includes monarchs that occur east of the Rocky Mountains and on multiple continents. Monarchs were ranked at priority level #8 on the species list (USFWS 2022). Monarchs were proposed for listing as Threatened under the ESA by the USFWS on December 12, 2024. In addition, the USFWS proposed the Moran Lake habitat area as one of the five designated critical habitat areas in Santa Cruz County. A final decision by the USFWS is expected in early 2026.

2.1.2 State

Monarchs are included on the California Department of Fish and Wildlife (CDFW) Terrestrial and Vernal Pool Invertebrates of Conservation Priority list with a State Ranking of S2S3, Imperiled/Vulnerable (CDFW 2017). The monarch is also listed as a Species of Greatest Conservation Need on California's State Wildlife Action Plan (CDFW 2015). The Sacramento Superior Court ruled in *Almond Alliance of California v. California Department of Fish and Wildlife,* Sacramento Superior Court No. 34-2019-80003216 (Nov. 13, 2020) that insects are not protected under the California Endangered Species Act (CESA). On May 31, 2022, an appellate court ruled that the CESA does in fact cover terrestrial invertebrates, thereby reversing the previous ruling (Sacramento Superior Court No. 34-2019-80003216CUWMGDS). Currently, monarchs are not listed under the CESA, though there is potential for the overwintering population to be listed in the future, based on the May 2022 ruling. Monarchs do have protection under California Fish and Game Code (Section 1002), which prohibits the take or possession of wildlife and California Code of Regulations Title 14 Sections 650(a) and (b), which requires a valid Scientific Collection Permit issued by CDFW for "handling monarchs, removing them from the wild, or otherwise taking them for scientific or propagation purposes, including captive rearing."

The California Coastal Act (CCA) defines Environmentally Sensitive Habitat Areas (ESHA) as "any area in which plant or animal life or their habitats are either rare or especially valuable because of their nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments." Wetlands, including the estuarine habitat in and near Moran Lake, are protected under Section 30233 of the Coastal Act. Additionally, marine resources, including the marine habitat that occurs in the southwestern portion of the Project Area, below the high tide line of the Pacific Ocean, are protected under Section 30230 of the Coastal Act. The Santa Cruz County Local Coastal Program (LCP) Implementation Plan (IP) (County Code/IP Section 16.32.040) definition of sensitive habitat includes unique plant habitats, rare and endangered plant and animal habitats,

wetlands, coastal streams, rocky points, sea cliffs, intertidal areas, and kelp beds. Therefore, according to the Santa Cruz County LCP, the riparian corridors within the Coastal Zone are also considered ESHAs and the riparian vegetation associated with Moran Creek is an ESHA. Areas which provide habitat for rare, endangered, or threatened species are also considered ESHA. The eucalyptus groves within Moran Lake County Park which provide overwintering habitat for the monarch butterfly are therefore also ESHAs.

2.1.3 Regional

The Santa Cruz County Code's Chapter 16.32 Sensitive Habitat Protection, section 16.32.040 defines ESHAs as Sensitive Habitat. Habitat is considered sensitive if it provides habitat for plant or animal species or communities that are locally unique or are recognized by the State or Federal Resource Agencies as being rare, threatened endangered, or a species of special concern (County of Santa Cruz 2024). The definition of sensitive habitat also included unique plant habitats, wetlands, coastal streams, rocky points, sea cliffs, intertidal areas, and kelp beds. Therefore, according to the Santa Cruz County LCP, the riparian corridors within the Coastal Zone are also considered ESHAs and the riparian vegetation associated with Moran Creek is an ESHA. Additionally, the marine and estuarine habitat that occurs in the southwestern portion of the Project Area, below the high tide line of the Pacific Ocean is also considered an ESHA. Areas which provide habitat for rare, endangered, or threatened species are also considered ESHA. The eucalyptus groves within Moran Lake County Park which provide overwintering habitat for the monarch butterfly are therefore also ESHAs.

County Code Chapter 16.34 Significant Trees Protection preserves significant trees and forest communities on private and public property in the County's Coastal Zone to protect and enhance the County's natural beauty, property values, and tourist industry. The ordinance prohibits the removal of significant trees without a Significant Tree Removal Permit. Significant trees include any tree, sprout clump, or group of trees, as follows:

(A) Within the urban services line or rural services line, any tree which is equal to or greater than 20 inches d.b.h. (approximately five feet in circumference); any sprout clump of five or more stems each of which is greater than 12 inches d.b.h. (approximately three feet in circumference); or any group consisting of five or more trees on one parcel, each of which is greater than 12 inches d.b.h. (approximately three feet in circumference).

(B) Outside the urban services line or rural services line, where visible from a scenic road, any beach, or within a designated scenic resource area, any tree which is equal to or greater than 40 inches d.b.h. (approximately 10 feet in circumference); any sprout clump of five or more stems, each of which is greater than 20 inches d.b.h. (approximately five feet in circumference); or, any group consisting of 10 or more trees on one parcel, each greater than 20 inches d.b.h. (approximately five feet in circumference).

(C) Any tree located in a sensitive habitat as defined in Chapter 16.32 SCCC. Also see SCCC 16.34.090(C), exemption of projects with other permits.

Tree removal exemptions listed in Section 16.34.080 include allowances for emergency tree work that require immediate action to abate hazards to safety of life or property. 16.34.090 of the ordinance includes exemptions for tree removals authorized pursuant to a valid discretionary permit.

Biological and water resources are protected by the County of Santa Cruz General Plan and the Local Coastal Plan (LCP) policies outlined in *Chapter 5: Conservation and Open Space* of the General Plan.

Relevant policies for the Moran Lake County Park Improvement Project include those outlined under the following General Plan and Local Coastal Plan objectives: *5.1 Biological Diversity, 5.2 Riparian Corridors and Wetlands, 5.3 Aquatic and Marine Habitats, 5.4 Monterey Bay and Coastal Water Quality,* and *5.7 Maintaining Surface Water Quality*.

2.2 Consistency with Other County Plans

The MBHMP is in the jurisdiction of two local land use plans: the Pleasure Point Community Plan and the Santa Cruz County 1994 General Plan and LCP. The Pleasure Point Community Plan was adopted in May 2010 through County ordinances and focuses primarily on design standards and public improvements in the Pleasure Point/26th Avenue area (Santa Cruz County 2010). Since the MBHMP does not propose development as a part of the plan, the Pleasure Point Community Plan does not apply and is not evaluated further within this document. However, the Santa Cruz County 1994 General Plan and LCP includes several policies that serve to protect sensitive habitat areas, and thus, avoid or mitigate potential impacts to sensitive habitat that may occur as a result of development in the County. The MBHMP's consistency with these policies is discussed below.

Table 1 MBHMP Consistency with the 2024 General Plan and Local Coastal Program

County of Santa Cruz LCP Policy and Programs	Consistency Discussion
Agriculture, Natural Resources, and Conservation Element	
ARC-3.1.4 Sensitive Habitat Protection Ordinance (LCP). Implement protection of sensitive habitats and of ESHA through SCCC Chapters 16.32 Sensitive Habitat Protection, 16.30 Riparian Corridor and Wetlands Protection, and 13.20 Coastal Zone Regulations. Any amendments to this ordinance shall require a finding that sensitive habitats shall be afforded equal or greater protection by the amended language.	**Consistent.** The MBHMP in itself serves to protect the monarch butterfly overwintering habitat by setting forth management actions consistent with Policy ARC-3.1.4.
ARC-3.1.6 Development within Sensitive Habitats (LCP). Sensitive habitats shall be protected against any significant disruption of habitat values, and any proposed development within or adjacent to these areas must maintain or enhance the functional capacity of the habitat. Reduce in scale, redesign, or, if no other alternative exists, deny any project that cannot sufficiently mitigate significant adverse impacts on sensitive habitats unless approval of a project is legally necessary to allow a reasonable use of the land.	**Consistent.** The MBHMP in itself serves to protect the monarch butterfly overwintering habitat by setting forth management actions consistent with Policy ARC-3.1.6.

County of Santa Cruz LCP Policy and Programs	Consistency Discussion
ARC-3.1.7 Site Design and Use Regulations (LCP). Protect sensitive habitats against any significant disruption or degradation of habitat values in accordance with the Sensitive Habitat Protection ordinance. Utilize the following site design and use regulations on parcels containing these resources. excluding existing agricultural operations: (1) Structures, when allowed, shall be placed as far from the habitat as feasible. (2) Delineate development envelopes to specify location of development in minor land divisions and subdivisions. (3) Consider use of conservation or open space easements, deed restrictions, Conditions of Approval or equivalent measures to protect that portion of a sensitive habitat on a project parcel which is undisturbed by a proposed development activity or to protect sensitive habitats on adjacent parcels. (4) Limit or restrict outdoor access of domestic animals where they threaten sensitive habitats. Santa Cruz County General Plan Page 5-50 3/18/2024 (5) Limit removal of native vegetation to the minimum amount necessary for structures, landscaping, driveways, septic systems and gardens. (6) Maintain regulations and impose development permit conditions of approval as warranted, to limit landscaping with invasive or exotic species and to strongly encourage or require the use of characteristic native species, as well as consistency with the Water Efficient Landscaping Ordinance.	**Consistent.** The plan would not result in disruption or degradation of a sensitive habitat and would incorporate native plants as appropriate to improve habitat for monarchs and other native species at Moran Lake**.**
ARC-3.1.9 Biotic Assessments (LCP). Within the following areas, require a biotic assessment as part of normal project review to determine whether a full biotic report should be prepared by a qualified biologist, and require biotic permits as part of application reviews as may be needed: (1) Areas of biotic concern, mapped; (2) Sensitive habitats, mapped and unmapped; and (3) For sites within the coastal zone, for the presence of ESHA.	**Consistent.** The MBHMP serves as a biotic assessment of the monarch habitat of Moran Lake. The primary goal is to enhance the function of Moran Lake through restoration activities which would better sustain a native monarch population.
ARC-3.1.10 Species Protection (LCP). Recognize that habitat protection is only one aspect of maintaining biodiversity and that certain wildlife species, such as migratory birds, may not utilize specific habitats. Require protection of these rare, endangered, and threatened species and continue to update policies as new information becomes available.	**Consistent.** The MBHMP provides updated management recommendations based on current data that will aid in the restoration, preservation, and enhancement of monarch overwintering habitat at Moran Lake. Implementation of the plan would improve habitat protection for monarchs.
ARC-3.2.4 Removal of Invasive Plant Species (LCP). Encourage the removal of invasive species and their replacement with characteristic native plants, except where such invasive species provide significant habitat value and where removal of such species would severely degrade the existing habitat. In such cases, develop long-term plans for gradual conversion to native species providing equal or better habitat values. Support the responsible use of herbicides to assist with the removal of invasive plant species.	**Consistent.** While blue gum eucalyptus, cape ivy, and english ivy can be considered invasive species, they provide critical habitat value to monarchs at Moran Lake. Therefore, within the core habitat zone , these species will be managed to provide habitat benefit to monarchs. Outside of the core habitat zone, recommended replacement trees include native species to the extent feasible to provide biodiversity and to facilitate a long-term transition toward more native species. Replacement trees will be selected based on the specific soil, water, sunlight, and need for wind protection at each location.

County of Santa Cruz LCP Policy and Programs	Consistency Discussion
ARC-3.3.3 Activities Within Riparian Corridors and Wetlands (LCP). Development activities, land alteration, and vegetation disturbance within riparian corridors and wetlands and required buffers shall be prohibited unless an exception permit is granted per the Riparian Corridor and Wetlands Protection ordinance. As a condition of a riparian exception permit, require evidence of compliance with applicable permit or review requirements of the U.S. Army Corps of Engineers, California Department of Fish and Wildlife, and other federal or state agencies that may have regulatory authority over activities within riparian corridors and wetlands.	**Consistent.** The project site contains Moran Lake: the coastal lagoon and associated wetlands. Recommended tree planting would occur directly adjacent to these areas. However, removal and replanting of trees and other management activities contemplated under this plan would be required to comply with all applicable laws and regulations and the protective measures outlined in this plan. These actions would limit any adverse effects on water quality in Moran Lake and associated waterways. Finally, the approval of this plan will include a Biotic Approval permit to cover management activities included in the plan.
ARC-3.3.8 Environmental Review for Riparian Corridor and Wetland Protection (LCP). Require environmental review of all proposed development projects affecting riparian corridors or wetlands and preparation of a Biotic Report for projects that, as proposed, may have a significant effect on the corridors or wetlands. Compliance with County regulations is generally considered to prevent the possibility of significant environmental impacts, and any biotic and/or riparian exception permit process may involve project specifications and/or conditions that would also prevent the possibility of significant environmental impacts.	**Consistent.** The MBHMP in itself is a biotic report which identifies sensitive habitats on the project site and sets forth management actions and associated protective measures to improve and protect the habitat. Future management plan actions proposed under the plan would not have adverse effects on Moran Lake nor its associated wetlands.
ARC-5.1.9 Significant Tree Removal Ordinance (LCP). Maintain the standards in the County's regulations that require a permit for removal of significant trees and other major vegetation located within the Coastal Zone, and provide appropriate protection for significant trees and other major vegetation in other areas of the County.	**Consistent**. The trees at Moran Lake are within sensitive habitat and are therefore considered significant. This plan provides specific recommendations for tree management, including regular assessment by a certified arborist, protective measures for tree work, removals, and replacement plantings to maintain sensitive monarch butterfly overwintering habitat. The plan requires mitigation for tree removals and that the mitigation be guided by a certified arborist and monarch butterfly specialist in order to enhance monarch habitat. Therefore, future management plan actions proposed under this plan will not have an adverse effect on the sensitive habitat and will be covered by a Biotic Approval and Riparian Exception, thereby meeting the requirements of the Significant Tree Removal Ordinance.

LCP = Local Coastal Plan; MBHMP = Monarch Butterfly Habitat Management Plan

Source: Santa Cruz County 1994

2.3 Community and Stakeholder Engagement

County Parks orchestrated significant stakeholder and community input over a three-year period during the development of the Moran Lake Monarch Butterfly Habitat Management Plan Update. Stakeholder and community input directly influenced the content and recommendations of the habitat management plan (HMP). Community and stakeholder engagement consisted of direct outreach to local regulatory agencies and monarch experts including the USFWS, the California Department of Fish and Wildlife, John Dayton, the Xerces Society, the California Coastal Commission, and Santa Cruz County Environmental Planning during development of the draft

habitat management plan in 2023 and 2024 to solicit feedback on the plan and to ensure that site-specific data on historic monarch roost locations and activities were incorporated in the plan.

In addition, County Parks shared a public draft of the HMP at a community meeting on July 23, 2024 and via email to neighbors, stakeholders, and other interested parties. The draft HMP was also posted on the County Parks website. Comments were collected during the public meeting, and the public comment period was open until August 16, 2024. Most of the public comments focused on the need for increased tree management and assessment and the need to prioritize public safety while protecting monarch habitat. Some commenters did not agree with recent tree planting at the park and expressed concern that private views were impacted, open space was being lost, and that County Parks did not conduct sufficient public comment prior to the planting. Other commenters expressed support for the recent tree planting and requested additional tree planting. Several commenters suggested that only California native species be planted. Other comments focused on the need to protect the existing eucalyptus trees, and some comments requested preservation of the trees on the 40 Moran Way parcel.

Based on feedback provided during the community meeting and in subsequent comments, County Parks, in partnership with the Sanitation District and First District Supervisor Manu Koenig, contracted with Althouse and Meade and Dr. Stu Weiss to prepare a wind study to analyze the relationship between the height of the existing eucalyptus trees and the wind protection that they provide to the monarch overwintering habitat. The wind study was completed in June 2025. Recommendations from the wind study, proposed changes to the habitat management plan that were informed by the wind study, as well as plans for conducting tree management in Summer 2025, were presented at a community meeting on June 24, 2025. The community meeting presentation was posted on the County Parks website, and the public comment period was open until July 11, 2025.

Most of the public comments expressed support for the increased management actions outlined in the presentation. Comments from neighbors expressed concern that eucalyptus trees along Placer Street and in the Southeast Grove were not scheduled for tree work in Summer 2025. Several commenters expressed concern that the management actions would not receive sufficient funding. Some comments noted the statewide significance of the monarch habitat at Moran Lake and expressed disagreement with the wind study results showing that removal of trees around the lake would not negatively impact overwintering habitat and expressed concern that the wind study did not take into account impacts to the fall roost sites in the South Creekside area. Other commenters noted that the findings of the wind study suggested that no additional trees needed to be planted around the lake and requested that planting locations prioritize the preservation of views from private residences and that County Parks conduct a robust public comment process prior to planting additional trees in the park. Some comments requested that Parks prioritize drainage improvements to the 40 Moran Way parcel and around areas of the lagoon with historic ponding.

3 Site Description

3.1 Location

The site is located in and around Moran Lake County Park in the unincorporated Live Oak area of the County, approximately 0.25-mile west of Soquel Point and directly northeast of the Pacific Ocean (Figure 1). The site is surrounded by residential neighborhoods to the west, north, east, and south, as well as Moran Lake Beach to the southwest (Figure 2). The site is depicted on the *Soquel, California* United States Geological Survey (USGS) 7.5-minute topographic quadrangle map and is located in Township 11 South, Range 1 West, Section 21.

The site is located within the Central Coast geographic subregion of California (Baldwin et al. 2012). The climate in this region is characterized by warm, dry summers and mild, wet winters. The average high temperature during summer months (June through September) is 75 degrees Fahrenheit (°F) and the average low temperature is 50 °F. The average high temperature during the winter months (December through March) is 62 °F and the average low temperature is 40 °F. Average annual precipitation is 29.3 inches, with the majority of rainfall occurring during November through March (Western Regional Climate Center 2022). Topography on-site is generally flat, with elevations ranging from approximately 10 to 50 feet above mean sea level.

The management area[3] for this MBHMP update includes the monarch butterfly overwintering habitat which is the eucalyptus groves within Moran Lake County Park and surrounding the Sanitation Facility, Moran Lake and Creek (the coastal lagoon and associated wetlands), the sandy beach around the lake, and the vegetation that comprises the windbreak at the site. It also includes a small rectangular parcel at 40 Moran Way, which previously contained additional eucalyptus grove habitat. A separate plan and project addressing the Moran Lake County Park amenities (trails, picnic tables, the restroom, etc.) and the culvert at East Cliff Drive will be prepared to address those features. Sensitive habitat on private properties immediately adjacent to the management area contributes important windbreak for the site. While the County cannot manage the private land, the designation of the parcels as sensitive habitat will function to conserve the habitat.

3.2 Soils

The U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS) Web Soil Survey identifies three soil map units within the management area: Watsonville loam, 0 to 2 percent slopes; Watsonville loam, thick surface, 0 to 2 percent slopes; and Watsonville loam, thick surface, 2 to 15 percent slopes. Watsonville loam soils are derived from alluvium and formed on marine terraces from 0 to 1,200 feet in elevation. The depth to the water table is more than 80 inches. The frequency of flooding and ponding is none. The available water supply is very low (about 2.9 inches), and the soils are somewhat poorly drained (USDA NRCS 2022a). Watsonville loam soils are included on the NRCS list of hydric soils (USDA NRCS 2022b). The soils in many areas of the site, particularly on the northern edge of the lagoon, and within the 40 Moran Way parcel, suffer from poor drainage and are prone to ponding. This has led to the failure of large eucalyptus trees due to windthrow.

[3] "Management area" and "Moran Lake site" will be used interchangeably throughout this report to refer to the outlined area depicted in Figure 2 and described in Section 3.1.

Figure 1 Regional Location



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Management Area

N

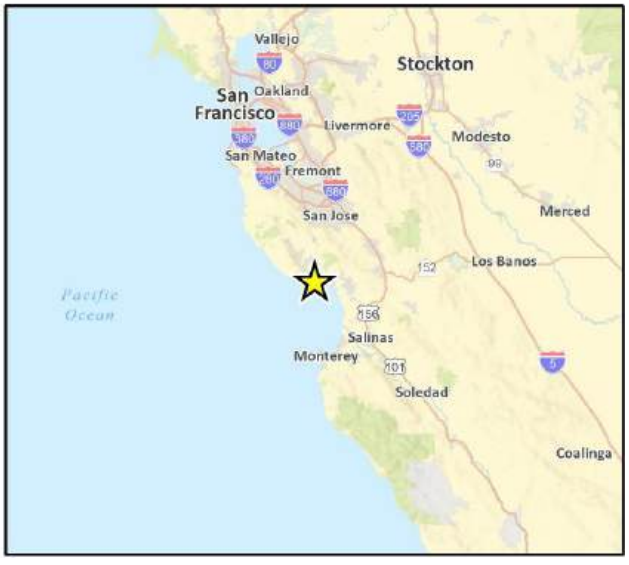
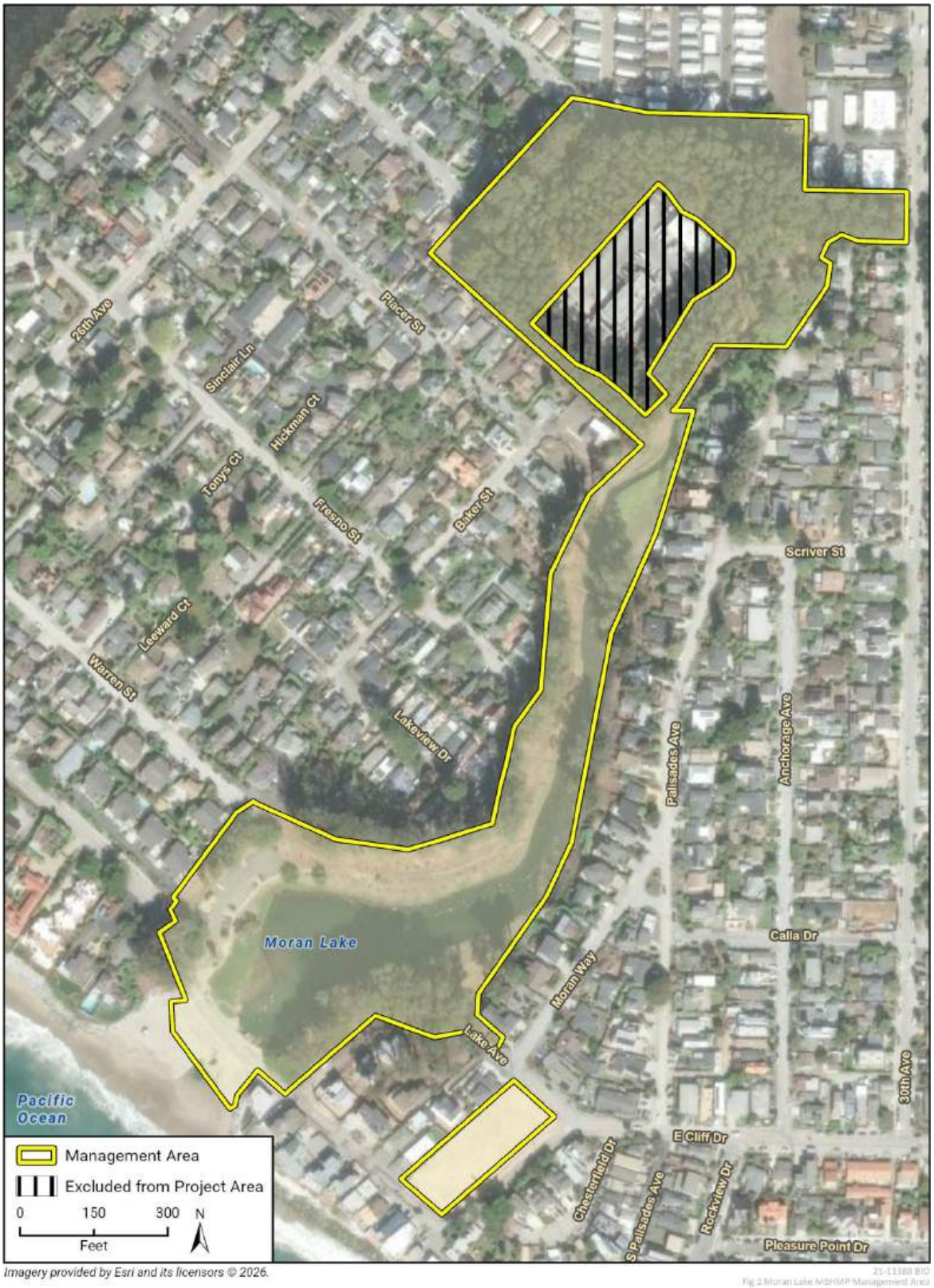


Figure 2 Monarch Habitat Management Area



3.3 Dominant Tree Community: Eucalyptus Grove

The eucalyptus groves in the management area currently most closely resemble the Eucalyptus spp. Woodland Semi-Natural Alliance (*Eucalyptus globulus* Association) described by Sawyer et al. (2009). Eucalyptus trees are dominant in this alliance and preclude most other plant species from growing in the understory. Eucalyptus groves were planted as windbreaks throughout California and have also been naturalized in many areas adjacent to streams and lakes.

Eucalyptus groves cover approximately 8.18 acres of the management area, with dense stands growing around the border of the D.A. Porath Sanitation Facility in the northern portion of the management area, along the western edge of the lagoon near the center of the management area, along the southeastern corner of the lagoon, and previously within the 40 Moran Way Parcel in the easternmost portion of the management area (Figure 2). The understory of the eucalyptus groves is generally scarce. Poison oak (*Toxicodendron diversilobum*) dominates the shrubby understory, forming low density and coverage thickets, and the herbaceous understory is generally absent, except for patches of English Ivy (*Hedera helix*). Although eucalyptus groves are non-native, they do comprise the important overwintering habitat for monarch butterflies on-site.

Rincon prepared the Moran Lake Arborist Report in 2022, which details the findings from the tree survey conducted by International Society of Arboriculture (ISA) certified arborist Casey Clark and Rincon Biologist Kate Ludwig on June 7 and June 8, 2022. During the survey, the location, species, diameter at breast height (DBH), height, canopy spread, general health condition, and any relevant notes (particularly pertaining to structural integrity) were recorded for each tree. A tree tag was also assigned to each tree surveyed. The 2022 Arborist Report is included in Appendix A.

3.4 Other Vegetation Communities

In addition to eucalyptus groves, the management area includes a coastal lagoon (Moran Lake) and its surrounding wetlands, which have been heavily modified by urban development and the introduction of non-native plant species. The 2005 Redevelopment Agency document discussed the trend/transition of vegetation on-site to dominant non-natives as “somewhat disturbing” when they compared the number of native shrubs and herbaceous plants then, to the 1980 Environmental Baseline Study for the Moran Lake Enhancement Plan. Upland native vegetation species identified in 1980 but not in 2004 include deerweed (*Lotus scoparius*), sky lupine (*Lupinus nanus*), bush lupine (*Lupinus arboreus*), coyote brush (*Baccharis pilularis*), California poppy (*Eschscholzia californica*), coast hedge nettle (*Stachys chamissonis*), seaside dandelion (*Agoseris apargioides*), loosestrife (*Lythrum hyssopifolia*), slough sedge (*Carex obnupta*), and bulrush (*Scirpus americanus*).

The following vegetation communities and land cover types exist within the management area: eucalyptus groves, pickleweed mats, disturbed riparian scrub, ice plant mats, sandy beach, annual grassland, ruderal, and developed. The Biological Resources Assessment Report prepared in 2022 provides a full discussion regarding vegetation communities and other biological resources and is included as part of Appendix A.

3.5 Current Management

A Memorandum of Understanding (MOU) for management of the monarch butterfly habitat surrounding the Sanitation Facility was approved between Parks and Sanitation in September 2025. Under the MOU, Parks is responsible for managing the habitat on Sanitation property in accordance

with the approved HMP. Previously, the monarch habitat on the two properties was managed independently, and general management activities within the two properties are described below. This new approach, whereby Parks manages the entire habitat, will lead to a more holistic and better coordinated management of monarch habitat.

3.5.1 County Parks Management

Regular vegetation maintenance is conducted at Moran Lake County Park, including annual high weed mowing along the east and west bank walkways, trimming of eucalyptus tree limbs upon County Parks' consulting arborist's recommendation (not more than one third of the new growth), and removal of small saplings that sprout from trunks of previously failed or removed eucalyptus trees. Parks' certified arborist conducts hazard tree assessments and identifies trees to be pruned or removed for the safety of the public and infrastructure. Potential removals are reviewed by a biologist/monarch butterfly specialist. Drainage features are maintained along the edges of Moran Lake to reduce the amount and duration of ponding water at the base of eucalyptus trees. Tree saplings are planted on an as-needed basis to fill in gaps in the windbreak and improve monarch habitat.

3.5.2 Sanitation District Management

Ongoing maintenance activities within the eucalyptus grove surrounding the D.A. Porath Sanitation Facility have been conducted to reduce the risk of falling limbs or trees, fire, and unauthorized encampment activities at the Sanitation Facility and adjacent properties. Regular maintenance consists of brush clearing, vegetation removal, and debris removal in the undergrowth of the grove. Vegetation management is carefully conducted to preserve nectar sources for monarchs. In addition, tree trimming is conducted on an as-needed basis to reduce the risk of tree failure into the Sanitation Facility, towards adjacent homes and trails. An ISA-certified arborist and Biologist/monarch butterfly specialist provided guidance and recommendations for all tree trimming and vegetation removal activities. Tree planting is conducted on an as-needed basis to fill in gaps in the canopy and improve monarch habitat within the grove, and saplings are irrigated and maintained to ensure survival. Saplings are flagged so they are not negatively impacted by vegetation clearing activities. Drainage features including ditches and storm drain pipes, are regularly maintained to prevent flooding and erosion within the grove.

3.5.3 Sensitive Habitat on Privately Owned Property

The hillsides, vegetation (including trees) and structures on private property immediately adjacent to the management area, provide critical windbreak to the habitat. Figure 3 displays the location of the sensitive habitat on private land. The County Board of Supervisors required that the sensitive habitat be designated and mapped through an amendment at the 2011 adoption of the 2010 Plan. These areas should be managed consistent with the actions described for the wind shelter and in coordination with the butterfly specialist.

3.6 Overwintering Habitat Zones

This plan update implements the USFWS Western Monarch Butterfly Conservation Recommendations (February 2023) to manage coastal California overwintering habitat as three zones.. The zones are the core zone (cluster area), shelter zone (wind protection and outer site

boundaries surrounding core zone) and support zone (area within 500 feet of an overwintering site that provides nectar, hydration, and microclimate protection). and are shown on Figure 4

Figure 3 Moran Lake Sensitive Habitat on Private Land



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Figure 4 Moran Lake Monarch Buttterfly Overwintering Habitat Zones



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3.7 Climate Change

Climate change and sea level rise is impacting all coastal communities around the world. In the past century, average global temperatures have increased by about 1.4 °F, and average global sea level has increased by 17 to 21 centimeters (7 to 8 inches) (Intergovernmental Panel on Climate Change 2013). Western monarchs are particularly vulnerable to climate change, due to their reliance on coastal overwintering habitat and their dependence on environmental cues to trigger reproduction, migration, and hibernation (Advani 2015). Increased temperatures, wildfires, and drought conditions are impacting eucalyptus grove habitat along the California coast, resulting in degraded or destroyed monarch overwintering habitat in multiple locations (Xerces Society 2020). Drought has impacted the health of the eucalyptus trees surrounding Moran Lake in recent decades, and climate change will likely continue to exacerbate both drought conditions and intense, episodic storm events. This plan serves to guide the management actions of the habitat to accommodate current and future climate change impacts, for example by adjusting the approach for tree replacement planting from requiring tree replacements at a 2:1 ratio to requiring replanting that supports the functional need of the habitat.

Coastal Santa Cruz County is already experiencing the impacts of climate change, and coastal lagoons in the county, including Moran Lake, are predicted to become more vulnerable to tidal inundation and coastal flooding in the coming years (Central Coast Wetlands Group 2017). Sea-level rise could alter salinity in Moran Lake and potentially impact the eucalyptus grove habitat surrounding Moran Lake. These impacts are most likely to occur during large swell and/or high-tide events, when the ocean inundates the lagoon and surrounding area and could affect eucalyptus trees directly and/or increase the soil salinity in and around the groves. For example, if winter storms cause the ocean to overtop and spill into Moran Lake with relative regularity, higher salinity inputs may negatively affect vegetation that cannot survive in higher saline environments. Around Moran Lake, if the water level rises, the salinity and saturated soils will rise with it and could cause trees and other vegetation to die off and retreat from the water line. Management recommendations provided in Section 5 below will aid in protecting and enhancing monarch overwintering habitat in the face of changing climatic conditions.

The Climate Action and Adaptation Plan (CAAP) developed by the County in December 2022 includes a number of strategies and objectives for responding to climate change. One of the strategies outlined in the CAAP is to increase the urban tree canopy (County 2022). The recommendations outlined in this MBHMP (e.g., improving the health of existing eucalyptus trees and planting new trees within eucalyptus groves at the Moran Lake site) will directly align with the objectives laid out in the CAAP for increasing the urban tree canopy in the county.

4 Monarch Overwintering Information

4.1 History of Counts

Xerces notes on their website that the past 25 years of data demonstrate that overwintering western monarchs have undergone a greater than 90 percent decline since the 1980s. Western monarch butterfly population numbers have generally seen a downward trajectory, since the inception of the Western Monarch Count in 1997, and counts have fluctuated widely over the years throughout California. The Moran Lake overwintering population is typically the third largest in Santa Cruz County, behind the Natural Bridges State Beach and Lighthouse Field sites.

The Moran Lake Overwintering Site boundary defined by the Xerces Society is roughly the same as the management area depicted in Figure 2, except for the inclusion of a small portion of the residential neighborhood around the lake. Monarch butterflies are present in the Moran Lake overwintering habitat from October through February in most years, and small numbers of monarchs have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as full-term overwintering habitat.

The current and historic estimated overwintering population numbers for the Moran Lake site were obtained through the Western Monarch Count (Xerces Society 2022). The Western Monarch Count is a citizen scientist-powered organization that is sponsored by the Xerces Society. The Western Monarch Count conducts annual population counts at overwintering sites throughout California each Thanksgiving and at the start of each new year (Xerces Society 2022). These data are used by many agencies and conservation organizations to aid in conservation efforts and estimate population trends for the western monarch butterfly.

Table 2 below provides the estimated monarch count at the Moran Lake site, along with every other overwintering site in the county, since the inception of the Western Monarch Count in 1997. Additionally, Table 2 provides the total number of overwintering monarchs in the county and California since 1997, the percentage of overwintering monarchs at the Moran Lake site each year in comparison to the total population of overwintering monarchs in the county, the percentage of overwintering monarchs at the Moran Lake site each year in comparison to the total number of overwintering monarchs in California, the yearly average of overwintering monarchs at each overwintering site, the county, and California since 1997, and the 10 year average of overwintering monarchs at each overwintering site, the county, and California (Xerces Society 2022).

These numbers help to identify regional and statewide fluctuations, to understand if fluctuations in the Moran Lake overwintering counts are consistent with the regional and state-wide changes, and to determine how the regional and statewide importance of Moran Lake as an overwintering site has changed since 1997.

Table 2 Western Monarch Count Statistics for Santa Cruz County Since 1997

Count Year	Overwintering Sites in Santa Cruz County				Santa Cruz County Total	California Total	% in Comparison to Santa Cruz County	% in Comparison to California
	Moran Lake	Natural Bridges State Beach	Lighthouse Field	Seascape Golf Course, Aptos				
1997	70,000	120,000	70,000	--	260,000	1,235,490	27%	5.7%
1998	8,000	60,000	50,000	240	119,898	564,349	7%	1.4%
1999	4,500	15,000	9,500	280	31,958	267,574	14%	1.7%
2000	4,000	20,000	35,000	1,050	62,961	390,057	6%	1.0%
2001	1,500	3,000	--	1,400	6,123	209,570	24%	0.7%
2002	1,000	6,000	3,200	4	10,234	99,353	10%	1.0%
2003	6,000	5,700	11,000	--	22,704	254,378	26%	2.4%
2004	4,500	9,600	9,600	950	25,276	205,085	18%	2.2%
2005	3,400	3,900	14,000	--	22,045	218,679	15%	1.6%
2006	6,600	7,300	10,300	2,000	28,271	221,058	23%	3.0%
2007	2,200	2,700	5,700	48	10,675	86,437	21%	2.5%
2008	4,023	3,500	2,607	1,560	12,127	131,889	33%	3.1%
2009	2,276	1,300	4,000	23	7,674	58,468	30%	3.9%
2010	3,000	2,300	4,000	1,000	10,332	143,204	29%	2.1%
2011	4,500	3,000	18,100	--	25,600	222,525	18%	2.0%
2012	2,500	500	3,200	2,500	9,316	144,812	27%	1.7%
2013	790	4,600	4,500	0	11,497	211,275	7%	0.4%
2014	4,300	3,400	7,000	--	15,981	234,731	27%	1.8%
2015	5,800	8,000	12,000	1,800	29,870	292,888	19%	2.0%
2016	4,000	3,500	12,000	1,000	28,101	298,464	14%	1.3%
2017	5,400	9,000	12,000	100	29,918	192,624	18%	2.8%
2018	1,373	1,120	1,802	--	5,043	27,721	27%	5.0%
2019	400	1,997	3,402	0	6,057	29,436	7%	1.4%
2020	50	550	50	0	711	1,899	7%	2.6%
2021	1,100	2,100	410	700	5,418	247,237	20%	0.4%
2022	5,701	7,500	3,365	500	17,861	335,479	32%	1.7%
2023	7,050	6,500	10,000	252	25,967	233,394	27%	11%
Average Count Since 1997	6,073	11,558	11,731	571	31,171	242,892	21%	2.1%
10-Year Average	2,856	3,842	5,430	733	14,525	183,324	20%	1.6%

It is important to note that the number of sites monitored fluctuates any given year. Over the past 7 years, more than 200 sites were monitored, whereas in years prior less than 200 sites were monitored.

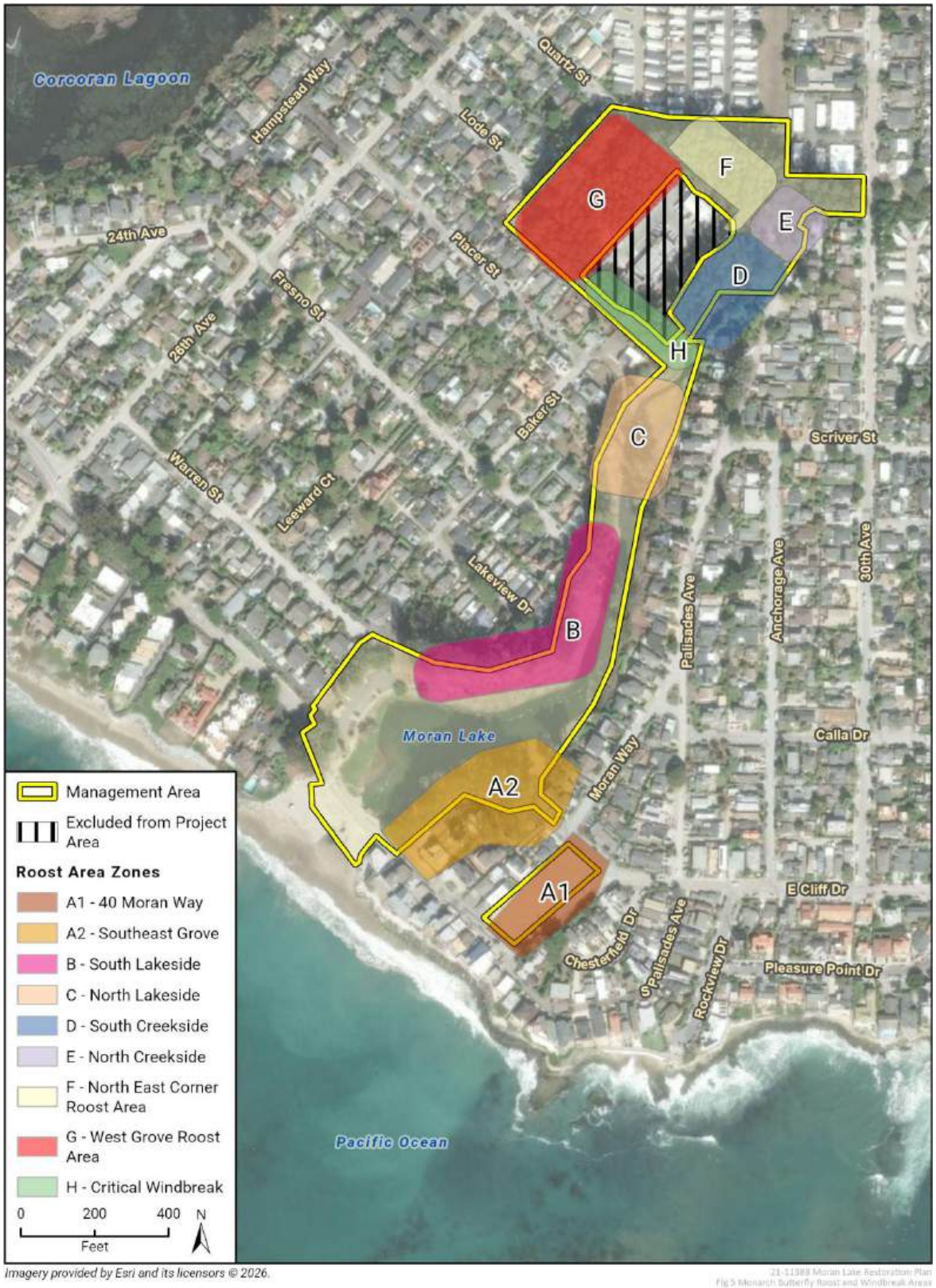
4.2 Monarch Activity History

The 2010 MBHMP provides a summary of historical patterns of monarchs at Moran Lake. See Figure 5 for a map of roost areas and windbreak areas, and that was adapted and updated from the 2010 MBHMP. Names of roost areas and windbreak areas used throughout this document are shown on this map. The text below was taken from the 2010 MBHMP:

> "Monarch butterflies are present in the Moran Lake wintering habitat from October through February in most years, and small numbers have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as a full-term overwintering habitat.
>
> In the past (1980s), monarchs typically began to congregate along the northwestern shore of Moran Lake during early October, and formed clusters in the North and South Lakeside roost areas. As the population increased during October, clusters also formed in the North and South Creekside roost areas and the lakeside butterflies gradually shifted north into the more sheltered Creekside roost areas (Figure 5). Then around mid-November the population shifted its clusters into the Primary Roosting area where they remained until warming temperatures initiated the spring migration sometime in February.
>
> The North Lakeside roost area usually supported clusters of roosting monarchs throughout the month of October, whereas the South Lakeside roost area typically supported clusters only intermittently during the fall. Thus the North Lakeside roost area historically functioned as an autumnal roost area and the South Lakeside roost area functioned as refuge/bivouac habitat. Tree and limb loss in these habitats has since reduced wind protection and eliminated many of the lower roost limbs that once supported clusters. Currently both roost areas function as refuge/bivouac habitats.
>
> Tree and limb losses in the North Creekside roost area have degraded this habitat over the past ten years resulting in less frequent occupation of the North Creekside roost area and a gradual shift of occupation to the South Creekside roost area. In March/April of 1999, residents on the property adjacent to the South Creekside roost area removed all the eucalyptus trees on their property along the east side of the creek and in that process eliminated all of the eastern windbreak/shade trees that sheltered the South Creekside roost area. During the winter preceding the tree removal (1998-99) the entire wintering population at Moran Lake (approximately 18,000 monarchs) occupied the South Creekside roost area from early October through most of November. During the winter of 1999-2000, no clusters were observed in the South Creekside roost area. Both North and South Creekside roost areas now function only intermittently as refuge/bivouac habitat.
>
> The Primary Roosting area, despite several significant tree removal events, has consistently supported mid-winter monarch populations for at least the past twenty years. With the loss of suitable autumnal habitat in the Lakeside and Creekside roost areas, the Primary Roosting area has now begun to function additionally as autumnal roost habitat. The Primary Roosting area is the only consistently occupied roost area remaining in the Moran Lake monarch wintering habitat.
>
> The grove of eucalyptus at the southeastern end of Moran Lake—the Southeastern Grove, which includes the Moran Way Windrow—in addition to providing critical wind protection for

the lake area, functions intermittently as refuge/bivouac habitat and occasionally supports small clusters during periods when monarchs are migrating and winds are relatively calm."

Figure 5 Monarch Butterfly Roost and Windbreak Areas

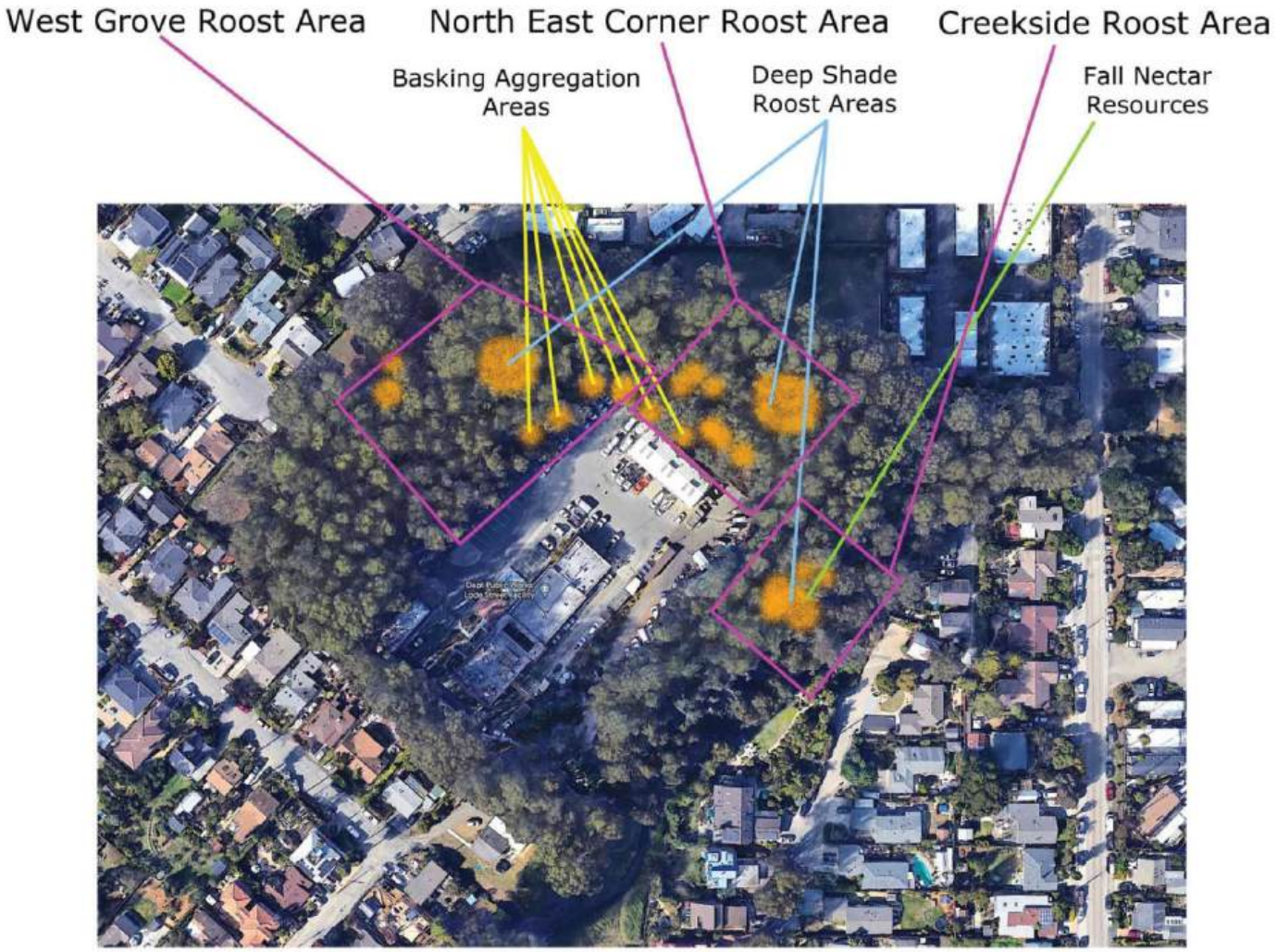


4.3 Roosting and Basking Sites

The entire management area and adjacent sensitive habitat provide the overwintering habitat for the monarch butterflies, which has been broken into distinct roost and windbreak areas for ease of discussion (Figure 5). The southeast eucalyptus grove provides a wind protected zone close to the coast which may help draw migrating monarchs to the area. The areas around the southeastern grove function intermittently as refuge/bivouac habitat and occasionally support small clusters during periods when monarchs are migrating and when winds are relatively calm (J. Dayton, personal communication, December 2023). The eucalyptus trees and structures on either side of the lake provide windbreak to the site. The eucalyptus trees provide upper canopy windbreak, and the higher topography along the southeastern side of the lake provides low and mid-level wind break. Figure 6 shows an overview of the core zone/roosting sites.

North of Moran Lake, the main eucalyptus grove surrounds the Santa Cruz Sanitation District's D.A. Porath Facility and comprises the primary roosting areas. Within the main grove, there are three distinct roost areas where the monarchs cluster and overwinter during the coldest and most inclement weather of the year and are shown in Figure 6: the creek side roost area (CSRA), the northeast corner roost area (NECRA), and the west groove roost area (WGRA) (J. Dayton, personal communication, December 2024). CSRA serves as an autumnal roost area, and NECRA and WGRA serve as the two winter roost areas, where the most protection is provided. Each roost area includes both trees that support clusters and that are typically located in the interior of the groves with the most wind protection, and trees that support basking aggregations and that are typically located on the edges of the grove where more sunlight is available. Monarchs bask in the sun to get warm and to reach the temperature at which they are able to fly. The basking areas are located toward the inner edge of the roost area adjacent to the Sanitation District facility, where more sunlight is available. (Note that basking aggregations may become clusters during appropriate weather conditions.) The interior roost (cluster) trees at NECRA and WGRA are not necessarily both used each year; typically, interior clusters form only in one of the two areas each year (J. Dayton, personal communication, December 2023). For example, the interior roost trees at the WGRA were not used in the 2021–22 wintering period, whereas the WGRA basking aggregation trees were used, even though most of the population remained clustered at NECRA, mostly above the road, but also including some clusters in the interior area (J. Dayton, personal communication, December 2023).

Figure 6 Moran Lake Monarch Buttterfly Roosting Site/Core Zone



Source: John Dayton, 12/2023.

4.4 Current Habitat Condition

An ideal overwintering site should have trees in good condition that are evenly spaced out and have healthy foliage and good vigor. An ideal overwintering site will also have saplings in the understory to replace trees as they die and a continuous, well-stratified canopy at the outer edges to offer wind protection. However, the canopy will not be so dense to prevent the entry of the necessary amount of direct and dappled insolating light. Insolation is primarily a factor on the southerly exposures.

Tree health was assessed and reported in the 2022 Arborist Report. This plan addresses the trees, habitat, management area, and the grove as a whole. When discussing the condition of the habitat, individual tree health is always considered, but equally and possibly more important is the management of the trees collectively. The creek's wet soils, ponds and puddles provide the water for the monarchs to drink. The late fall and winter blooming eucalyptus tree flowers provide critical nectar for the monarchs to consume while they overwinter.

In 2024, Weiss (2022) provided a habitat assessment using hemispherical photography, LiDAR, and wind measurements to understand canopy structure and resultant microclimates within the grove. Key conclusions regarding canopy structure and monarch use from that study include:

The primary cluster zone within the grove north of the sanitation yard (North East Corner Roost Zone in Figure 5) has good insolation exposure through the south edge facing the open yard but also has good wind shelter from the trees across the yard along Placer Street.

The main vulnerability of the primary cluster zone is wind exposure from the "Boneyard" to the north. The open trail/road into the grove from this edge allows northerly winds to penetrate into the cluster zone. When strong northerly winds occur, monarchs tend to leave this zone and move to Creekside. The assessment recommended planting a row of cypress in the Boneyard to block this gap into the primary cluster zone.

At Creekside, there is high morning insolation exposure, but also high wind exposure to the east and southeast. Monarchs will cluster in this zone early in the season before storms occur, and during calm sunny periods, but will move to the primary cluster zone when winds become too strong.

In 2025, an additional study (Weiss and Matley 2025) was conducted to answer specific questions about the effects of grove modifications on wind exposure within the primary cluster zone. This study used LiDAR and wind modeling with Eddy 3D to simulate wind patterns within the complex grove. Several scenarios regarding tree height reductions and tree removals were explored. Estimating the height of the Placer Street trees necessary for maintaining wind shelter from southwest winds at the primary cluster zone was a major goal. But other tree removal and height reduction scenarios were also explored.

Selected results of the 2025 wind study are interspersed in this document at the appropriate spots. (especially Critical Windbreak along Placer Street – Area H below).

Both full reports are attached as Appendix D.

4.4.1 Roosting and Basking Habitat (Sanitation District and County-Owned Land)

The north, northeastern, and northwestern portion of the main eucalyptus grove on Sanitation Facility property that is home to the Northeast Corner Roost Area (NECRA), the Creekside Roost Area (CSRA), and the West Grove Roost Area (WGRA) is well-established with spaced-out trees that are generally in good health. Young saplings are distributed naturally throughout. Blue gums to the south and western sides of the grove are generally in fair health. The nature of blue gums includes shedding bark and branch and limb loss, and it is not unusual for the species to be rated with fair to poor health.

One area near the southern corner of the Sanitation Facility immediately south of the small pump station in the Critical Windbreak Area H is missing a tree canopy wind break. This gap in canopy creates the opportunity for wind and cold temperatures to blow into the roosting and basking areas and should be filled. Additionally, there are gaps in the Critical Windbreak Area H along Placer Street that should be planted with replacement trees. The narrowness of this area presents a particular challenge because there is limited space to plant windbreak trees.

Grove specific measurements, including, but not limited to, an assessment of wind measurements, light exposure, and canopy height and structure derived from hemispherical photographs and LiDAR are provided in Appendix A. These measurements represent why the main cluster site is suitable for overwintering monarchs.

Currently, the Creekside Roost Area (CSRA) is one of the areas most in need of repair and to enhance with mitigation planting. Recent tree failures and removals have exposed this area to disturbance by east-southeast winds and excessive sun exposure. Approximately 1,000 monarchs roosted in this area during much of November 2021 (J. Dayton, Personal Communication, December 2023).

4.4.2 North and South Lakeside Habitat (County-Owned Land)

As mentioned, the eucalyptus trees, hillside, vegetation, and structures along the southeastern and eastern side of the lake provide an important wind break to the management area, as do the trees, vegetation and structures on the western side of the lake.

Eucalyptus trees have died or have been removed in the past in the North and South Lakeside areas, without replacement, which has led to reduced wind protection and stands that are comprised of mostly mature trees with minimal mid-level wind protection and high canopies that are exposed to windthrow. Eucalyptus along the North and South Lakeside areas have experienced die back likely related to ponded water and saturated soils in low areas along the trail and at the base of the trees. This area is in need of drainage improvements and replacement plantings to enhance the windbreak and ensure long-term survival of the trees.

A portion of the North Lakeside habitat on the east side of the creek, where eucalyptus trees are absent, is comprised of a low-lying riparian meadow where a bed of grasses and other herbaceous species are present and offers the potential for nectar planting.

4.4.3 Southeast Grove and 40 Moran Way Habitat (County- and Privately Owned Land)

The Southeast Grove is located on the southeast side of the County-owned Moran Lake property, and on private parcels along Moran Way and the recently built Ryan's Way. As development of the private property in this area has progressed over the years, this area has lost many of its trees. The remaining portion of the grove still functions in providing wind protection—though substantially diminished—for the surrounding habitat. However, it only very rarely provides wind protected roost habitat for Fall migrants; it is currently too open to wind and sun to support roosting monarchs in the Fall (J. Dayton, Personal Communication, December 2023).

More recently, during development of this HMP update, the February 2024 high-wind event resulted in the failure of 20 eucalyptus trees on the 40 Moran Way parcel, which further degraded the ability of this area to function as a windbreak. This widespread failure of trees on the 40 Moran Way parcel left the remaining trees more exposed to winds and therefore more vulnerable to windthrow. In response, the County's ISA-certified consulting arborist recommended that the remaining eucalyptus trees on the parcel be removed to reduce the risk of additional failures. The County's consulting arborist and monarch butterfly specialist determined that the 40 Moran Way property no longer functioned as a viable windbreak and approved the removals. The trees were removed in Summer of 2025. The property was re-graded in Fall 2025 to improve drainage in preparation for future re-planting of the parcel with native trees and shrubs. Planting is currently scheduled for Fall 2026.

4.5 Nectar Sources

Monarchs are less likely to use nectar plants in deep shade, so the forest understory near the main clustering sites are poor places for nectar plants. The most important nectar plants are those that bloom in the fall (October through November), because they help retain monarchs at the site, which in turn attracts more butterflies that are passing by.

The main sources of nectar plants for monarchs at Moran Lake are the blue gum eucalyptus flowers. Nectar for early to mid-fall is from introduced plants. The most common introduced nectar plants on-site, along with their bloom periods, are listed in order of abundance in Table 3 below. English ivy (*Hedera helix*) and Cape ivy (*Delairea odorata*) are found growing throughout the understory of the eucalyptus groves, and some have climbed up the trunks of trees where they function as important nectar sources for the monarchs. Ivy on the ground has limited utility as a monarch nectar source due to heavy shade. Ice plant (*Carpobrotus edulis*) and pride-of-Madeira (*Echium candicans*) are found growing adjacent to the parking lot and the Park's hiking trail.

Bermuda sorrel is present on the site, but is rarely used by monarchs when other, preferable nectar sources are present. Wild radish and jointed charlock are present near the Moran Lake Park parking area—and are often used as nectar sources by monarchs at other sites—but are too far from the roost areas for practical use at Moran Lake (J. Dayton, personal communication, December 2023).

Table 3 Fall and Winter Monarch Nectar Plants in the Management Area

Species	Bloom Period
Blue gum eucalyptus (*Eucalyptus globulus*)	December through March
English ivy (*Hedera helix*)	October through November

Cape ivy (*Delairea odorata*)	Variable bloom period depends on sun/shade availability, usually December-January
Ice plant (*Carpobrotus edulis*)	Typically October-March
Pride-of-Madeira (*Echium candicans*)	Late February-March

The existing Cape ivy, English ivy, ice plant, and pride-of-Madeira within the management area provide an important and abundant supply of nectar for fall returning and overwintering monarchs, which is currently not supplied in the management area, or its vicinity, by native plants (See Table 3). Due to its importance as a nectar supply, Ivy requires careful management, rather than wholesale removal. Both species of Ivy only bloom when they receive sufficient sun exposure. English Ivy only blooms when it has climbed up a structure (tree).

4.6 Hazardous Trees

The eucalyptus trees provide the overwintering habitat, but all trees have risk or liability. An ISA certified arborist with the ISA's Tree Risk Assessment Qualification assessed the trees in the management area for risk in 2022, using the diagnostic techniques developed by ISA. A tree risk assessment is conducted to identify and manage the risk of trees for safety. The results of the assessment are included in the Arborist Report. Risks are evaluated based on a number of elements, including structural deficiencies and visible presence of disease or rot, etc. The locations of all potentially hazardous trees, as well as specific notes regarding each potentially hazardous tree and their removal or hazard pruning recommendation as of 2022, are provided in the appendix of the Existing Conditions Report which is Appendix A of this Habitat Management Plan.

County Parks' consulting arborist has been implementing routine risk assessments of all trees on County Parks and Sanitation District property since Fall 2025 to comply with recommendations of this Plan. The Tree Risk Assessment from January 2026 supersedes the 2022 Risk Assessment, and is included in Appendix H. The document includes identification of potential risk categories, identifies specific trees of concern, and provides recommendations to mitigate risks.

4.7 Fire Risk Assessment

Managing the habitat and fire risk should be done in coordination with the fire department and the monarch butterfly specialist or entomologist. Research conducted in California show that species that produce oily resins, such as blue gum, are far more ignitable than those that do not. On a scale of 1 to 10 for ignition potential, with 1 representing species most easy to ignite and 10 most difficult, blue gum scored 1 to 2 (very high ignition potential). For comparison, oak/bay woodland received a score of 6 to 8, redwood 8, scrub vegetation 4 to 8, and annual grassland vegetation 1 to 3 (LSA Associates 2009).

Ladder fuels are one of the most important considerations for the spread of fire. The monarch habitat contains very little ladder fuel, and the understory is generally sparse and contains poison oak, Cape ivy, and English ivy, when present. These are evergreen species and are generally nonflammable. Due to the lack of ladder fuels within the management area (as a result of ongoing site management by the Sanitation District), the urban/developed surroundings, and the persistent summer coastal fog, the risk of a severe crown fire spreading into or originating within the site is relatively low.

4.8 Monarch Predators

While the monarch's distinctive colors are known to display to others that they are distasteful and toxic, predators affect monarchs as eggs, caterpillars, and adults. Predators include ants, spiders, and wasps, as well as birds and rats. Predators at the Moran Lake site are not well documented or understood. However, it is likely that they are present and impact the overwintering adult population to some degree. When winds blow the monarchs onto the ground, overnight or during cool temperatures, their bodies are not warm enough to fly and predation increases. Understory brush and vegetation located beneath aggregation and transitory sites can be instrumental in limiting predation by catching the monarchs prior to landing on the ground and providing structure for them to climb off the ground.

5 Management Plan Actions

The management actions recommended here focus on the preservation of the overwintering habitat, trees, and features that create them. The continued recommendations are to maintain the grove's spatial configuration and size and preserve and/or enhance windbreak trees, appropriate nectar and water sources and understory vegetation within the management area. A general recommended timeline to implement each action is provided in the tables at the end of each section. In the tables, Year 1 means the action is recommended for action now; Ongoing means now and each year after unless otherwise stated in the section, and As-Needed means that actions will be taken if identified as necessary by County staff or consultants following the guidelines established in this plan.

5.1 Monarch Surveys

Assessing overwintering monarchs' use of the management area will be crucial to assessing the effectiveness of this site management plan and to adapting habitat restoration and enhancement techniques. Volunteers and biologists monitor the overwintering clusters at Moran Lake, as well as other local overwintering sites and collect important data as part of the Xerces Western Monarch Thanksgiving Count and New Year's Count.

Additional monitoring (ideally twice monthly from October through March) for a minimum of 1 year after major management actions would provide the information needed to track how monarchs respond to changes in grove conditions. Recording monarch clusters' size and location over the course of the overwintering season will help refine the current understanding of monarchs' use of the site and can directly inform management actions in future years.

An approach for conducting surveys is to train and use the County's maintenance staff, who are on-site regularly, to conduct the twice-monthly surveys. Staff would need to be trained to:

- Know where historic roosting and basking sites are located
- Know how to conduct counts by attending the virtual trainings for the Western Monarch Count at the Xerces' Help Count Monarchs website
- Coordinate with the Xerces Regional Coordinator once annually, in the early part of the overwintering season, to calibrate counting with Xerces
- Record information for each count in a consistent way and post the results so that the public can access the information

Action	Year 1	Ongoing	As-Needed
Monarch Surveys and Monitoring		X	

5.2 Monarch Habitat Monitoring

Annual monitoring of the grove's suitability for monarchs will be conducted to identify potential grove issues as soon as possible. Any additional threats or conservation issues (e.g., new tree fall, pest infestations) will be added to the management records and incorporated into the management

plan. This will help managers plan future management actions (at both short-and long-term time scales) and obtain funding as needed.

County Parks' monarch specialists and ISA-certified arborists will continue to assess the management area at least once a year to identify any potential issues and develop strategies for planting or replanting of trees that comprise the habitat.

The management area will be monitored for a change in predators, such as increased rat dens and observations of Steller's jays. If predators increase the County will consult with the monarch specialist regarding changes that can be made. The management area will continue to be kept clear of trash and food.

Tools that can be used as the standard protocols and data sheets for assessing grove health (Habitat Assessments) are available at www.westernmonarchcount.org and are included in Appendix D.

Action	Year 1	Ongoing	As-Needed
Monarch Habitat Monitoring		X	

5.3 Habitat/Forest Management

Habitat and Forest Management will be planned and implemented to achieve the following goals:

- Prioritization of public safety
- Protection and improvement of monarch habitat
- Restoration of native species and habitat for biodiversity

The most important forest management action is to regularly assess trees for risk of failure and to mitigate that risk through trimming or removals. Tree failure poses a hazard to the public and to monarch habitat. Hazardous trees will be addressed as quickly as possible by trimming or removing the trees to alleviate risk to the public and the roosting and basking sites. Trimming or removal recommendations will be made by a certified arborist. Hazardous trees and proactive risk assessment are addressed in more detail in Section 5.3.2.

The monarch overwintering season at Moran Lake is loosely defined as October through March.

- No tree work will occur within the **core habitat zone** (Figure 4) between October 1 through March 31 unless a true emergency arises.
- Outside of the core habitat zone and within the **shelter habitat zone** (Figure 4), no tree work will occur between October 15 through March 15 unless a true emergency arises.

If a hazardous tree must be removed during either of these times, then a certified arborist and qualified monarch butterfly specialist will be retained by the County to monitor and provide input regarding the tree maintenance activities prior to and during the removal.

Management of the overwintering habitat will be approached as a forest versus single trees and in compliance with Section 2.1.3. above. The forest is comprised of thousands of trees; it is dynamic and changes continually due to a number of factors, including weather and storm events. As discussed in Section 4.3, the spacing and composition of the tree canopy is what creates the overwintering habitat and wind protection for the monarchs. Because of this, replacing trees that have been removed or succumb to die-off with another single tree or trees may or may not be advisable. Whether to plant replacement trees will be determined in collaboration with a certified

arborist and the County's monarch specialist. This will be done in alignment with the three goals noted above. To protect and improve monarch habitat, tree planting is recommended in certain areas to add or replace canopy that was previously lost or is absent in the eucalyptus groves and windbreaks. See section 5.3.1 for more information on tree planting and management.

Nectaring plants will be planted to boost overwintering population numbers; see section 5.3.4 for more information on nectaring plants.

Drainage improvements were installed by County Parks staff in Fall 2024 at the northern edge of the southeastern windrow, at the 40 Moran Way parcel, and in other problematic areas around the margins of the lagoon in the North and South Lakeside areas to reduce ponding water and saturated soils at the tree bases. These areas should continue to be maintained to reduce ponding water. See section 5.3.5 for more information on drainage.

Tortoise beetles and eucalyptus long-horned beetles are two major pests that can damage or kill blue gum eucalyptus trees. While an effective control for these pests has not yet been developed, the County should proactively remove dead wood from the eucalyptus groves, since the presence of dead wood has been shown to increase infestations. The County Parks staff should be informed about how to identify these and other local pests and the damage they can cause. County Parks staff should report observations of infestations observed to their supervisor and the information should be shared with the County-approved arborist immediately.

The recommendations in subsections below for timing of implementation of management actions have been developed in collaboration with County Parks staff, the County's ISA-certified arborists, and the County's monarch butterfly specialists after viewing the management area conditions and dynamics as a group during development of the HMP. Figure 7 shows the general approach for planting replacement trees and nectaring plants, and locations where drainage management is needed.

A summary of all recommended habitat/forest management actions and their required protective measures are outlined in Table 6 at the end of this section. The protective measures outlined in Table 6 will be required for all management actions in order to avoid and minimize impacts to the maximum extent feasible.

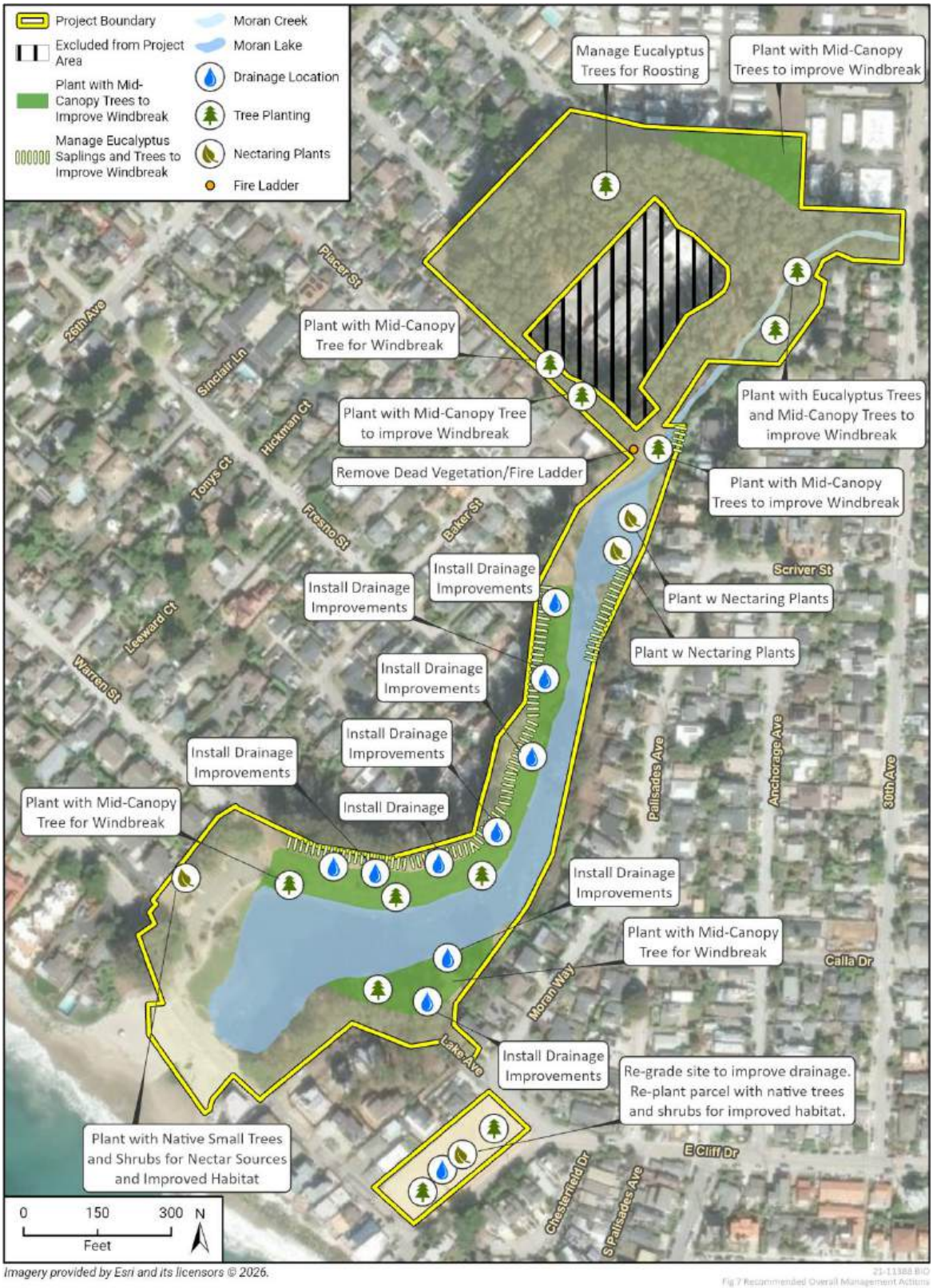
Overwintering Habitat on Private Property

Trees and vegetation on private property adjacent to the management area, shown in Figure 3, will be designated by the County as Sensitive Habitat. This will serve to clarify where Sensitive Habitat restrictions are to be applied for adjacent development. This clarification was required by the County Board of Supervisors by amendment at the 2011 adoption of the 2010 Plan.

Action	Year 1	Ongoing	As-needed
Habitat & Forest Management*		X	

*General habitat & Forest Management will be conducted every year. Refer to subsequent sections for specific actions and frequencies.

Figure 7 Recommended Overall Management Actions



5.3.1 Tree Planting and Management

Recommendations for tree planting were developed by Creekside Science's Dr. Stu Weiss in collaboration with County staff and the County's consulting team of certified arborists and biologists. Past reports with recommendations from the County's arborist and monarch specialist also address issues discussed in this section and applicable recommendations from past documents are included in this section for continuity. Appendix D provides past studies and reports for the management area. Tree planting location recommendations are shown in Figure 7, and recommended tree species to be planted in each habitat area (Areas A-H, as defined in Figure 5) are shown in Table 4, and discussed in greater detail below. Some of the recommendations are based on addressing existing deficiencies and are expected to improve monarch habitat over time. Other recommendations are to address replacements for potential failures or removals that could occur in the future.

When existing trees or branches fail, or become hazardous and need to be removed, their removal can negatively impact the monarch habitat. Failures and removals will be assessed by a certified arborist and the County's monarch specialist, and will include a recommendation for replacement, or a justification for why replacement is not recommended. The number, location, and species of the replacement tree(s) will be determined in collaboration with a certified arborist and the County's monarch specialist. The recommendations above will be based on achieving the three overarching goals of forest/habitat management described by this Plan:

- Prioritization of public safety
- Protection and improvement of monarch habitat
- Restoration of native species and habitat for biodiversity

Determining what tree species **not** to plant is as important as outlining recommended species. Section 7 of this plan contains a table documenting the species, location, and observations for tree species which have been planted at Moran Lake and which have failed (Table 7). The County should systematically track this information so that it can be used to inform future tree planting efforts.

Table 4 Tree Species to Plant in Specific Habitat Areas on Figure 5

Zones D, E, F, & G – Main Eucalyptus Groves & Roosting and Basking Areas		
Species	**Canopy Replacement**	**Notes**
Blue gum eucalyptus (*Eucalyptus globulus*)	Upper, highest canopy in habitat area	Compatible with existing BGE in groves. Important nectar source for Monarchs. Plant w/in 50' of roosting or basking areas and where canopy higher than 50' is needed
Red ironbark (*Eucalyptus sideroxylon*)	Mid to upper canopy, typically not as high as blue gum	Use to replace BGE where canopy up to 50' is needed. Plant away from public paths and structures.
Monterey Cypress *(Hesperocyparis macrocarpa)*	Mid-canopy, varies based on age and location	Plant along north and east edges of main grove as windbreak. Regional native. Good salinity, coastal, and wind tolerance.
Coast Redwood *(Sequoia sempervirens)*	Upper, highest canopy in habitat area	Plant only along east side of Creek. Regional native. Riparian adapted.
Zone H – Critical Windbreak (along Placer Way)		
Species	**Canopy Replacement**	**Notes**

Monterey Pine (*Pinus radiata*)	Mid to upper canopy	Plant to fill in mid to upper canopy gaps in the critical windbreak. California and regional native.
Canary Island Pine (Pinus canariensis)	Mid to upper canopy	Plant to fill in mid to upper canopy gaps in the critical windbreak
Blue gum eucalyptus (*Eucalyptus globulus*)	Upper, highest canopy in habitat area	Plant where highest canopy replacement is needed in the critical windbreak.
Zones A2, B & C – Southeast Grove and South and North Lakeside		
Species	**Canopy Replacement**	**Notes**
Red Alder *(Alnus rubra)*	Mid to upper canopy	Regional native. Good salinity tolerance, coastal and riparian adapted.
Monterey Cypress *(Hesperocyparis macrocarpa)*	Mid-canopy, varies based on age and location	Regional native. Good salinity, coastal, and wind tolerance.
Monterey Pine (*Pinus radiata*)	Mid to upper canopy	Plant to fill in mid to upper canopy gaps in the critical windbreak. California and regional native.
Torrey Pine *(Pinus torreyana)*	Lower to mid-canopy	California native. Good salinity and coastal tolerance, wind resistance.
Island Oak (*Quercus tomentella)*	Lower to mid-canopy	California native. Good salinity and coastal tolerance, wind resistance.
Coast Live Oak (*Quercus agrifolia*)	Lower to mid-canopy	Regional native. Good salinity and coastal tolerance, wind resistance.
Arroyo Willow *(Salix lasiolepis)*	Low canopy	Regional native. Good salinity and flooding tolerance. Riparian adapted. Winter nectar source.
Zone A1 - 40 Moran Way		
Species	**Canopy Replacement**	**Notes**
Monterey Cypress *(Hesperocyparis macrocarpa)*	Mid-canopy, varies based on age and location	Regional native. Good salinity, coastal, and wind tolerance.
Toyon *(Heteromeles arbutifolia)*	Lower canopy	Regional native. Good salinity, coastal, and wind tolerance. Good general habitat tree.
California buckeye *(Aesculus californica)*	Lower to mid-canopy	Regional native. Good salinity, coastal, and wind tolerance. Good general habitat tree.
Coast Live Oak (*Quercus agrifolia*)	Lower to mid-canopy	Regional native. Good salinity and coastal tolerance, wind resistance. Good habitat tree.
Arroyo Willow *(Salix lasiolepis)*	Low canopy	Regional native. Good salinity and flooding tolerance. Riparian adapted. Winter nectar source.
Blue Elderberry *(Sambucus mexicana)*	Low canopy	Regional native. Coastal tolerance. Good general habitat tree.

The following recommendations update the guidelines in the 2010 Plan on page 20 under New Tree Planting and Monitoring Guidelines.

Tree removals must be considered with the input of a certified arborist and the County's monarch specialist and if a replacement tree is recommended, it must be replaced by the next rainy season with a tree that will fulfill the functional needs of the overwintering habitat and the forest. The previous recommendation to replace every removed tree with a minimum of two trees is not viable

within the management area. The limiting factor is space; there is not enough space to double the number of trees on-site and maintain a healthy forest and functional overwintering habitat.

The **core habitat zone** (Figure 4) is where monarchs roost and bask during the overwintering season. This is the most sensitive part of the monarch habitat. The core habitat zone is expected to remain a mostly eucalyptus grove for the foreseeable future. Failures and removals of eucalyptus trees in the core habitat zone will be assessed by a certified arborist and the County's monarch specialist for replacement. If recommended, they will be replaced with Blue gum eucalyptus (*Eucalyptus globulus*) or Red ironbark eucalyptus *(Eucalyptus sideroxylon)* trees, or in limited cases, Monterey Cypress (*Hesperocyparis macrocarpa*) trees. The species selection will depend upon the canopy need. Blue gums will be used when the replacements are made in or within 50 feet of the roosting and basking areas and when canopy roughly 50-feet high or more is needed. Red ironbark will be used to replace blue gums when canopy roughly 25- to 50-feet high is needed. Blue gums provide consistency in canopy structure and red ironbark trees have been observed to be more drought resistant in the region. Planting red ironbark also serves to diversify the species of the grove. Red ironbark will be located away from public paths and structures due to their potential for limb failure. Monterey Cypress provides lower-level canopy and roosting locations within the larger eucalyptus grove. If, at some time in the future the trees become overcrowded, forest thinning may be considered to promote an increase in the health condition and vigor in the grove. Thinning will only be done with the input of the certified arborist and monarch butterfly specialist.

The **shelter habitat zone** surrounds the core habitat zone and serves to buffer the core habitat zone from adverse weather conditions. Failures and removals within the shelter habitat zone will be assessed by a certified arborist and the County's monarch specialist for replacement. If replacement(s) are recommended, potential species that will be considered for planting include Monterey Cypress (*Hesperocyparis macrocarpa*), Coast Live Oak (*Quercus agrifolia*), Island Oak (*Quercus tomentella*), Monterey Pine (*Pinus radiata*), Torrey Pine (*Pinus torreyana*), Canary Island Pine (*Pinus canariensis*), Toyon (*Heteromeles arbutifolia*), Red Alder *(Alnus rubra)*, and Red Ironback *(Eucalyptus sideroxylon)*. Blue Gum Eucalyptus (*Eucalyptus globulus*) will only be planted in specific situations where high canopy is required and other replacement species have failed. Native trees are preferred and will be planted where feasible. Shorter stature trees and trees that can withstand wind and coastal pressure, will be planted along the southwestern boundary of the management area nearest the coast. Additional native and eucalyptus tree species are being considered and these recommendations may need to be modified over time. Replacing and maintaining the tree wind shelter around the core habitat zone is essential to the site's longevity. In areas where blue gums have experienced consistent failures, the County will explore planting different species and/or a more diverse palette of tree species that are less prone to failure, thereby reducing the risk of negative impacts to the habitat and public safety. As noted above, native tree species are preferred. The County's long-term goal outside of the core habitat zone is to plant enough native trees to eventually replace the blue gum eucalyptus with trees that are better suited to the site conditions, do not grow as tall, and that support native biodiversity.

Eucalyptus trees are generally not available for purchase in the nursery trade; therefore, the County will make arrangements as needed to grow the trees with an entity such as Cal Poly or UC Santa Cruz, which have the expertise and ability to grow them on a regular basis.

Planted trees will generally be in either a 5-gallon or 15-gallon (or a comparable container size used for native plants), largely due to the expense and difficulty of planting a larger tree in the forest, and the fact that native trees perform better when planted at a smaller size. The trees will be inspected

by a certified arborist to ensure they are in good health. The contract with the tree grower will specify that root bound trees will not be accepted.

The exact location, species, and number of replacement trees to be planted will be determined in collaboration with County staff, a certified arborist, and a monarch specialist prior to or immediately following (within 15 working days) of a tree removal. Replacement tree plantings will be:

- Staked with two lodge pole stakes per tree and secured with flexible ties
- Mulched with a 3-inch-deep layer of wood chips at a minimum radius of 3 feet from the trunk, contingent on their locations and surrounding growing conditions. Mulch material must also be set back at least 4 inches from the trunk.
- Irrigated or hand watered as-needed in order to grow at optimal rates, with either a ring of Netafim Irrigation Tubing placed over the root ball or with two emitters per tree for irrigation, or the use of tree watering bags or donuts to facilitate efficient hand watering.

Maintenance of the replacement trees is also critical to ensure tree survival and to optimize tree growth. Either the County Parks staff or a landscape contractor will:

- Conduct twice-monthly inspections to ensure that the irrigation system is functioning and that weed competition is eradicated around the new trees
- Replenish the wood chip mulch around the trees periodically
- Remove the tree support stakes 3 years after installation and ties must be adjusted annually as not to girdle the tree where it's tied to the stakes
- The irrigation system will be adjusted over time to correctly be placed over tree root zones and to adjust the volume of water required to ensure optimal tree growth.

If tree replacement plantings fail (die), they must be replaced with a tree that fulfills the need of the overwintering habitat. Tree failures should be investigated to determine cause of death and records kept of successful and unsuccessful trees species to improve long-term management of the habitat.

Replacing and maintaining the trees that create the wind shelter around the perimeter of the management area is also essential to the site's longevity.

Specific Area Recommendations for Management Areas (Refer to Figure 5 for location of Management areas)

Northeast Corner Roost Area – Area F

- Plant Monterey cypress to fill the gaps between eucalyptus rows at the outer northeast and northwest edges of the area, north of the Sanitation Facility. There is some concern about maintaining sightlines into the grove to detect occupancy by unauthorized occupants so close coordination with public safety agencies is important.
- Plant Monterey cypress in the Sanitation District's 'Boneyard' area (northeast of the main eucalyptus grove) to block low and mid-level wind. Center the planting on the existing gap in the tree canopy created by the maintenance access road.
- Encourage blue gum saplings to grow and do not remove them within the roosting sites when they serve to provide canopies in the open row spaces.
- Maintain a partially open canopy along the boundary of the yard so that direct sunlight can penetrate from the yard edge for basking. This is one of the most important habitat

improvements and will allow the butterflies to remain in the interior when strong northerly winds occur.

- Keeping the future option of selective precise thinning of specific parts of the grove is important. Maintaining individual tree health in the face of aridification may require reduction of basal area. The remaining trees will fill in the canopy, as water and light availability allow. Pruning, if it occurs, will be directed by a certified arborist and the County's monarch specialist.

Critical Windbreak along Placer Street – Area H

- Maintaining wind shelter along the southwest boundary of the entire grove in the District's land is crucial for the monarchs clustering on the opposite side of the Sanitation Facility, particularly along Placer Street where the windbreak is narrow and there is limited space to plant trees. The eucalyptus in this area also abut residential properties along Placer Street, complicating management of the trees.
- Tree risks will be considered routinely and if trimming trees and removing hazard branches in this area is necessary, it will be done in collaboration with the County's monarch butterfly specialist and certified arborist to minimize impacts to the windbreak. Trees that have posed risks to the neighbors were topped in the past to reduce the risk while still maintaining the trees' ability to function as a windbreak. These topped trees will require more frequent maintenance and assessment by an arborist to remove weakly attached branches. Management of this windbreak should focus on preserving and enhancing a semi-permeable barrier of vegetation to allow for moderation of wind.
- The windbreak along Placer was one of the focus areas of the wind study conducted by Dr. Stu Weiss and Althouse & Meade that was completed in June 2025. The wind study simulated canopy height reductions along the Placer Street windbreak. The wind study model showed minimal changes in wind speed in the monarch habitat for canopy heights down to 80 feet. Canopy heights between 80 feet and 60 feet demonstrated slight increases in wind speed in the monarch habitat. Canopy heights below 60 feet resulted in rapid increases in wind speed throughout the monarch habitat. Therefore, the wind study analysis suggested that the critical height of tree canopy along Placer Street is approximately 80 feet. This height provides sufficient wind protection for the monarch habitat and provides a buffer of 10-20 feet of canopy height before monarch habitat is negatively impacted.
- Trees planted along the Placer Street windbreak must therefore have a mature height of roughly 80 feet in order to align with the results of the wind study and to provide sufficient long-term wind protection for monarch habitat.
- There are existing gaps in the Placer Street windbreak. Plant these gaps with the following tree species, with species selection to be based on specific canopy needs:
    - Canary Island Pine *(Pinus canariensis)*
    - Monterey Pine *(Pinus radiata)*
    - Other species if specifically recommended by a certified arborist and the County's monarch specialist
    - Blue gum eucalyptus *(Eucalyptus globulus)* will be planted if the other species above do not demonstrate good health and the potential to create a sufficient windbreak after a period of 5 years from planting, as determined by an arborist and monarch butterfly specialist. Factors that the arborist and monarch butterfly specialist may use to determine if the trees demonstrate potential to create a sufficient windbreak include: tolerance of soil, moisture,

and light conditions at the planting site, successful establishment adjacent to mature blue gum eucalyptus trees, demonstration of active growth, and the tree reaching an appropriate size for its age.

- Redwood trees were planted at this location in the past but did not successfully establish in part due to a lack of irrigation, and the fact that this location is ill-suited for Redwood's higher water needs.
- The wind study also analyzed the effects of partial removal of the existing blue gum eucalyptus trees. This was done to simulate the long-term plan to selectively remove some of the existing blue gum eucalyptus and replace them with a lower-growing tree species that still reaches roughly 80' to provide sufficient windbreak for the monarch habitat. The study showed that existing trees could be selectively removed from the Placer Street windbreak without negatively impacting the monarch habitat.
- Once existing gaps in the windbreak are planted, and the newly planted trees are in good health and demonstrate good structure after a period of at least 3 years, consider selectively removing 1-3 existing blue gum eucalyptus trees that were previously topped in consultation with a certified arborist and the County's monarch specialist as part of a pilot program to eventually replace the mature blue gum eucalyptus with lower-growing trees that still reach the 80' critical height. After removal, plant a replacement tree from the list above for each removed tree no later than the next rainy season. Evaluate the success of the pilot replacement program every 3 years by monitoring growth of the replacement tree and monitoring monarch behavior in the overwintering habitat. If the pilot replacements are successful, work with a certified arborist and the County's monarch specialist to continue selective replacement without negatively impacting monarch habitat.
- Plant a small stand of Monterey cypress at the southern corner of the Sanitation Facility, just south of the small, separate pump station, opposite the trail opening, to close the canopy gap and prevent southerly winds that penetrate into the grove along the trail and drive the monarchs away from the interior cluster site.

North and South Creekside Roost Area – Areas D and E

- In the Creekside Area, maintain and fill-in the row of trees southeast of the creek on the County-owned parcel that is east of the Creek and north of the Humphrey's parcel (APN 028-291-57). The public property is dominated by shrubs, including blackberries and other shrubs. Interplanting trees, such as Coast Redwood *(Sequoia sempervirens)* and Monterey Cypress *(Hesperocyparis macrocarpa)*, will reinforce existing wind shelter. However, care must be taken over the long run to not deeply shade the cluster sites along the creek.
- There are several eucalyptus trees that have previously been topped in the area west of the Humphrey's parcel. These trees should be monitored by an arborist for future management needs.
- There are several redwoods on the Sanitation Facility side of the drainage ditch at the southeast corner of the yard, that appear to be in poor to fair health. Monitor their progress, and if they do not maintain a healthy canopy or if they fail, replace them with blue gum or red iron bark eucalyptus for high-canopy wind shelter and Monterey cypress for mid-canopy wind shelter.

North and South Lakeside Roost Areas – Areas B and C

- Poor drainage along the margins of the lagoon contributed to past failures of blue gums between the trail and adjacent private properties in the North and South Lakeside areas. To

mitigate this, and to ensure the viability of the remaining trees, drainage features will be created and maintained so that standing water does not occur along the trail and at the base of the trees. Drainage improvements were installed in winter 2024/2025 and were recently improved in fall 2025. The drainage improvements will be routinely assessed and maintained. See section 5.3.5 below for more information regarding drainage.

- Approximately 47 Monterey cypress *(Hesperocyparis macrocarpa)* were planted between the lagoon and the trail in Area B in December 2024. Once mature, the trees will provide additional mid-level wind protection. This species has proven to do well in the immediate area. The recently planted trees will be maintained and additional trees will be planted in future years to enhance the windbreak, improve native habitat and biodiversity, and contribute to a long-term goal of eventually replacing the blue gum eucalyptus species in this part of the habitat with appropriate native species.
- Additional native trees such as Monterey Cypress, Monterey Pine *(Pinus radiata),* Coast Live Oak *(Quercus agrifolia)*, and Island Oak *(Quercus tomentella)* should be planted along the lagoon banks in Area C to fill in gaps in the windbreak where there is sufficient space.
- Salt-tolerant smaller trees and shrubs such as Arroyo Willow *(Salix lasiolepis),* Toyon *(Heteromeles arbutifolia),* Ceanothus species*,* and Coyote Brush *(Baccharis pilularis)* will be added along the lagoon banks to improve riparian habitat and native biodiversity. These plantings will include species that provide nectar to overwintering monarchs where possible.
- For Area C primarily, plant nectar plants of various species (see section 5.3.4 below) in areas that receive morning sun, or in spots with dappled light. The moist soil here allows for many species to thrive, as there are a variety of microhabitats available including marshy areas, creekbanks, and open grassy fields. Other narrow zones, between the trail and water on the west side of the lagoon, should also be planted with nectaring plants. Table 5 below provides recommended nectaring plants.
- For trees on the east side of the creek in Area C, where soil conditions are appropriate (not too wet), plant shorter stature trees and shrubs that can withstand wind and coastal pressure such as Arroyo Willow (*Salix lasiolepis)*, Shining Willow (*Salix lasiandra), Coyote Brush (Baccharis pilularis),* Mulefat *(Baccharis salicifolia),* or Saltmarsh Baccharis *(Baccharis glutinosa)*. These species are also nectaring sources for monarchs.

Southeast Grove – Area A2

- This area includes the southeast shore of the lagoon where there is a large, low-lying roughly triangular shaped piece of land that is available for tree planting. This area should be planted to enhance the existing windbreak and to facilitate the eventual replacement of blue gums with native trees. Drainage improvements were installed in this area in winter 2024/25 to reduce ponding of water. Eleven White Alder and six Monterey Cypress trees were planted in this area in December 2024. The White Alders did not survive, potentially due to lack of summer irrigation. Additional tree species should continue to be planted in this area to determine what will be successful. If the soil conditions allow tree roots to grow and succeed over time, evergreen trees such as Monterey Cypress and Monterey Pine (*Pinus radiata*) should be planted. If soil conditions are not appropriate for evergreen trees, California white alder (*Alnus rhombifolia*) and/or Red alder (*Alnus rubra*) were both recommended in the 2010 HMP and should be planted, but additional summer irrigation will likely be required for establishment. Arroyo Willow (*Salix lasiolepis*) should be planted along the east and southern portion of this area adjacent to the drainage swale.

Parcel at 40 Moran Way – Area A1

- The eucalyptus trees on the parcel at 40 Moran Way have experienced fungus and pest infestations and some have fallen or have been removed in the past. More recently, the February 2024 high-wind event caused 20 trees to fall and caused damage to adjacent private residences, property, and vehicles. Many of the remaining trees were weakened and four hazardous trees were immediately removed as a result of the storm; the remainder were topped in Summer 2024 to reduce their potential to fall. After the widespread failure of eucalyptus trees at this location, the County's certified arborist and monarch butterfly specialist determined that the property no longer functioned as a viable windbreak. Further, the County's certified arborist recommended removal of all eucalyptus trees on the property. All of the remaining trees were removed from the property and any stumps were ground in Summer 2025. The property was then completely re-graded in Fall 2025 to create positive drainage across the property and seeded annual grasses and legumes to provide erosion control.
- The parcel will be re-planted with at least 45 native trees and additional native shrubs in Fall 2026. The planting list for the parcel was developed by County Parks staff in conjunction with a certified arborist, biologists, and a monarch butterfly specialist, and consists of the following native trees: California Buckeye *(Aesculus californica),* Monterey Cypress *(Hesperocyparis macrocarpa),* Coast Live Oak *(Quercus agrifolia)*, Island Oak *(Quercus tomentella)*, Arroyo Willow *(Salix lasiolepis)*, Toyon *(Heteromeles arbutifolia),* and Blue Elderberry *(Sambucus mexicana)*. Native shrubs such as Baccharis species, Ceanothus species, Bush Monkeyflower *(Diplacus aurantiacus)*, California Coffeeberry *(Frangula californica)*, Coast Silktassel *(Garrya elliptica)*, Pacific Wax Myrtle *(Morella californica)*, and Pink Flowering Currant *(Ribes sanguineum var. glutinosum)* will also be planted. All plants are well-adapted to the specific conditions at this location, including wind and coastal conditions, and will provide improved habitat value for monarchs, pollinators, and other native species. None of the trees proposed for the property grow as tall as blue-gum eucalyptus, and large trees will be located away from private residences. Small trees and large shrubs will be planted along the western edge of the property bordering houses.

West of the Parking Lot

- In the area west of the parking lot and restrooms, shorter stature vegetation (small trees and large shrubs) that can withstand wind and coastal pressure, and that offer nectar or other habitat value should be planted such as Arroyo Willow *(Salix lasiolepis)*, Toyon *(Heteromeles arbutifolia),* Blue Elderberry *(Sambucus mexicana)*, Baccharis species, Ceanothus species, Bush Monkeyflower *(Diplacus aurantiacus)*, California Coffeeberry *(Frangula californica)*, Coast Silktassel *(Garrya elliptica)*, Pacific Wax Myrtle *(Morella californica)*, and Pink Flowering Currant *(Ribes sanguineum var. glutinosum).*

Tree planting described above will be conducted in the short term (1-3 years). Additional plantings in the future will be done in response to changes in the forest. A certified arborist and qualified entomologist will be consulted regarding future planting recommendations.

Action	Year 1	Ongoing	As-needed
Tree Planting		X	X

5.3.2 Hazard Trees

A certified arborist with a Tree Risk Assessment Qualification (TRAQ) from the International Society for Aboriculture (ISA) will routinely and proactively assess trees on County owned property at least twice a year, once in the spring and once in the fall. A TRAQ-certified arborist will also assess trees on an as-needed basis following major storm events and if a new risk is identified. If hazards or other issues are identified, they will be addressed as noted below.

Hazard pruning and/or hazard removal recommendations to address identified hazards will be made by a certified arborist and will be based on the tree's health condition, structural integrity, and its hazard potential using standardized protocol and guidance from ISA. In general, if the tree is dead or declining or poses a hazardous condition but is located within a natural area with low to no human traffic, the tree is typically not recommended for removal or hazard pruning. However, removal or pruning is typically recommended for hazard trees that are located within a high-traffic area, in areas adjacent to residences, in areas with sensitive infrastructure, and for dead trees within the groves surrounding the Sanitation Facility. The County will prioritize public safety in tree management actions. As such, trees will be maintained routinely through trimming and/or removal when they pose a hazard to public safety.

Safety pruning, rather than removal, is preferred where it is feasible to address identified hazards. Topping of trees is not recommended due to the weakly attached nature of epicormic shoots; rather safety pruning should be conducted to preserve the health of the tree while addressing the hazard. Removals will also be done to reduce risk of tree failure when identified as necessary by a certified arborist as noted above. This may negate benefits of the tree for monarch habitat, but the County will prioritize public safety when addressing hazardous trees. If hazardous tree(s) are removed, a certified arborist and monarch specialist will assess the impact of the removal(s) on monarch habitat and recommend replacement tree(s), if appropriate. Replacement trees, if recommended per above, will be planted at the beginning of the next rainy season to ensure optimal growing conditions and survival.

If hazards are identified within the **core habitat zone**, special care will be taken in assessing urgency and targets of falling trees/branches. The potential for opening the cluster sites to wind if any of the trees or their branches are removed will be assessed by a monarch specialist prior to removal. Removal of trees or branches will be the minimum necessary to sufficiently reduce the hazard to minimize changes that could potentially degrade the monarch habitat.

No tree work will occur within the **core habitat zone** (Figure 4) between **October 1 through March 31** unless a true emergency arises. Outside of the core habitat zone and within the **shelter habitat zone** (Figure 4), no tree work will occur between **October 15 through March 15** unless a true emergency arises. If a hazardous tree must be removed during either of these times, then a certified arborist and qualified monarch butterfly specialist will be retained by the County to monitor and provide input regarding the tree maintenance activities prior to and during the removal. The protective measures outlined in Table 6 will be required for all tree work to avoid and minimize impacts to the maximum extent feasible.

Tree risk assessments will be conducted routinely and on an as-needed basis. Hazardous tree or branch removals will be done as needed to mitigate safety risk to the public, monarch habitat, and park resources.

Action	Year 1	On-Going	As-needed

Tree Risk Assessments	X	X
Safety Pruning and/or Hazardous Tree Removal		X

5.3.3 Fire Risk Abatement

Mid-story trees and shrubs can potentially create ladder fuels in the management area. However, the vertical continuity of fuels could be partially ameliorated by spatial separation of the shrub later from the mid-story tree layer, via offset plantings. Exact configurations of these wind shelterbelts will require detailed field examination and will need to consider light availability and potential crowding. If a vertical continuity of fuels (i.e., ladder fuels) is created through the addition of mid-story trees and shrubs, the risk of a ground fire spreading into a high intensity canopy fire rises.

Blue gum limbs and trees that have naturally fallen throughout the management area will be actively removed to decrease fuel loading and eliminate ladder fuel within the understory of the groves on-site. If the Sanitation Facility groves' understory is sealed with mid-story trees and shrubs, they will be spatially separated from each other and the blue gum canopy by offsetting the plantings to avoid the creation of ladder fuels to the maximum extent feasible.

The existing plants will be maintained during Year 1 and until the new nectaring plants are planted, have established, and are flowering.

Action	Year 1	Ongoing	As-needed
Fire Risk Abatement		X	

5.3.4 Nectaring Plants

Monarchs are less likely to use nectar plants in deep shade. Therefore, nectar plants of various species will be planted primarily in sunny areas, or in areas with dappled light outside the blue gum groves. Nectar plants of various species (listed in the 2010 draft plan and in the Xerces Society lists) will be planted primarily in areas that receive morning sun, or in spots with dappled light. Spring and summer nectar sources and milkweeds (*Asclepias* spp.) will not be planted in the management area. These plants disrupt the monarchs natural spring migration pattern. Disrupting the monarchs' natural migration pattern can lead to further conditions that may contribute to population decline. Although introduced plants also provide nectar for monarchs, native plants are recommended for planting due to the additional ecological value that they provide, as well as being adapted to their local environment (e.g., drought, coastal influence, soil).

Allowing Ivy to climb up trees without negatively impacting the health of the tree is an important management goal. Ivy that has climbed into tree canopies will be managed by cutting it back and removing it from the canopy. Starting at the tip of the ivy, it will be removed until it is no longer harming the health of the tree. Ivy will be retained on roughly 25 trees for nectar and will be trimmed regularly to prevent entry to the canopies. Ivy located on the east side of the grove where it receives morning insolation is likely to be preferred by monarchs.

North and South Lakeside – Areas B & C

The prime area for nectaring plants is on the east side of the creek in the sunny grassy area at the head of the lagoon. The moist soil here allows for many species to thrive, and on a microscale, the variety of habitats available including marshy areas, creekbanks, and open grassy fields. Other

narrow zones between the trail and water on the west side of the lagoon will be considered. Table 5 provides a list of recommended nectar plants, their bloom periods, and species-specific notes for the Moran Creek Bank.

Table 5 Recommended Nectaring Plants

Moran Creek Banks		
Shrubs/Small Trees		
Species	**Bloom period**	**Notes**
Douglas' Baccharis (*Baccharis glutinosa*)	July through October	Likely entire genus is attractive to monarchs. Important nectar source for many insects
Coyote Brush (*Baccharis pilularis*)	All year	
Mulefat (*Baccharis salicifolia*)	All year	
Arroyo Willow *(Salix lasiolepis)*	Winter & Spring	High quality riparian habitat plant and nectar source.
Perennial Herbaceous Plants		
Species	**Bloom period**	**Notes**
Coastal gumweed (*Grindelia stricta*)	May through October	-
Western goldenrod (*Euthamia occidentalis*)	July through November	Likely entire genus is attractive to monarchs
Canada goldenrod (*Solidago canadenis)*)	August through October	Likely the entire genus is attractive to monarchs. Great late season nectar source
Seaside daisy (*Erigeron glaucus*)	January through August	-

Nectaring plants will be planted in the short term (1-3 years) and monitored for survival. If plants do not survive they will be replaced in-kind immediately. Some plants are likely to die-off over time. Plantings will be monitored annually and replanted when/as plants die-off.

Additional Recommended Nectaring Plants

The Xerces Society recommends nectaring plants for coastal California that should also be considered. The list, in Appendix G, includes the blooming season of the plants. For the purposes of this plan, the County should plant those that bloom in the fall, winter and spring when monarchs are overwintering on site.

Action	Year 1	Ongoing	As-needed
Nectar Planting		X	

5.3.5 Drainage Improvements

Several areas of the habitat management area suffer from poor drainage. This had led to saturated soils and water-ponding around the base of existing trees. The saturated soils and ponding has in turn likely contributed to tree failure. Therefore, improving drainage is a critical goal to prevent additional tree failures and improve the health of existing trees. In addition, some areas will require improved drainage before replacement trees can be successfully grown.

South Lakeside and North Lakeside – Areas B & C

When the D.A. Porath Sanitation Facility was built in 1953, a sewer line was also installed along the western margins of the lake. The installation of the sewer line modified drainage patterns along the western side of the lake, creating artificial mounds and low-spots that restrict runoff flowing toward the lake. These problems persist today.

Ponding water and saturated soils are present at the base of the eucalyptus windrow along the western boundary of the management area between the residences and the trail along Moran Lake. The wet condition within the critical root zone of the eucalyptus trees negatively impacts roots. Simple drainages will be created to allow the water to flow to the lake. The drainages will be placed at the lowest points where ponding occurs and as shown in Figure 6.

40 Moran Way – Area A1

A majority of this parcel is poorly drained and experiences saturated soil conditions during the rainy season. This parcel experienced 20 tree failures during the February 2024 high-wind event. There is an existing drain inlet along East Cliff Drive at the southeastern corner of the parcel. The County regraded the entire parcel in Fall 2025 to create positive drainage that directs runoff toward the existing drain inlet and reduces ponding and soil saturation. The drainage of this parcel should be monitored and maintained on an ongoing basis.

Action	Year 1	Ongoing	As-needed
Install Drainages	X		X
Maintain Drainages		X	

Table 6 Summary of Management Actions and associated Protective Measures

Action	Timeline	Protective Measures
Tree risk assessment	Ongoing	A certified arborist with a Tree risk Assessment Qualification (TRAQ) from ISA will assess trees on County owned property at least twice a year, once in the spring and once in the fall. A TRAQ-certified arborist will also assess trees as needed following major storm events and if a new risk is identified. If hazards or other issues are identified, they will be addressed as noted below.
Maintenance pruning and other routine tree work	As-needed	A certified arborist will recommend maintenance pruning and other routine tree work as part of the tree risk assessments to reduce risk to public safety and monarch habitat. Recommended tree work will occur outside of the monarch overwintering season (core habitat zone Oct 1 – Mar 31; shelter habitat zone Oct 15 – Mar 15), unless a true emergency arises (see emergency tree work below). Tree work will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Tree work will avoid damaging adjacent trees or limbs. A nesting bird survey will be required if tree work is conducted during nesting bird season. If necessary, preconstruction training will be required for contractors performing tree work to avoid and minimize impacts to sensitive resources.
Removal of hazardous tree or limbs	As-needed	Removals will be assessed by a certified arborist. Removals will occur outside of the monarch overwintering season (core habitat zone Oct 1 – Mar 31; shelter habitat zone Oct 15 – Mar 15), unless a true emergency arises (see emergency tree work below). Removals will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Removals will avoid damaging adjacent trees or limbs. A nesting bird survey will be required if removals are conducted during nesting bird season, and if nesting birds are found Certified arborist and monarch specialist will assess impact of removal on monarch habitat and recommend replacement tree, if appropriate. Plant replacement tree if recommended per above at the beginning of the next rainy season. If necessary, preconstruction training will be required for contractors performing tree work to avoid and minimize impacts to sensitive resources.
Failure of tree within monarch habitat	As-needed	Failures will be assessed by a certified arborist. Tree work associated with failures will occur outside of the monarch overwintering season (core habitat zone Oct 1 – Mar 31; shelter habitat zone Oct 15 – Mar 15), unless a true emergency arises (see emergency tree work below). A nesting bird survey will be required if tree work is conducted during nesting bird season. Certified arborist and monarch specialist assess impact of failure on monarch habitat and recommend replacement tree, if appropriate. Plant replacement tree if recommended per above at the beginning of the next rainy season.

Action	Timeline	Protective Measures
Emergency tree work (during monarch overwintering season)	As-needed	Tree work will be overseen by a certified arborist and monarch specialist who will recommend best management practices to avoid and minimize impacts to monarchs. Tree work will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Tree work will minimize damage to adjacent trees or limbs. Certified arborist and monarch specialist will assess impact of removal on monarch habitat and recommend replacement tree, if appropriate. Plant replacement tree if recommended per above at the beginning of the next rainy season. Preconstruction training will be required for contractors performing tree work to avoid and minimize impacts to sensitive resources.
Critical Windbreak Tree Replacement (Pilot Project)	As-needed	The critical windbreak will be enhanced by planting existing gaps in the windbreak with recommended tree species in Table 4. Selective removal of existing eucalyptus will be recommended by a certified arborist and monarch specialist and will not occur unless the existing gaps in the windbreak are planted. Removals will be overseen by a certified arborist and monarch specialist who will recommend best management practices to avoid and minimize impacts to monarchs. Removals will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Removals will minimize damage to adjacent trees or limbs. Certified arborist and monarch specialist will assess impact of removal on monarch habitat and recommend replacement trees. Follow guidelines for tree height established by the wind study to avoid negatively impacting monarch habitat.
Install and maintain positive drainage at base of trees to reduce ponding	Ongoing	Install and maintain drainages using best management practices to reduce erosion and prevent sediment deposition into Moran Lagoon. Prepare drainages prior to rainy season.
Maintenance of understory in eucalyptus groves	Ongoing	The understory within the eucalyptus groves will be managed to avoid the growth of ladder fuels and to keep sight-lines clear. Vegetation management will minimize impacts to monarch habitat by preserving nectar sources where feasible. If needed, a monarch specialist will advise vegetation management. Ivy that has climbed into trees will not be trimmed without input from a monarch specialist.
Removal of invasive species	Ongoing	Invasive species, other than blue gum eucalyptus that are necessary for monarch habitat, may be removed to restore native biodiversity and habitat. Where invasive species are removed, they will be replaced by wood chip mulch or native species that will achieve the habitat and restoration goals in this habitat management plan.
Tree and shrub planting	Ongoing	Tree planting will conform to the guidelines in this habitat management plan or be recommended by a certified arborist and monarch specialist. Native species will be planted where feasible, unless non-native species are necessary for monarch habitat enhancement or protection as outlined in this habitat management plan. Species selected for shrub planting will align with the public safety, habitat, and restoration goals in this habitat management plan.

Action	Timeline	Protective Measures
Removal of dead eucalyptus wood to reduce potential for eucalyptus pests	Ongoing	Not applicable

6 Monitoring Plan

This plan serves to manage and maintain the overwintering habitat at Moran Lake. Table 1 provides the historic data and counts of overwintering monarchs here. The two factors to be monitored are the number of monarchs that overwinter at Moran Lake and the quality of the habitat that the management area provides. Data in Table 1 helps to display regional and state-wide fluctuations, and to understand if the Moran Lake overwintering counts are consistent with the other sites in the county or possibly if the Moran Lake site is playing a more, or less, important role over time.

In order to analyze the effectiveness of the Moran Lake habitat, annual counts at Moran should be compared to other sites across the state and the immediate region as monarch counts will inevitably fluctuate between years. The goal should be to ensure that Moran Lake is hosting numbers that are proportionally similar to, or above, other regional sites. This will help determine whether habitat quality at Moran is the limiting factor in increasing the population of overwintering Monarchs at Moran.

6.1 Monarch Surveys

Monarch surveys will be conducted at least twice annually, and twice monthly as possible, during the overwintering season (October 15 to March 31). Surveys will be consistent with the Xerces Society's standards. Results will be recorded, uploaded to the Western Monarch Count database, and included in the annual report for this management plan.

6.2 Habitat Assessments

The long-term functionality of the management area habitat depends on the replacement trees survival and resulting wind protection needed by the overwintering monarchs. Replacement tree establishment must be prioritized by County Parks.

Depending upon the size of the trees planted and planting conditions (soil, water availability, etc.), trees could take up to 20 years or longer to reach full maturity and height, and shrubs could take 5 to 10 years. The goal of the plantings is to provide wind protection in the management area and particularly at the roosting and basking areas. Wind penetration will be measured using current wind modeling technology and applications every 3 to 5 years to understand the effectiveness of the plantings.

Tree health will continue to be assessed and monitored annually to identify hazardous trees and to identify trees with declining health. Health will be monitored by County's certified arborist and could be monitored by County's maintenance staff regularly. County staff can collaborate with the certified arborist to be aware of and notify them of situations like insect infestation or new potential tree hazards, so the arborist can monitor anything of significance.

6.3 Monarch Predator Assessments

During monarch surveys any change in the presence or evidence of predators will be recorded and discussed with the monarch butterfly specialist to determine if and what action may be needed.

6.4 Annual Report

Monitoring the tree plantings, habitat health, establishment of nectaring plants and other forest management actions will be done in Year 1 and annually. An annual monitoring report detailing the progress and findings will be prepared. Logs documenting implementation of the forest management actions will be completed and saved by the County. The report will include, as an appendix, other reports from the County arborist and monarch specialist.

The report will be used to determine if changes in management actions are necessary. Any corrective actions implemented to address threats to monarch habitat (i.e., pests, diseases, flood/erosion) and changes to monarch habitat use will be detailed in an annual monitoring report. The report will be saved by the County and be available to the public and resource agencies upon request.

6.5 USFWS Monitoring and Reporting Requirements 2022

County Parks was awarded a $20,000 grant to prepare this MBHMP update. To meet the grant requirements, monitoring data and analyses will be summarized in annual performance report that will be submitted to the USFWS. The Work Plan is included as Appendix C. The annual performance reports will include:

- Year 1: A detailed description of activities completed by County Parks, including the scope of activities, the date(s) and the specific location(s) within the management area
- Year 2 and annually thereafter: A description of the activities completed since the last reporting period, with the specific dates, such as X day of X month during X year. Description with a figure or sketch specifying where all activities occurred during the time period. The report will include:
  - Photos, before and after (whatever is appropriate);
  - Statements explaining any problems or delays in implementing project tasks;
  - Lessons learned (if appropriate); and
  - Other Reporting: If submitting reports to other federal, State, and local agencies and the above annual report content met then submitting these reports is acceptable.

Additionally, a final report will be submitted to the USFWS that will include all the above information/headings with a synthesis of all project activities completed. Annual and final reports must be submitted to the USFWS Project Officer, whose contact information is provided below.

Samantha Marcum
Coastal Program Regional Coordinator
U.S. Fish and Wildlife Service

6.6 California Coastal Commission

The Project Area is located within the County's Coastal Zone and the habitat management actions in this Plan, including vegetation removal and planting, constitute development pursuant to the

California Coastal Act[4], and thus coastal development permit (CDP) authorization is required. Portions of the recommended overall management actions (see Figure 7) fall within the original permitting jurisdiction of the California Coastal Commission, and therefore County Parks anticipates pursuing a consolidated CDP[5] from the Coastal Commission to comply with the requirements of the Coastal Act. For the purposes of that CDP, County Parks proposes the following reporting and adaptive management actions:

- County Parks will seek a five-year authorization through to April 30, 2031 to implement the overall management actions described in this Plan. Additionally, County Parks proposes that this authorization may be extended beyond the initial five-year period subject to review and approval by the Commission's Executive Director with a finding that there are no changed circumstances that may affect consistency with the policies of Chapter 3 of the Coastal Act and thus warrant re-review of the authorization. County Parks will submit a five-year extension request in writing to the Commission's Central Coast District Office by December 1, 2030, and the Executive Director's determination will be made in writing to County Parks.
- Annual reports as described above in Section 6.4 will be submitted by March 31 (or another date, subject to Executive Director approval) annually to the Commission's Central Coast District Office for Executive Director review and approval and will include:
    - A description of the actions completed during the previous year, including, but not limited to: (1) the number, species, and location of trees removed and planted; (2) location and nature of major limbing activities; (3) photos of the site before and after work; (4) any actions taken to address pests or predators; (5) a discussion of other project implementation actions not already included above and subsequent performance; and (6) adaptive management actions County Parks plans to implement over the subsequent year to ensure continued or more successful management, and progress towards long term management goals.

The annual report submitted to the Coastal Commission will be an enforceable component of the Commission's CDP authorization for the Plan and will require review and approval by the Commission's Executive Director prior to implementing any adaptive management actions.

[4] See Public Resources Code Section 30106.

[5] See Public Resources Code Section 30601.3.

7 Adaptive Management

The Moran Lake monarch butterfly overwintering habitat is regionally important, and care has been taken to preserve it. However, climate changes are impacting monarch habitat throughout coastal California that may require the County and other landowners and managers to respond and adjust to changes in real time. Monarch counts in the future are likely to fluctuate greatly, regionally, and at this site due to many factors, including climate change. At this time, preserving and managing the habitat so that it retains the key characteristics for overwintering is the objective of this management plan. Several recommendations for adaptive management are below. The County Park's arborist and entomologist will be consulted prior to initiating management actions.

- If the health of blue gums within the grove decreases and mass foliage losses occur at the cluster sites, the grove will be assessed for additional management actions.
- Soil amendments will be considered to encourage new vegetation growth, and a drip irrigation system could be installed to provide additional water, which is likely the greatest limiting resource.

This MBHMP update is an adaptive action taken to address the changing conditions and needs of the habitat. As discussed, tracking and adjusting replacement tree species and numbers is another adaption meant to more specifically address the changing needs of the site. Table 7 provides information about tree speices that did not thrive in the management area in the past. It will be important to track what species thrive and those that do not into the future and adjust accordingly.

Table 7 Tree Species Not Well-Suited to the Management Area

Tree Species	Location Planted in the Past	Observed issue
Pohutukawa	Between parking lot and lagoon	Poor growth, but the individual tree was planted in a very exposed location where no trees are currently thriving.
Coast redwood	Zones B and C – North and South Lakeside	Poor growth. This species is sensitive to salt spray and saline soils near the coast or tidal areas.
Coast Redwood	Zone H – Critical Windbreak along Placer Street	Trees died due to failed irrigation. May not be an appropriate area for coast redwoods due to lack of soil moisture.
Flooded-Gum Eucalyptus (*Eucalyptus rudis)*	North Lakeside	Infested by red-gum lerp psyllids.
Swamp gum	40 Moran Way	Insect infestation
California bay	Western margin of western grove, shaded area	Did not grow, potentially due to heavy shade, or competition from adjacent eucalyptus.

The 2010 Plan, Appendices 3.3 Recommended Plants for Overwintering Restoration, of included a list of species with their potential ecological role. Trees listed should be considered for planting in the appropriate locations and for the appropriate ecological role.

If plans or projects are developed in the future for Moran Lake, this plan will need to be incorporated into the plan with input from the County arborist and monarch specialist.

If the western monarch butterfly population is listed as a threatened or endangered by the USFWS, the agency will designate critical habitat for the species. It is likely the known or historic overwintering sites will be included as critical habitat. As a result, the regulatory setting for managing their habitat will become more complex and will include review and approval by USFWS. This management plan would very likely require an update or amendment to be consistent with the federal habitat protection requirements.

8 References

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Appendix A

Moran Lake Monarch Overwintering Habitat Existing Conditions Report and Associated Appendices



Moran Lake Existing Conditions Report

Monarch Butterfly Overwintering Habitat

prepared by

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September 2022

RINCON CONSULTANTS, INC.
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Appendices

Appendix A Assessment of Moran Lake Monarch Overwintering Habitat

Appendix B Moran Lake Restoration Project Arborist Report

Appendix C Moran Lake County Park Improvement Project Biological Resources Assessment

1 Introduction

This Monarch Butterfly Overwintering Habitat Existing Conditions Report (Report) was prepared to summarize data and information compiled during the monarch butterfly overwintering habitat monitoring and site assessment conducted by Creekside Science (Creekside) and Rincon Consultants, Inc. (Rincon) in the winter of 2021 through summer of 2022. It includes site management recommendations for the prolonged use and enhancement of monarch butterfly overwintering habitat at Moran Lake County Park (Park). This Report will be used to inform and update overwintering management decisions and the future Park restoration plan. More specifically, this Report provides historic monarch overwintering and habitat condition information from the 2010 Moran Lake County Park Habitat Management Plan, includes the methods and results of the 2021/2022 overwintering habitat monitoring and site assessment, and includes management recommendations based on current site conditions.

2 Background

Over the past thirty years much of the traditional monarch butterfly wintering habitat at Moran Lake has been significantly impacted due to several factors including: tree loss due to natural causes, permitted and non-permitted tree removal, and improper tree maintenance. These factors, combined with the absence of a cooperative management plan that coordinates the activities of county agencies and local property owners, place the monarch butterfly wintering habitat at Moran Lake in jeopardy.

Monarch butterflies are present in the Moran Lake wintering habitat from October through February in most years, and small numbers have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as full-term overwintering habitat.

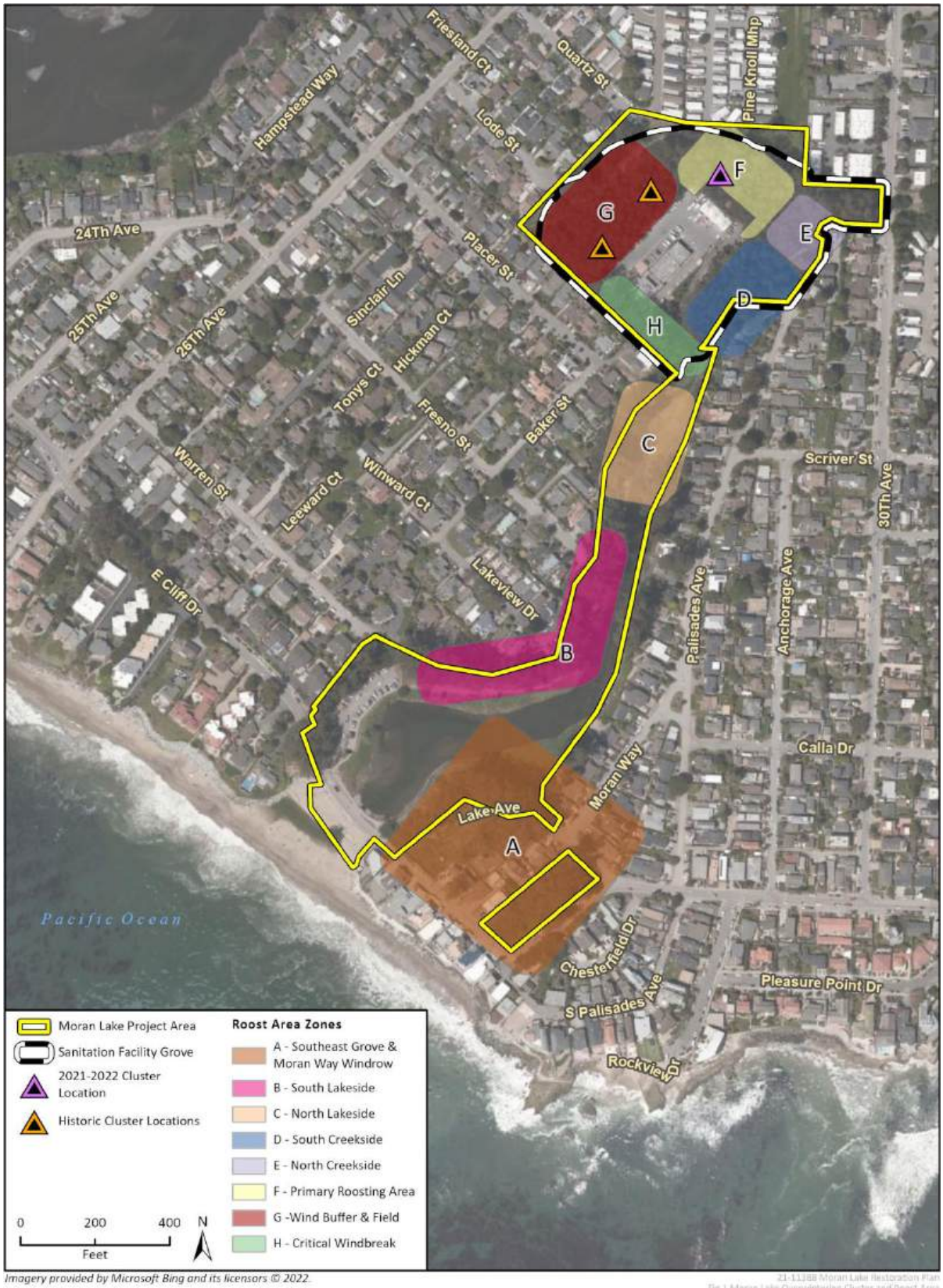
In the past (1980s), monarchs typically began to congregate along the northwestern shore of Moran Lake during early October and formed clusters in the North and South Lakeside Roost Areas (Figure 1). As the population increased during October, clusters also formed in the North and South Creekside Roost Areas and the lakeside butterflies gradually shifted north into the more sheltered Creekside Roost Areas. Then around mid-November, the population shifted its clusters into the Primary Roosting Area where they remained until warming temperatures initiated the spring migration sometime in February. The North Lakeside Roost Area usually supported clusters of roosting monarchs throughout the month of October, whereas the South Lakeside Roost Area typically supported clusters only intermittently during the fall. Thus, the North Lakeside Roost Area historically functioned as an autumnal roost area and the South Lakeside Roost Area functioned as refuge/ bivouac habitat. Tree and limb loss in these habitats has since reduced wind protection and eliminated many of the lower roost limbs that once supported clusters. Currently both roost areas function as refuge/ bivouac habitats. Figure 1 delineates the monarch butterfly roosting areas in Moran Lake County Park.

Tree and limb losses in the North Creekside Roost Area have degraded this habitat over the past ten years resulting in less frequent occupation of the North Creekside Roost Area and a gradual shift of occupation to the South Creekside Roost Area. In March/April of 1999, residents on the property adjacent to the South Creekside Roost Area removed all the eucalyptus trees (*Eucalyptus* spp.) on their property along the east side of the creek and in that process eliminated all the eastern windbreak/ shade trees that sheltered the South Creekside Roost Area. During the winter preceding the tree removal (1998-99) the entire wintering population at Moran Lake (approximately 18,000 monarchs) occupied the South Creekside Roost Area from early October through most of November. During the winter of 1999-2000, no clusters were observed in the South Creekside Roost Area. Both North and South Creekside Roost Areas now function only intermittently as refuge/bivouac habitat.

The Primary Roosting Area, despite several significant tree removal events, has consistently supported mid-winter monarch populations for at least the past twenty years. With the loss of suitable autumnal habitat in the Lakeside and Creekside Roost Areas, the Primary Roosting Area has now begun to function additionally as autumnal roost habitat. The Primary Roosting Area is the only consistently occupied roost area remaining in the Moran Lake monarch wintering habitat.

The grove of eucalyptus at the southeastern end of Moran Lake—the Southeastern Grove, which includes the Moran Way Windrow—in addition to providing wind protection for the lake area,

Figure 1 Moran Lake Overwintering Clusters and Roost Area Zones Map



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functions intermittently as refuge/bivouac habitat and occasionally supports small clusters during periods when monarchs are migrating, and winds are relatively calm.

3 Methods

Cluster areas, population behavior, microclimate conditions, and major vulnerabilities to the Park's overwintering habitat were assessed by Dr. Stu Weiss of Creekside between October 2021 and June 2022. The monitoring and site assessment was conducted with the use of Light Detection and Ranging (LiDAR) technology and hemispherical photography. A detailed description of the LiDAR and hemispherical survey methods are provided in Attachment A: Assessment of Moran Lake Monarch Overwintering Habitat. Consultation with Samantha Marcum at the U.S. Fish and Wildlife Service (who has monitored Moran Lake monarchs for several years) identified key cluster areas over the past several years including 2021-2022. Direct observations by Creekside staff in November and January supplemented this information.

The overwintering site conditions, winter nectar sources, and identification of tree removals or hazard pruning were analyzed by Rincon through the results of the 2022 arborist, botanical, and biological resource assessment surveys. Factors such as tree species, health, density, forest stratification, and dead wooding were analyzed within the Park to determine the fire risk potential. A detailed description of the methods used during the 2022 arborist survey is provided in Attachment B: Moran Lake Restoration Project Arborist Report[1]. A detailed description of the methods used for the completion of the 2022 botanical and biological resource assessment surveys is provided in Attachment C: Moran Lake County Park Improvement Project Biological Resources Assessment.

The Park's current and historic estimated overwintering population numbers were obtained through the Western Monarch Count (Xerces 2022). The Western Monarch Count is a citizen scientist powered organization that is sponsored by the Xerces Society. Western Monarch Count conducts annual population counts at overwintering sites throughout California each thanksgiving and at the start of each new year (Xerces 2022). These data are used by many agencies and conservation organizations to aid in conservation efforts and estimate population trends for the western monarch butterfly.

[1] Excluding the sanitation facility grove, all newly planted native trees in the park, landscape/ornamental trees, and all naturally occurring trees with a diameter at breast height (DBH) of 4 inches or greater were surveyed if they had any portion of their canopy in the Park. Due to time constraints, only priority trees (i.e., dead, dying [i.e., Poor Health trees], newly planted trees, and hazard trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). However, notes on the grove's average DBH and DBH range, average height and height range, average canopy spread, total canopy coverage, and health condition were taken.

4 Results

4.1 Cluster Areas

Dr. Stu Weiss observed one monarch cluster overwintering in the large blue gum (*Eucalyptus globulus*) grove surrounding the sanitation facility (i.e., the sanitation facility grove) in November of 2021. The monarchs were observed clustering 20-30 feet up the blue gums in the northeastern sector of the grove (i.e., Roost Area F). In the last several years, Samantha Marcum reported two additional cluster sites along the southeastern boundary of Roost Area G, one on the northeastern and one on the southeastern side of the access road leading into the sanitation facility. In January, during a northerly wind event, monarchs were scarce in the northeastern cluster area due to its windward exposure. At this time, hundreds of monarchs were observed flying freely in the open areas on the leeward side of the sanitation facility grove in Roost Area D. This behavior corresponds to the historical descriptions reported by S. Marcum. Figure 1 provides the locations of the most recent and the historic overwintering roost locations in relation to the sanitation facility grove and the previously delineated Roost Areas.

The trees south of the sanitation facility grove (i.e., Roost Areas A, B, and C) were found to provide early season roosting habitat but were abandoned once storms brought substantial winds. The viability of the sanitation facility grove cluster sites is much less dependent on trees in these areas than the trees found within and surrounding the sanitation facility grove (i.e., Roost Areas D, E, F, G, and H). Roost Areas A, B, and C were observed being used opportunistically by the monarchs during the site assessment surveys but do not provide the microclimate conditions necessary to support overwintering clusters.

4.2 Overwintering Site Condition

The health of the blue gums within the sanitation facility grove is generally fair, excluding the northeastern portion of the grove which was more established and contained larger and more spaced-out trees in a good health condition. A copious amount of branch dieback and epicormic shoots were observed on the blue gums during the 2022 arborist survey along with several dead or dying trees, indicating stress. The grove is likely experiencing drought pressure and is generally overcrowded. Over time, many additional eucalyptus trees in the shaded understory will be outcompeted by larger trees and will die. An ideal overwintering site should have trees in good condition, that are evenly spaced out, have healthy foliage, and good vigor. An ideal overwintering site should also have saplings in the understory to replace trees as they die and a continuous, well stratified, canopy at the outer edges to offer wind protection. However, the canopy should not be so dense to prevent the entry of the necessary amount of direct and dappled insolating light. Insolation is primarily a factor on the southerly exposures.

Specific notes regarding the grove, including notes on its overall condition and the identification of specific dead, dying, and hazard trees, is provided in Attachment B: Moran Lake Restoration Project Arborist Report.

4.3 Microclimate Conditions

The microclimate conditions within the northeastern and northwestern portions of the sanitation facility grove (Roosting Areas F and G) are the most ideal for overwintering monarchs. The monarchs prefer these locations within the grove due to the presence of wind shelter and an adequate amount of direct and dappled light. The tall blue gums surrounding the inner boundary of the grove provide adequate wind shelter and the opening in the grove (where the sanitation facility is located) allows the necessary amount of solar insolation into the cluster areas. The microclimate conditions found throughout Roosting Areas A, B, and C are not suitable to support overwintering monarch clusters, largely due to the lack of adequate wind shelter.

Grove specific measurements, including, but not limited to, an assessment of wind measurements, light exposure, and canopy height and structure derived from hemispherical photographs and LiDAR are provided in Attachment A: Assessment of Moran Lake Monarch Overwintering Habitat. The measurements included within Attachment A represent why the main cluster site is suitable for overwintering monarchs.

4.4 Major Vulnerabilities to Overwintering Habitat

The biggest vulnerability of the Park's overwintering habitat is wind penetration into the sanitation facility grove. The microclimate conditions necessary to support overwintering monarchs is much less dependent on the trees outside of the sanitation facility grove. A list of the major vulnerabilities to the Park's overwintering habitat is provided below.

1. Northerly wind penetration into the northeastern cluster area (Roosting Area G) through the opening in the northeastern boundary of the grove.
2. Southerly wind penetration into the northeastern cluster area (Roosting Area G). Including a combination of penetration over the sanitation facility and around the northeastern corner of the sanitation facility through the creek.
3. Northerly wind penetration into the northwestern cluster area (Roosting Area F) through the rows of trees beneath the overstory and along the access road.
4. A gap in the southeastern portion of the grove produces a wind tunnel that allows wind to penetrate both cluster areas (Roosting Areas F and G).

4.5 Population Numbers

Western monarch butterfly population numbers have generally been seeing a steady decline, with some fluctuation, since the inception of the Western Monarch Count in 1997. In 1997, over 70,000 individual monarch butterflies were recorded overwintering at the Park and this previous year's count provided an estimated population of 1,100 individual monarchs (Xerces 2020). Since 2012, the Park has supported an average of approximately 2,500 monarchs a year, constituting approximately 17% (range 7% to 27%) of the County's total overwintering population. Additionally, the Park has supported an average of 1.9% of the entire California overwintering population (range 0.4% to 5%). In years of sharp declines in western monarchs (i.e., 2009 and 2018), the Park held 3.9% and 5%, respectively, of the entire California overwintering population. Table 1 below provides the estimated monarch count at the Park along with every other overwintering site in Santa Cruz County since the inception of the Western Monarch Count in 1997. Additionally, Table 1 provides the total

number of overwintering monarchs in Santa Cruz County and California since 1997, the percentage of overwintering monarchs at the Park each year in comparison to the total population of overwintering monarchs in Santa Cruz County, the percentage of overwintering monarchs at the Park each year in comparison to the total number of overwintering monarchs in California, the yearly average of overwintering monarchs at each overwintering site, the County, and California since 1997, and the ten year average of overwintering monarchs at each overwintering site, the County, and California.

Table 1 Western Monarch Count Statistics for Santa Cruz County Since 1997

		Overwintering Sites in Santa Cruz County						
Count Year	Moran Lake	Natural Bridges State Beach	Lighthouse Field	Seascape Golf Course, Aptos	Santa Cruz County Total	California Total	% in Comparison to Santa Cruz County	% in Comparison to California
1997	70,000	120,000	70,000	--	60,000	1,235,490	27%	5.7%
1998	8,000	60,000	50,000	240	19,898	564,349	7%	1.4%
1999	4,500	15,000	9,500	280	31,958	267,574	14%	1.7%
2000	4,000	20,000	35,000	1,050	62,961	390,057	6%	1.0%
2001	1,500	3,000	--	1,400	6,123	209,570	24%	0.7%
2002	1,000	6,000	3,200	4	10,234	99,353	10%	1.0%
2003	6,000	5,700	11,000	--	22,704	254,378	26%	2.4%
2004	4,500	9,600	9,600	950	25,276	205,085	18%	2.2%
2005	3,400	3,900	14,000	--	22,045	218,679	15%	1.6%
2006	6,600	7,300	10,300	2,000	28,271	221,058	23%	3.0%
2007	2,200	2,700	5,700	48	10,675	86,437	21%	2.5%
2008	4,023	3,500	2,607	1,560	12,127	131,889	33%	3.1%
2009	2,276	1,300	4,000	23	7,674	58,468	30%	3.9%
2010	3,000	2,300	4,000	1,000	10,332	143,204	29%	2.1%
2011	4,500	3,000	18,100	--	25,600	222,525	18%	2.0%
2012	2,500	500	3,200	2,500	9,316	144,812	27%	1.7%
2013	790	4,600	4,500	0	11,497	211,275	7%	0.4%
2014	4,300	3,400	7,000	--	15,981	234,731	27%	1.8%
2015	5,800	8,000	12,000	1,800	29,870	292,888	19%	2.0%
2016	4,000	3,500	12,000	1,000	28,101	298,464	14%	1.3%
2017	5,400	9,000	12,000	100	29,918	192,624	18%	2.8%
2018	1,373	1,120	1,802	--	5,043	27,721	27%	5.0%
2019	400	1,997	3,402	0	6,057	29,436	7%	1.4%
2020	50	550	50	0	711	1,899	7%	2.6%
2021	1,100	2,100	410	700	5,418	247,237	20%	0.4%
Average Count Since 1997	6,048	11,923	12,640	771	31,912	239,568	19%	2.1%
Ten Year Average	2,571	3,477	5,636	763	14,191	168,109	17%	2%

4.6 Potentially Hazardous Trees

Seven potentially hazardous trees were identified during the 2022 arborist survey. Three of these trees (tree numbers 3058, 3063, and 3076) are located within the sanitation facility grove. The remaining four potentially hazardous trees (tree numbers 1045, 1258, 1285, and 1342) are located south of the sanitation facility grove in Roost Areas A and B adjacent to the bike path and hiking trail, respectively. The locations of all potentially hazardous trees are shown in Figure 2 and specific notes regarding each potentially hazardous tree and their removal or hazard pruning recommendation is provided in Section 5.2.5.

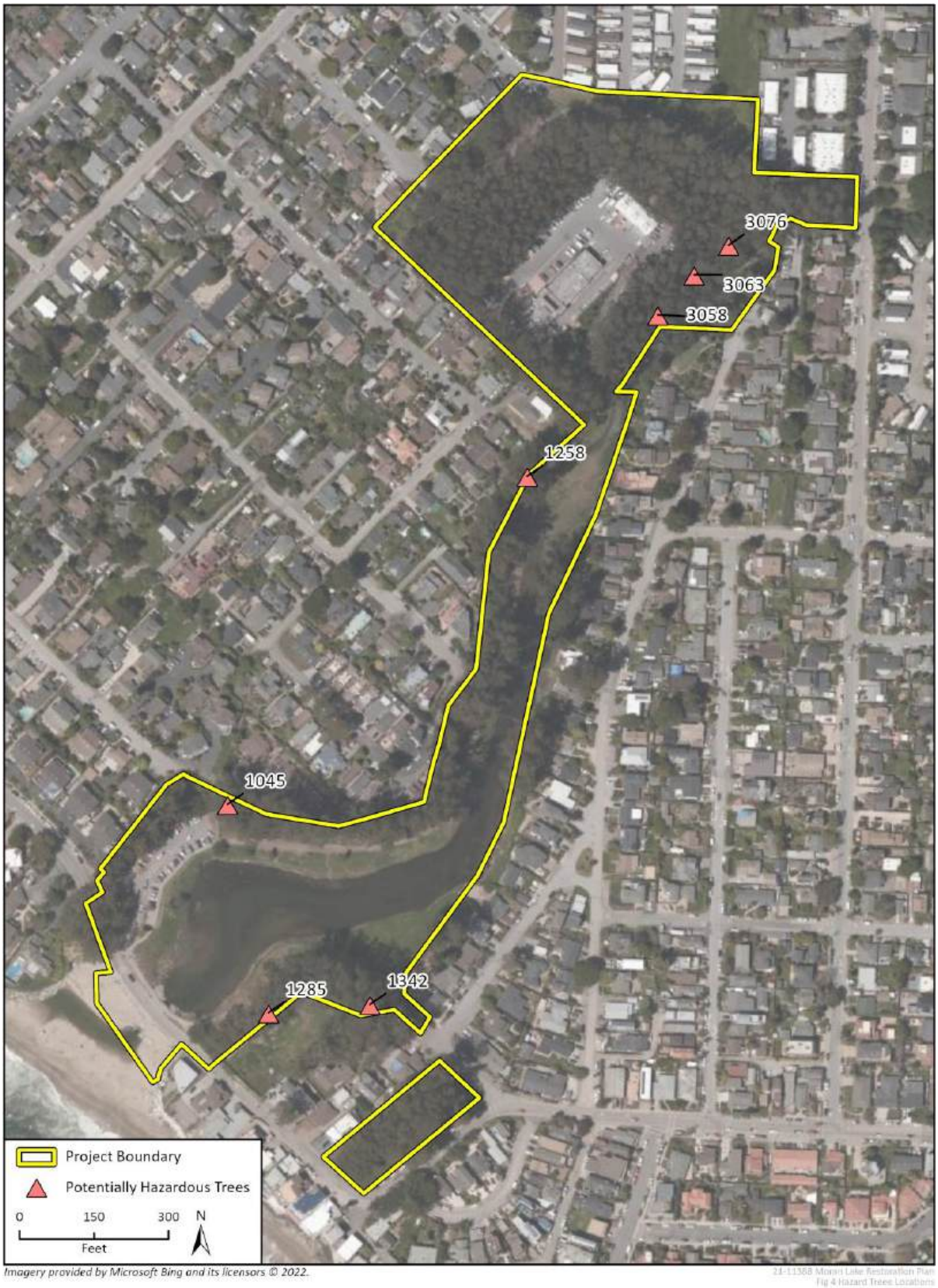
4.7 Fire Risk Assessment

If a fire were to originate or spread into the Park, the likelihood of that fire being a severe crown fire is very high. Blue gums are prone to fire and are known to produce combustible resins which are excreted through their leaves. Additionally, the eucalyptus canopies within the Park form a dense continuous layer and contain an ample amount of fuel loading and dead wood. A severe crown fire would most likely be spread through a house fire adjacent to any of the Parks eucalyptus groves. If a house fire did occur and spread into the groves canopy, the entire grove (and monarch overwintering habitat) would likely be destroyed due to the canopy's dense nature, flammable resins, and exposure to coastal wind patterns, which would spread the fire through the canopy rapidly.

However, the area surrounding the Park is developed and contains very little fuel and the understory of the grove, and the Park, is generally sparse and contains poison oak (*Toxicodendron diversilobum*), cape ivy (*Delairea odorata*), and English ivy (*Hedera helix*), when present. These are evergreen species and are generally nonflammable. Therefore, ladder fuels, which are required to spread a ground fire into a crown fire, are largely absent. Due to the lack of ladder fuels within the Park, and the Parks urban/developed surroundings, the risk of a severe crown fire spreading into or originating within the Park is relatively low.

It should be noted that to create good wind shelter, select edges of the sanitation facility groves understory should be sealed with mid-story trees and shrubs. This prescription potentially creates ladder fuels. However, the vertical continuity of fuels could be partially ameliorated by spatial separation of the shrub later from the mid-story tree layer, via offset plantings. Exact configurations of these wind shelterbelts will require detailed field examination and will need to consider light availability and potential crowding. If a vertical continuity of fuels (i.e., ladder fuels) is created through the addition of mid-story trees and shrubs, the risk of a ground fire spreading into a high intensity canopy fire becomes moderate to high.

Figure 2 Potentially Hazardous Trees Map



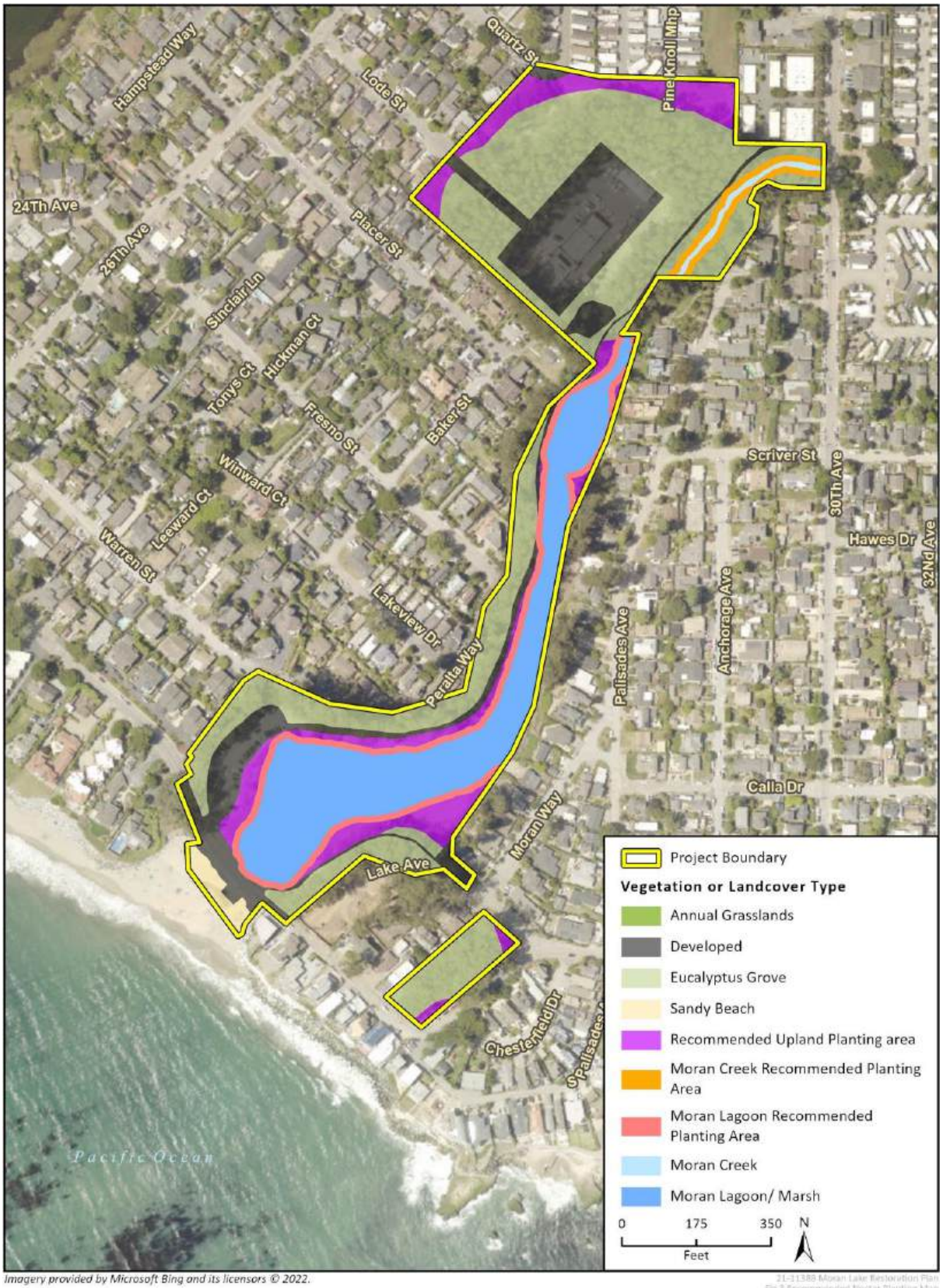
4.8 Fall and Winter Nectar Plants

Native monarch nectar plants are absent in the Park. The sole source of nectar for fall returning and overwintering monarchs is from introduced plants. The most common introduced nectar plants in the Park, along with their bloom periods, are listed in order of abundance in Table 2 below. The English ivy and cape ivy are found growing throughout the understory of the eucalyptus groves and the ice plant (*Carpobrotus edulis*) and pride-of-madeira (*Echium candicans*) are found growing adjacent to the parking lot and the Park's hiking trail. The vegetation communities where these nectar plants occur are shown in Figure 3.

Table 2 Fall and Winter Monarch Nectar Plants found in the Park

Species	Bloom Period
English ivy (*Hedera helix*)	August through November
Cape ivy (*Delairea odorata*)	November through March
Ice plant (*Carpobrotus edulis*)	Typically year round
Pride-of-Madeira (*Echium candicans*)	February through October
Blue gum eucalyptus (*Eucalyptus globulus*)	January through March

Figure 3 Recommended Nectar Planting Map



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5 Recommendations

The 2010 Monarch Butterfly Habitat Management Plan's focus of management is the preservation of trees that create and protect roosting areas. The plan recommended that the grooves should be designed to maintain their spatial configuration and size. The plan called for equally important considerations, including the preservation and/or enhancement of appropriate nectar and water sources and understory vegetation within the Park.

The Park's current management priority should focus on planting location specific tree species that provide additional wind shelter to the sanitation facility groves cluster sites. Monarch butterfly nectar plantings should be considered during the creation of the restoration plan to encourage a boost in overwintering population numbers. Forest thinning could be considered, especially if the groves health decreases, to promote an increase in the health condition and vigor in the grove.

Detailed recommendations regarding the delineation of management zones, vegetation management, and management action thresholds are provided below.

5.1 Delineation of Management Zones

The trees extending south along Moran Creek and Moran Lagoon, south of the sanitation facility grove (Roost Areas A, B, and C), appear to have minimal effect on the microclimate conditions of the sanitation facility grove. Therefore, management efforts should concentrate on the immediate surroundings of the sanitation facility grove and within the sanitation facility grove itself (Roost Areas D, E, F, G, and H).

5.2 Vegetation Management

5.2.1 Tree and Shrub Plantings for Wind Shelter

Recommendations for tree and shrub plantings for wind shelter were made based off the microclimate data obtained during the 2021/2022 site assessment surveys. Species specific recommendations were made based on suitability to the microclimate conditions found within that segment of the Park. Native plants are recommended for planting due to the additional ecological value they provide as well as being adapted to their local environment (e.g., drought, coastal influence, soil).

A series of plantings should be installed surrounding the sanitation facility grove to seal up the outer edges to wind exposure. The priority planting areas include the open northeastern and northwestern edges of the grove, within the grove's southeastern gap, and along the southeastern boundary of the grove, southeast of Moran Creek. Figure 4 depicts the wind shelter planting locations by the management recommendation number listed below.

The following wind shelter plantings are recommended:

1. California bay (*Umbellularia californica*), coast live oak (*Quercus agrifolia*), and/or Monterey cypress (*Hesperocyparis macrocarpa*) should be planted along the northeastern edge of the sanitation facility grove.

2. Coast live oaks and California bays should be planted along the northwestern boundary of the grove.
3. The existing blue gum saplings within the open rows of the grove should be encouraged to fill in the canopy. Additional blue gums should be planted in areas where saplings are not present and where there is an opening in the groves canopy.
4. A small stand of Monterey cypress trees should be planted along the southwestern corner of the northeastern boundary of the grove, opposite of the trail opening, to seal against northernly winds.
5. Evergreen trees, such as coast redwood (*Sequoia sempervirens*) or California bay, should be planted to fill in the existing row of trees along the southeastern boundary of the grove on the southeastern side of Moran Creek, if approved by the private land owners.
6. Blue gums should be planted at the top of the slope to fill in the grove's southeastern gap.

5.2.2 Nectar Planting and Management

Nectar planting and nectar plant management recommendations were made through a combination of literature review and background research and were location specific to the habitat documented during the 2022 Biological Resources Assessment field survey (Attachment C). The resources analyzed during the literature review and background research included the Xerces Society's recommended list for monarch nectar plants in California (Xerces 2019), Calflora's Information on Wild California Plants (Calflora 2022), and The Jepson Manual (Baldwin et al. 2012). These resources were analyzed to determine habitat specific monarch nectar plants that are known to occur within the vegetation communities in the Park and within the Park's vicinity. Only fall and winter nectar plants were recommended. Fall nectar plants were recommended to attract monarchs back to the site and to build up fat reserves for the winter and winter nectar plants were recommended to retain monarchs throughout the overwintering season and to provide them with the necessary sugars to build fat reserves prior to spring migration. Spring and summer nectar sources and milkweeds (*Ascelpias* spp.) should not be planted in the Park. These plants disrupt the monarchs natural spring migration pattern. Disrupting the monarchs natural migration pattern can lead to further conditions which may contribute to population decline. Although introduced plants also provide nectar for monarchs, native plants are recommended for planting due to the additional ecological value they provide as well as being adapted to their local environment (e.g., drought, coastal influence, soil).

Monarchs are less likely to use nectar plants in deep shade. Therefore, nectar plants of various species should be planted primarily in sunny areas, or in areas with dappled light outside of the blue gum groves. Since monarchs will fly hundreds of meters to nectar sources, there are a variety of suitable planting locations within the Park. The most suitable nectar plant locations include the annual grasslands, ruderal land cover, and ice plant mat (if restored) areas. Figure 3 depicts the recommended planting locations, which are found south of the grove along the hiking trail and adjacent to Moran Creek, surrounding the parking lot, to the northwest and northeast of the grove, and south of Moran Lagoon. The banks of Moran Lagoon are also a suitable location for marsh nectar species. The banks of Moran Creek contain suitable habitat for riparian nectar species; however, this location is less likely to be used for nectaring due to the presence of a deep shade provided by the surrounding blue gums. A concentrated pollinator garden could be considered near the parking lot or in an open area adjacent to the hiking trail south of the sanitation facility grove.

Table 3 provides a list of recommended nectar plants, their bloom periods, and species-specific notes and is organized by the plant form (i.e., herbaceous plant, shrub, or tree) and the recommended habitat type for planting.

Table 3 Recommended Fall and Winter Nectar Plants for Overwintering Monarchs

Upland Areas (i.e., grasslands, ice plant mats, ruderal land cover)		
Shrubs		
Species	**Bloom period**	**Notes**
Brittle leaf manzanita (*Arctostaphylos crustacea*)	February through April	Likely entire genus is attractive to monarchs.
California goldenbrush (*Ericameria ericoides*)	September through November	Great late season nectar source.
Coyote bush (*Baccharis pilularis*)	September through January	Easy to grow, does well in previously disturbed areas. Entire genus is likely attractive to monarchs.
Hoary manzanita (*Arctostaphylos canescens*)	January through May	Likely entire genus is attractive to monarchs.
Santa Cruz manzanita (*Arctostaphylos andersonii*)	January through March	Endemic to Santa Cruz and surrounding counties. Likely entire genus is attractive to monarchs.
Perennial Herbaceous Plants		
Species	**Bloom period**	**Notes**
California goldenrod (*Solidago velutina*)	August through October	Likely the entire genus is attractive to monarchs. Great late season nectar source.
Roughleaf aster (*Eurybia radulina*)	January through October	-
Seaside daisy (*Erigeron glaucus*)	January through August	-
Moran Creek Banks		
Trees		
Species	**Bloom period**	**Notes**
Arroyo willow (*Salix lasiolepis*)	January through July	Deciduous – would not provide complete wind protection during the winter.
Red willow (*Salix laevigata*)	December through June	
Shrubs		
Species	**Bloom period**	**Notes**
Douglas' baccharis (*Baccharis glutinosa*)	July through October	Likely entire genus is attractive to monarchs. Important nectar source for many insects.
Mulefat (*Baccharis salicifolia*)	All year	
Perennial Herbaceous Plants		
Species	**Bloom period**	**Notes**
Coastal gumweed (*Grindelia stricta*)	May through October	-
Western goldenrod (*Euthamia occidentalis*)	July through November	Likely entire genus is attractive to monarchs.

Moran Lagoon Banks		
Shrubs		
Species	**Bloom period**	**Notes**
Douglas' baccharis (*Baccharis glutinosa*)	July through October	Likely entire genus is attractive to monarchs. Important nectar source for many insects.
Perennial Herbaceous Plants		
Species	**Bloom period**	**Notes**
Coastal gumweed (*Grindelia stricta*)	May through October	-
Western goldenrod (*Euthamia occidentalis*)	July through November	Likely entire genus is attractive to monarchs.

5.2.3 Existing Nectar Plant Management

The Park's existing cape ivy, English ivy, ice plant, and pride-of-madeira should not be removed during restoration activities unless they occur directly within a designated restoration area or are actively impacting the health of a necessary wind shelter or roost tree within the sanitation facility grove. These species provide an abundant supply of nectar for fall returning and overwintering monarchs, which is currently not supplied in the Park, or the Park's vicinity, by native plants.

5.2.4 Forest Thinning and Fire Risk Abatement

Forest thinning recommendations were made based on the data gathered during the 2022 arborist survey. Grove health, density, and individual tree size were analyzed to determine the health of the grove in relation to the number of trees present.

Selective thinning would benefit the groves overall health. Selective thinning would reduce competition between trees, allowing the health of the remaining trees to increase noticeably. Trees selected for removal should include trees that are of lesser health (i.e., poor health trees mapped during the 2022 arborist survey [Attachment B]), trees that are generally within the understory of the grove and should include trees that are evenly spaced out to prevent large canopy openings. Selective thinning would reduce competition and free up valuable resources, allowing the remaining groves health to increase. The remaining blue gums canopy would expand and fill in the gaps of the removed trees over time. Selective thinning would also decrease the groves susceptibility to a high-intensity crown fire by decreasing the overall fuel load and dead wood within the canopy. Care should be taken to not overthin the grove. If selective thinning is pursued, a registered professional forester should be contracted to identify which trees should be removed and coordination should be undergone with the Project's entomologist to ensure removal would not alter the microclimate of the grove in such a way to negatively affect overwintering monarchs.

In addition to forest thinning, blue gum limbs and trees that have naturally fallen throughout the Park should be actively removed to decrease fuel loading and eliminate ladder fuel within the understory of the Park's groves. Lastly, if the sanitation facility groves understory is sealed with mid-story trees and shrubs, they should be spatially separated from each other and the blue gum canopy by offsetting the plantings to avoid the creation of ladder fuels to the maximum extent feasible.

5.2.5 Tree Removals and Hazard Pruning

Removal and hazard pruning recommendations were based on the tree's health condition, structural integrity, and its hazard potential. In general, if the tree is dead or declining or possess a

hazardous condition but is located within a natural area with low to no human traffic, the tree was not recommended for removal or hazard pruning. However, removal or pruning is recommended for hazard trees that are located within a high-traffic area, in areas with sensitive infrastructure, and for dead trees within the sanitation facility grove. Dead trees within the sanitation facility grove are located within a natural area with low to no human traffic; however, the dead trees and leafless branches do not contribute to monarch habitat and are a liability to nearby trees when they fall, which could decrease monarch roosting habitat and open up the grove to wind penetration.

Care should be taken in assessing the urgency of all current and future hazardous trees within the sanitation facility grove. The potential for opening the cluster sites to wind if any of the trees or their branches are removed shall be assessed prior to removal. The smallest amount of the tree should be removed as feasible to reduce the hazard. Topping of trees is not recommended due to the weakly attached nature of epicormic shoots. Additionally, epicormic shoots generally do not grow as tall as other mature eucalyptus trees and may not provide adequate wind protection for overwintering monarchs. These trees, and all other hazardous trees, should be removed or pruned in a timely manner. All tree work should occur outside of monarch overwintering season (October-March), unless a true emergency arises. The Project's entomologist should be consulted prior to any tree maintenance activities within the grove.

Removal of trees or branches of potentially hazardous trees outside of the sanitation facility grove should be routine if hazards are identified. Removal of these hazardous trees or their parts would likely not alter the microclimate conditions in such a way to negatively impact overwintering monarchs in the grove. Table 4 provides the potential hazard and the recommended action for each hazard tree identified during the 2022 arborist survey. The locations of the potential hazard trees are depicted in Figure 4. All dead trees located within the sanitation facility grove are depicted in Appendix A and Appendix B of the Moran Lake Restoration Project Arborist Report (Attachment B).

Table 4 Recommended Actions for Hazard Trees in the Park

Tree Number	Species	Potential Hazard	Recommendation
1045	Blue gum	Long heavy branches leaning over pathway.	Trees are outside of the sanitation facility grove. Tree maintenance will not impact the microclimate conditions within the overwintering cluster sites. Hazardous branches should be pruned back so they no longer overhang the pathway or hiking trail.
1258	Blue gum	Broken limb hanging over trail	
1285	Blue gum	Heavy codominant steam leaning over pathway.	
1342	Blue gum	Dead branches over hiking trail.	
3058	Blue gum	Dead tree that is significantly leaning over hiking trail.	Tree is within the sanitation facility grove, but it is dead with no canopy. Tree should be removed to eliminate the hazard.
3063	Blue gum	Fair health tree with a large heavy branch with included bark at its attachment overhanging the hiking trail.	Tree is within the sanitation facility grove but the large overhanging branch presents a potential hazard to hikers. The branch should be removed at its conjunction with the tree's trunk.
3076	Blue gum	Tree is significantly leaning over the hiking trail (60 degrees)	The tree is within the sanitation facility grove but presents a hazard to hikers. The tree is generally a smaller understory tree in fair condition, removal will likely not significantly impact the microclimate conditions within the grove. Tree should be removed.

Figure 4 Recommended Wind Shelter Plantings Map



5.3 Management Action Thresholds

If the health of blue gums within the grove decreases and mass foliage losses occur at the cluster sites, additional management actions within the grove should be assessed. Selective thinning should be considered to free up necessary resources, soil amendments should be considered to encourage new growth, and a drip irrigation system could be installed to provide additional water, which is likely the greatest limiting resource. The Park's arborist and entomologist should be consulted prior to initiating management actions.

If monarchs are not observed within the Park or within any other known overwintering grove throughout the central coast (i.e., Santa Barbara through Santa Cruz) for more than 5 consecutive years, they should be considered extirpated from the region. Management resources should be reallocated to other Park interests.

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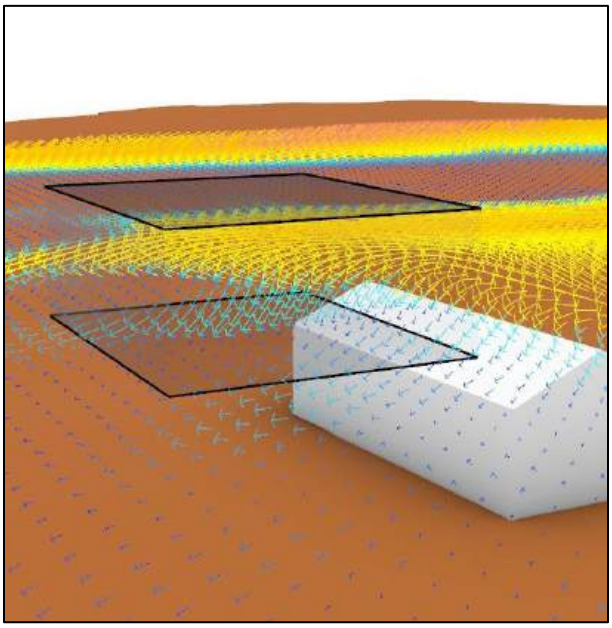
Appendix A

Assessment of Moran Lake Monarch Overwintering Habitat

Moran Lake Monarch Butterfly Habitat and Tree Management Assessment
June 2025



Monarchs at Moran Lake



Wind Model Output

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June 2025

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Moran Lake monarchs clustering Creekside area November 2022

Executive Summary

To assess the effects of tree hazard management at the Moran Lake monarch overwintering site, we did intensive modeling of 10 m/s (22 mph) wind within the forest canopy under current conditions and under various management scenarios. We concentrated on the cluster zone in the grove NE of the sanitation yard.

Conclusions include:

1) Monarchs have opportunities to make small changes in distribution to track wind and sunlight within the cluster zone. The cluster zone grove itself provides significant, but not complete, wind shelter from SW winds.
2) The Placer Street trees provide a critical windbreak from SW winds but could be reduced to 80 ft and still provide suitable wind shelter from SW winds for the cluster zone NE of the sanitation facility yard.
3) An idealized scenario that reduces tree heights to 1x the distance to targets also provides suitable SW wind shelter for the cluster zone. The practicality of this configuration is deemed feasible in terms of tree health and structure.
4) The cluster zone is currently well-sheltered from SSW winds. Removal of the SE and S Lakeside groves has a minimal effect on SSW wind speeds in the cluster zone, which are below 2 m/s (5.2 mph). Removal of the N Lakeside grove in addition does increase SSW wind exposure so that 27% of the cluster zone experienced S-winds greater than 2 m/s.
5) Reducing the heights of these Lakeside groves to 70 ft provides better shelter than complete removal.
6) Reducing tree heights along the north-edge to equal the distance to the nearest target has minimal effect on north-wind exposure in the cluster zone. A previous recommendation for planting cypress trees in the “Boneyard” to block wind penetrating through an existing road/trail opening would secure this north-edge.
7) Several trees in the Creekside area are regularly occupied by monarchs, so no major modifications (beyond trimming immediate hazard branches) in this area are acceptable for monarchs.
8) The proposed tree removal and height reduction is compatible with tree health and possible with long-term commitments to grove management.

Objectives

Overwintering monarch butterflies are highly sensitive to wind, which along with sun exposure, is a fundamental driver of site occupancy and movements. Creating and maintaining suitable wind shelter is a critical aspect of overwintering site management. We seek to accomplish this while addressing public safety concerns from hazard trees. A detailed assessment of Moran Lake habitat conditions is presented by Weiss (2022).

The primary objective of this study is to model baseline wind conditions within the Moran Lake Monarch Overwintering Site (Xerces Society Site Identification 2983), and assess the effects of potential canopy modifications (to reduce treefall hazards to property) on the distribution of wind within the monarch cluster zone. We considered 7 scenarios designed to test various management treatments to different groups of trees across the site (Table 1, Map 1).

Table 1. Scenarios considered:

Scenario Number	Description
1	Placer Street Windbreak Critical Height and Baseline
2	Placer Street Windbreak 1x Height to Target
3&4	Complete Removal of Southern Groves
5	70-foot Canopy Height at Southern Groves
6	North Edge 1x Height to Target
7	South Creekside at Critical Heigh

Scenario 1 includes simulations of 10 ft incremental height reduction of the Placer Street trees to identify the critical height from 140 ft down to 30 ft. A complete removal was simulated as an “end member” (absolute/farthest possible end of a range) to evaluate the isolated sheltering effect of the forest edge in the cluster zone. See *Wind Speed Percentiles with Placer Height* section for why 80 ft was selected as the critical height.

Scenario 2 postulates a windbreak design that removes all canopy within 1x the distance to the nearest target along Placer Street with a “stepped back” design.

Scenarios 3 and 4 postulate complete removal of stands of trees around Moran Lake, south of Placer Street Windbreak and main monarch habitat around the sanitation yard. This includes North Lakeside, South Lakeside, and Southeast Groves.

Scenario 5 postulates reducing those southern groves to 70 ft.

Scenario 6 postulates height reduction to 1x distance to targets along the North Edge.

Scenario 7 considers reduction of tree heights in the Creekside Zone, SE of the yard.

Map 1. Groves Overview



Methods

The basic workflow to simulate wind conditions was as follows:

First we acquired LiDAR data from NOAA's Data Access Viewer (OCM Partners, 2025). The LiDAR dataset had an estimated point spacing of 0.19 meters. The LiDAR data was part of a collection effort that spanned the timeframe of 2020-03-22 to 2020-04-15.

The LiDAR point cloud came in the .las file format. Our first step in processing the point cloud was to load it in CloudCompare, where we separated the point cloud into classifications of ground, and unclassified points. We then exported the point clouds to the .e57 file format.

Next, we loaded the .e57 point cloud of ground classified points in Rhino 7 using Grasshopper and Volvox, plugins for Rhino 7. In Rhino 7 we used a Delaunay triangulation method to connect the ground points into a mesh surface representing ground terrain. In order to resolve imperfections in this resulting geometry we had to perform three iterations of quad-remeshing to smooth the geometry and produce a valid "good" mesh representing the ground. Some of the imperfections eliminated by this process include self-intersecting faces, mesh surfaces with aspect ratios greater than 1:5, and angles less than 60°.

We created building geometries by manually extruding box geometries to the maximum height and extent of each building nearest to the Placer Street windbreak, and north edge groves. Buildings within the sanitation yard were modeled with greater precision than those buildings surrounding the groves. This includes matching roof slope for the building closest to the main monarch cluster location.

Canopy/tree geometries were created using a voxel technique in which a 1 cubic meter voxel would be generated within a standard grid across the site if there were unclassified points located within that volume.

The software used to simulate wind conditions given these input geometries was Eddy3D. Eddy3D uses the OpenFOAM computational fluid dynamics toolbox to simulate wind conditions.

For each scenario we set the wind direction to be in-line with the canopy volume of interest and the main cluster zone. We used a standard wind speed of 10 m/s (22 mph), which represents a moderately strong wind that is likely to occur in any given year. Incoming wind directions were as follows for the scenarios:

Scenario 1: 225° SW

Scenario 2: 225° SW

Scenario 3&4: 200° SSW

Scenario 5: 200° SSW

Scenario 6: 0° N

Scenario 7: 180° S

Voxels were inputted to the Eddy3D model domain as Eddy3D tree objects with a 'Type' set to 'dense'.

Choice of Wind Speeds

We chose a standard wind speed of 10 m/s (22.5 mph) for modeling because that sustained wind threshold is encountered almost every year for at least an hour, especially for SW winds. The wind rose for Watsonville is the only detailed one available for the region and represents wind along the northern Monterey Bay coastline (Windrose).

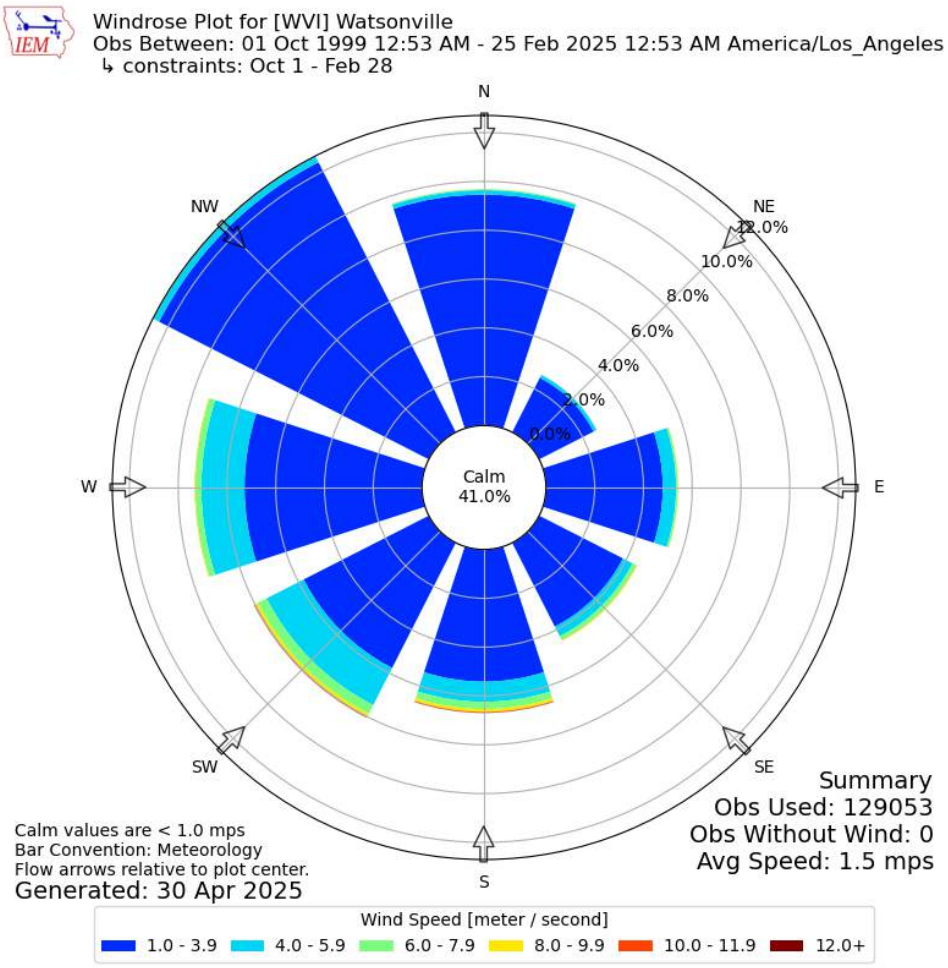
The 10 m/s sustained hourly wind occurs on average 3.5 hours/year from all directions, from SW 1.6 and from S 1.5 hours per year (Table 2).

The choice of the 2 m/s threshold for monarch occupancy is based on Kingston Leong's published work (Leong 1990, 1991) and personal communications. Leong found that the occupancy of a monarch microsite was highly unlikely if the ground-level wind speed was greater than 2 m/s (5.2 mph). Because wind speeds generally increase with height in forest canopies, the wind speed at the monarch cluster sites (often 5-15 m height) will be greater. Therefore the 2 m/s threshold is conservative when considering the height of the clusters.

Table 2. Wind Speed Hours Per Year (October-February)

Direction	Hours per year >10m/s
N	0.0
NE	0.0
E	0.0
SE	0.2
S	1.5
SW	1.6
W	0.2
NW	0.0
Total	3.5

Windrose



Data Visualizations

We use a variety of data visualizations and statistical characterizations to compare scenarios. These include:

1) Oblique views with colorized wind vectors, and a birds-eye view for current conditions.
2) A consistent vertical slice taken perpendicular to the Placer Street windbreak (SW to NE) at the thinnest portion of the windbreak. This is the primary visualization of wind vectors for the Placer Street modifications. A similar vertical slice was taken for the N-edge simulation.
3) Statistical characterization of wind speeds within the cluster zone, based on 4,825 points within an 80 ft (along the fence line) x 65 ft (depth from the forest edge) x 30 ft

(30 ft to 60 ft height from ground) box that encompassed the cluster sites NE of the yard.

a. Depth profiles of absolute wind speed, with density quantiles.
b. Height depth profiles of differences from current conditions (including a scenario with no Placer Street windbreak to characterize the local sheltering effect of the NE forest edge).
c. Histograms of differences.
d. Percentiles of wind speeds with different Placer Street heights.
e. Histograms of absolute wind speed in Scenarios 3-7.

Scenarios

Scenario 1: Placer Street Windbreak Baseline and Critical Height

Scenario 1 first establishes a baseline model of current conditions according to the state of the canopy at the time of LiDAR collection. All scenarios are compared with current conditions. We seek to identify the "critical height," meaning the minimum height of the trees that would maintain acceptable wind conditions for the main cluster site of monarch butterflies. We identified the critical height by successively reducing the canopy height from current conditions (~145 ft tall). And produced a scenario with complete removal of Placer trees to understand the intrinsic shelter provided by the cluster zone trees themselves.

Wind patterns as the result of different canopy geometry can vary in counter-intuitive ways at fine scales because turbulent wind shadows behind obstacles tumble and create eddies. Eddies and waves downwind of canopy obstructions can direct wind in any direction depending on the specifics of the canopy geometry and wind speed. Especially when combined with planar visualizations, which only shows one dimension of the wind conditions, these patterns can cause wind speeds to increase in specific areas even when additional windbreak geometry is added. The inverse is also true, and some areas may show lower windspeeds when windbreak geometry is reduced. The wavelengths of the eddies also depend on the absolute wind speed modeled.

With these caveats in mind, we are looking for robust results that do not depend on these noisy aspects of wind modeling and provide some margin of safety for monarchs and people/property.

Photo 1. Panorama of Placer Street windbreak looking NE showing large gap in center



The vertical slice chosen for visualization runs through the gap, as a worst-case position with the highest wind speed. However, all statistics are done on the entirely of the cluster zone volume so the effects of this gap and more dense parts of the windbreak are spread over a larger volume.

Photo 2. Hemiphotos from an interior cluster location (949) and the N corner of yard (957), The Placer trees extend 10-15° above the horizon from the cluster site. Note that E and W are reversed from map views because the photos are taken looking upward.

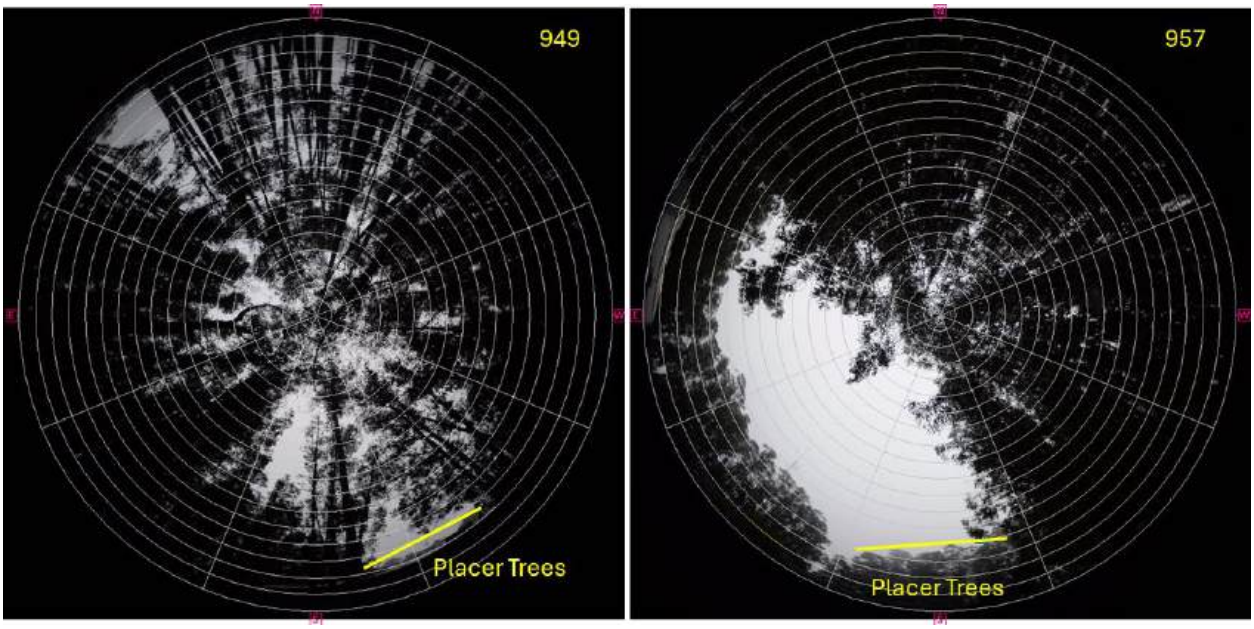


Photo 949 is a cluster site along the opening to the NE (old road access), 50 ft from the forest edge to the SE). The Placer trees occupy 10-15° above the horizon from the cluster site. Photo 957 is at the N corner of the yard; the Placer trees occupy ~20° above the horizon.

Figure 1. Oblique View of Placer Street Windbreak in the model, showing the same gaps as in the photo above. Vectors are wind conditions 30 feet above ground. Canopy voxels shown. The cluster zone is the white box visible at the end of the yard.

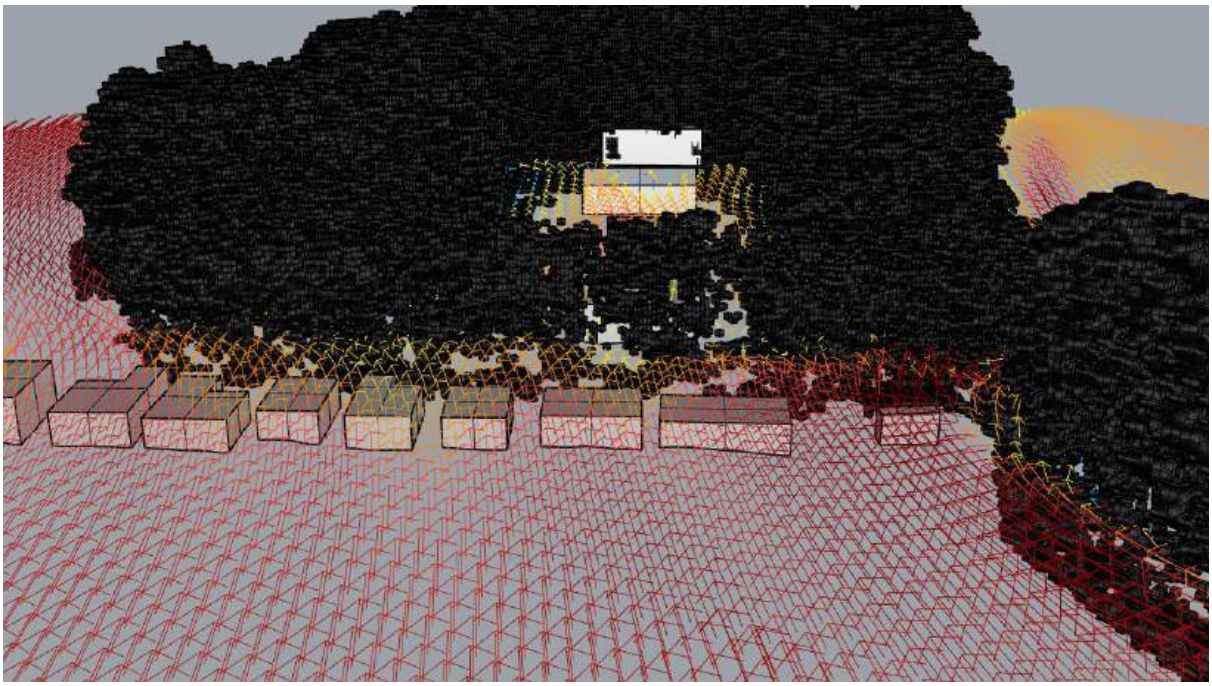


Figure 2. Oblique View of Placer Street Windbreak, Canopy Voxels Hidden. Current wind conditions 30 feet above ground.

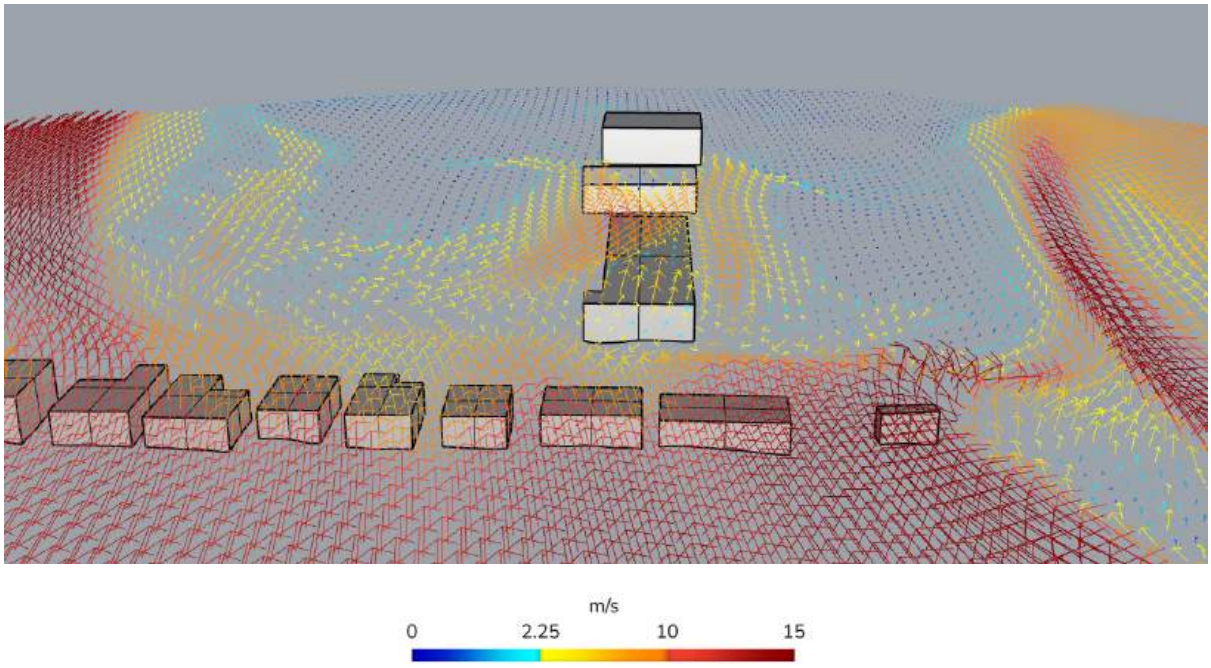


Figure 3. Vertical slice profile of wind through center of yard. Note the vertical variations in direction. From now on the vertical slice profile will be standard graphic.

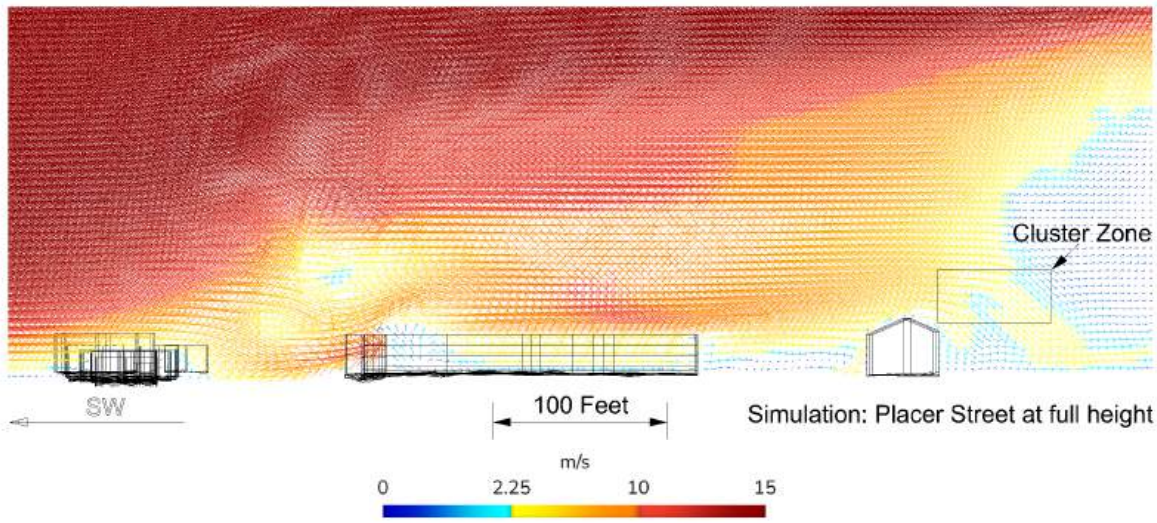
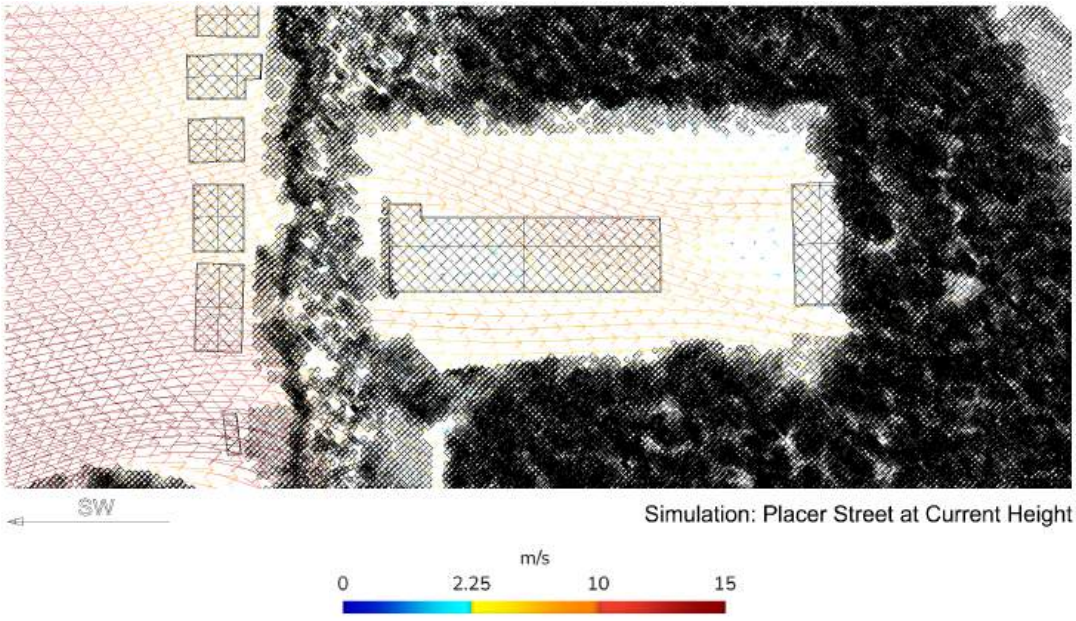


Figure 4. Bird's-eye View of Yard with incoming SW wind, tree voxels shown. Note the changes in wind direction within the yard.



Figures 3 and 4 show the current conditions from two views. Under current conditions, wind penetrates the Placer windbreak most in-line with the main building in the sanitation yard. The highest wind speeds over the yard are dispersed by the far building and canopy edge of the cluster zone (canopy voxels hidden in the representation). The slice of the cluster zone is all yellow and blue (wind speeds 1-3 m/s). The statistics of the entire cluster zone are shown below (Figure 6).

Figure 5A. Vertical Slice for Current Conditions, canopy voxels not shown

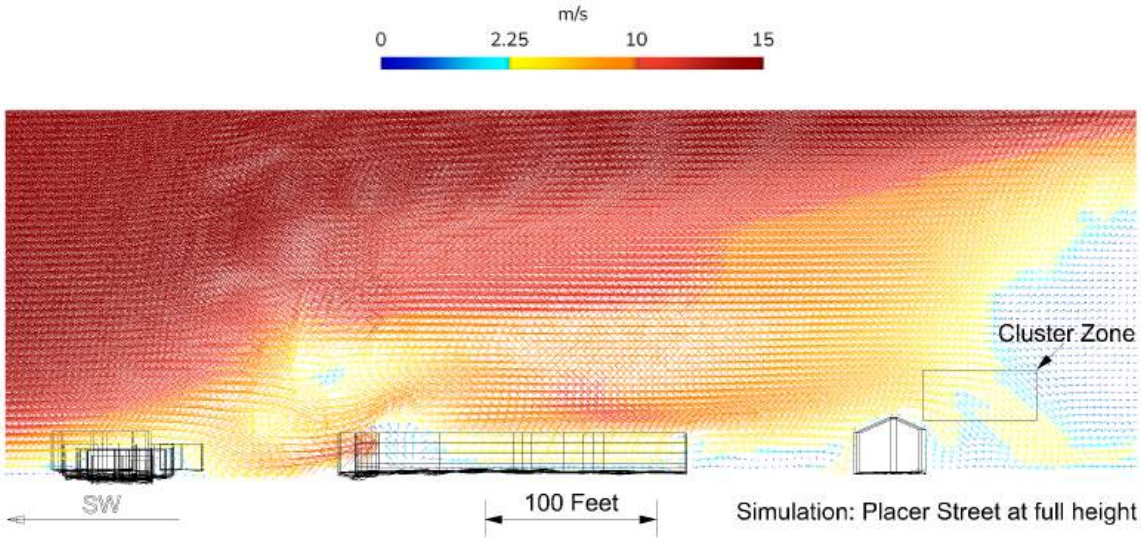


Figure 5B. Vertical Slice for Complete Removal.

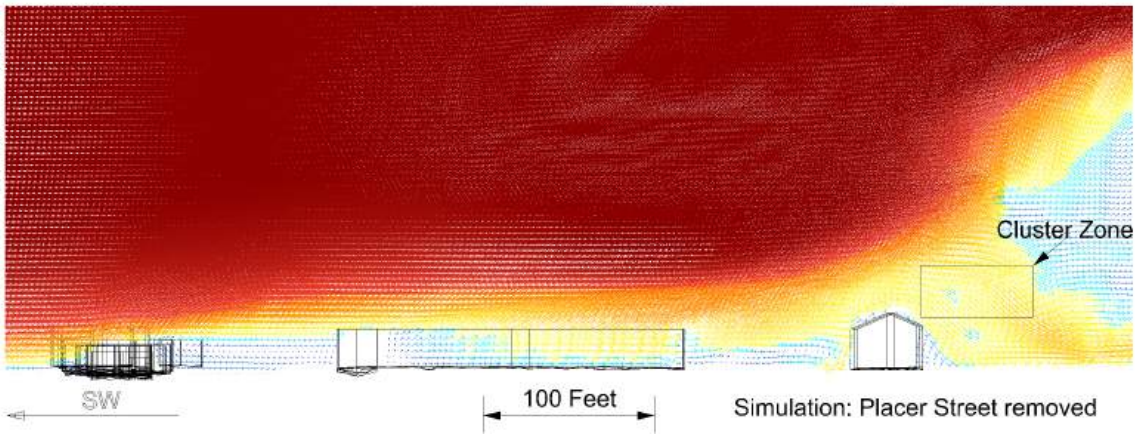
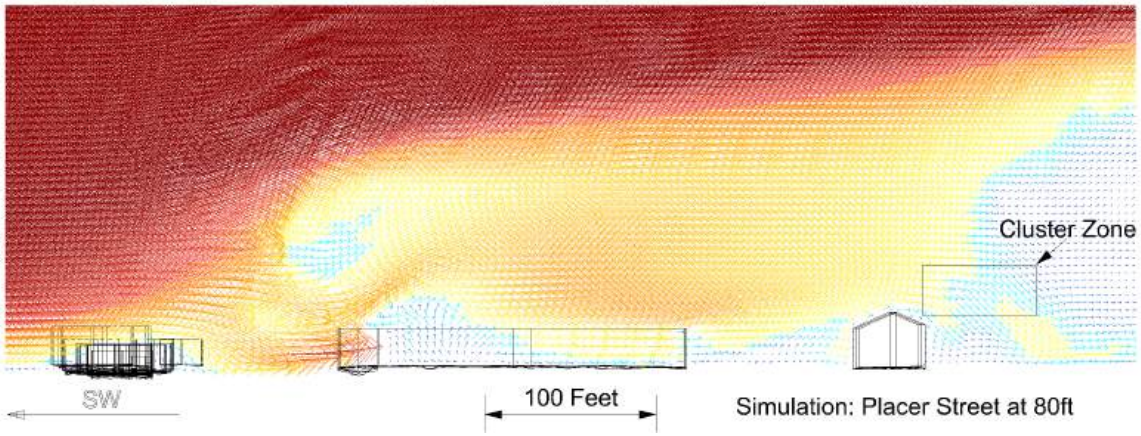


Figure 5C. Vertical Slice for 80 ft Placer Height

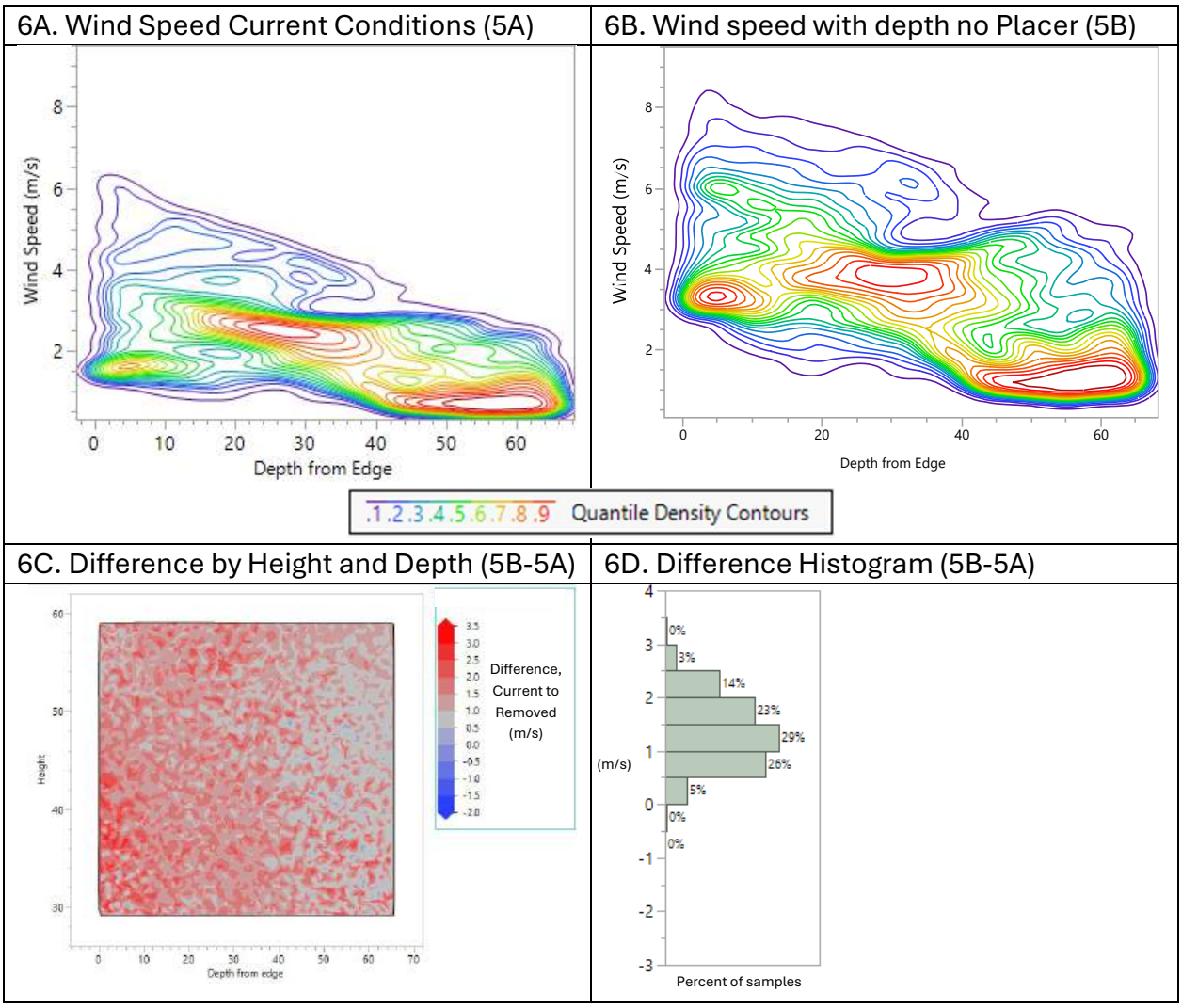


Some of the interesting details of Figure 5 and the variations include:

1) Under current conditions (5A), wind ascends over the Placer trees and there is a calm spot in the middle of the trees.
2) The wind shadow of the Placer trees extends downwind over the entire reach shown.
3) Wind penetrates at low heights through the gap in Photo 1 and Figure 1. That wind ascends and an eddy forms over the main building.
4) The wind accelerates back to ~10 m/s again past that eddy just above the main building.
5) Wind slows to ~3-5 m/s (yellow) at the edge of the cluster zone above the far-right building.
6) The wind descends over the far-right building, and the cluster zone is primarily blue and yellow. The taller trees above the cluster zone attenuate the wind to less than 2 m/s. The open understory below the cluster zone allows wind to remain above 2 m/s near ground level.
7) Under complete removal (5B), the wind stays at 10 m/s across the yard and the friction effect of the main building slows the wind in the first 20 ft above.
8) The red zone of high wind ascends at the forest edge above the cluster zone, but the high interior of the grove is below 2 m/s.
9) The blue vectors in the cluster zone virtually disappear with full removal.
10) The 80 ft Placer scenario (5C) is very similar to the current condition (5A).

The full distribution of wind speeds within the cluster zone are treated in Figure 6 below.

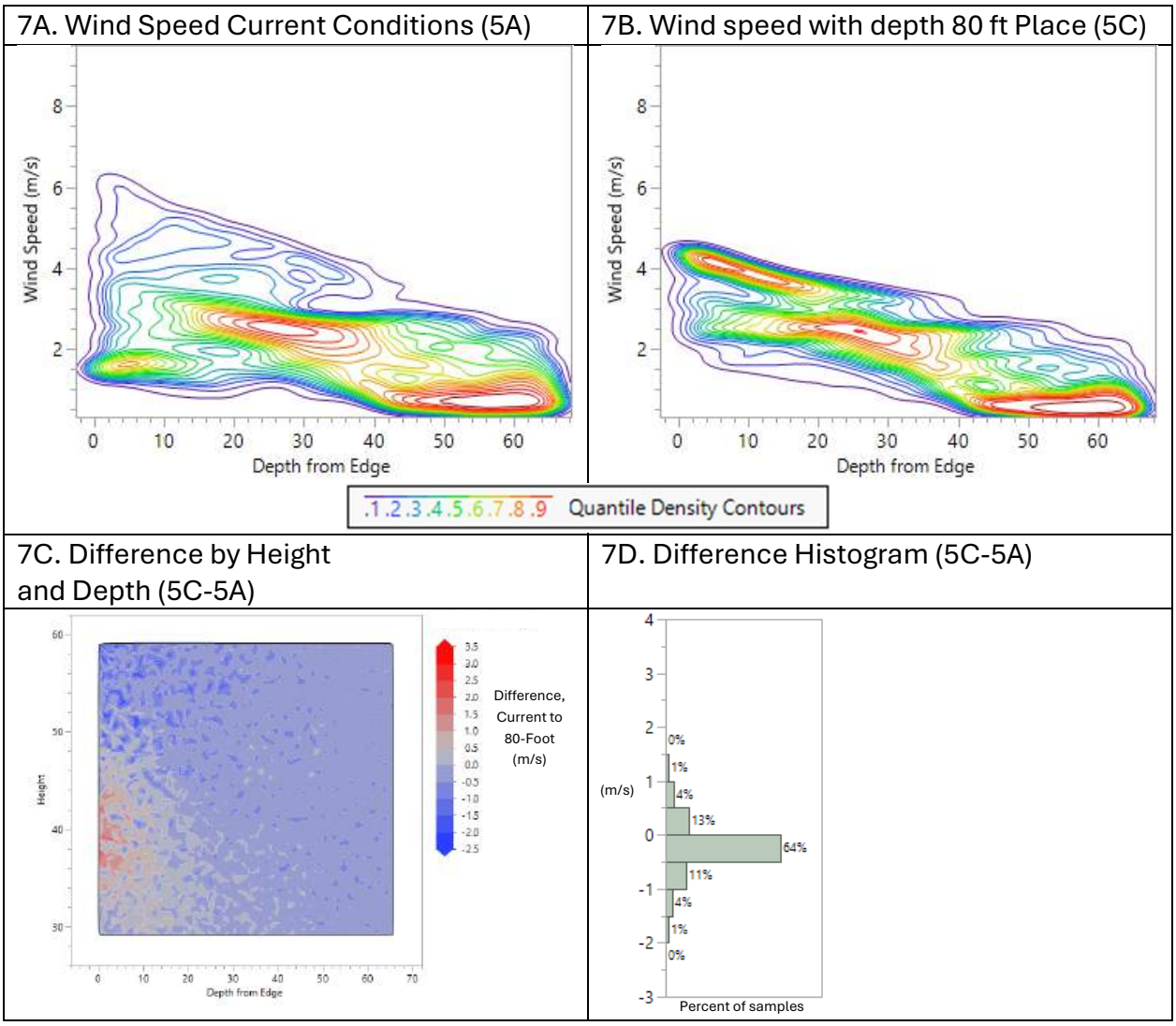
Figure 6. Comparison of current conditions (A) versus complete removal of Placer (B) with depth from edge. Orange and red quantile contours show the relative density of points. The difference by height and depth (C) and the difference histogram (D).



The complete removal scenario is an “end member” so that the wind attenuation of the cluster zone grove itself is isolated. With the current conditions (6A), there are many sites with wind less than 2 m/s at all depths, especially deeper into the cluster zone (40 ft and beyond). With complete removal (6B), the only sites below 2 m/s are greater than 40 ft from the edge. The contour plot of the differences (6C) shows increased wind speed throughout the height and depth of the cluster zone, up to 3 m/s near the edge. The histogram shows 69% of the sites increasing by 1 m/s or more, and 17% increasing by 2 m/s or more.

Remember that the cluster microsites are 40 – 60 ft from the edge.

Figure 7. Comparison of Current Versus 80 ft Placer with depth from edge. Layout is the same as previous figure.



With the 80 ft Placer, the zone close to the edge loses lower wind speeds, but the deeper zone remains less than 2 m/s (7B). When the difference is plotted with height and depth (7C), wind speeds increase (grey and red) primarily within ~20 ft of the edge. 64% of the cluster zone has no change (7D). The 40-60 ft depth zone where the monarchs cluster exhibits little change.

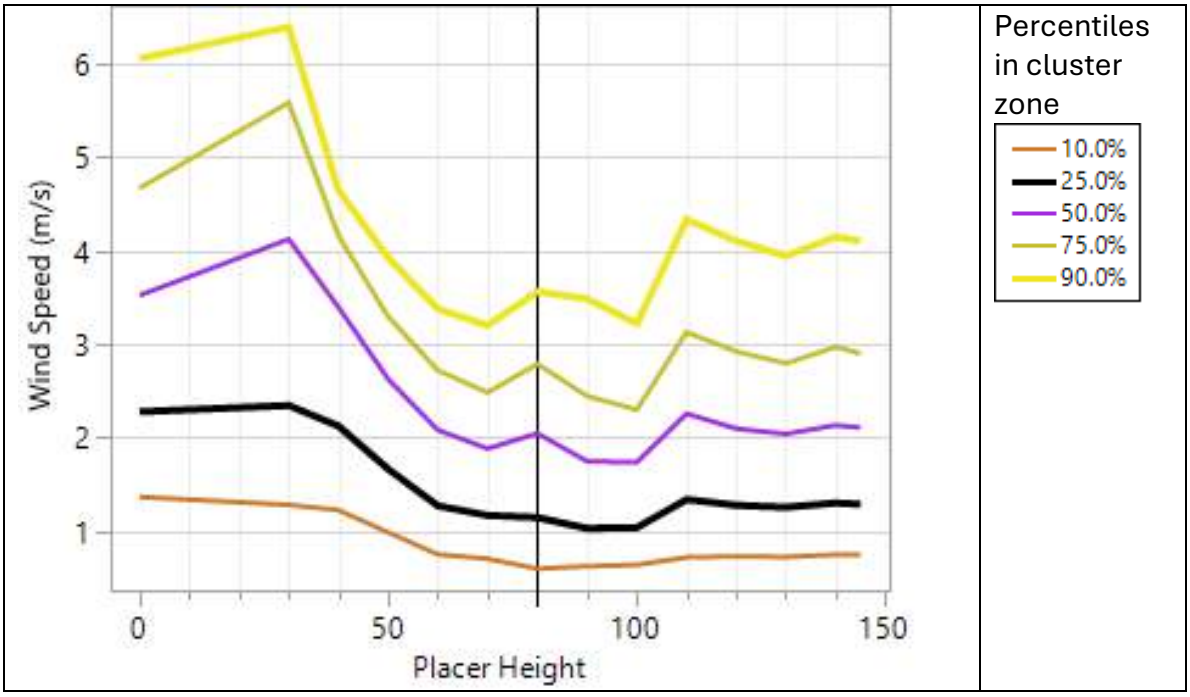
These graphics have been generated for all of the Placer heights considered, but these three scenarios provide sufficient examples of how the wind attenuation works that little will be gained by presenting them all. The synthesis of all the runs is below in Figure 8 with an analysis of wind speed percentiles within the cluster zone.

Wind Speed Percentiles with Placer Height

The results of all the Placer height scenarios are summarized in Figure 8 below. The percentiles of wind speed within the cluster zone are plotted for each Placer height scenario and connected (145 is the current condition, 0 is complete removal as an end member). The black line is the 25th percentile (i.e. 25% of the points within the cluster zone are less than that wind speed). For the 80 ft Placer scenario (vertical line), the 25th percentile (1.15 m/s) and the 50th percentile (2.04 m/s) are virtually the same as in the current condition. Only when Placer is reduced to below 60 ft, do the 25th percentile and other percentiles start to rise. The irregularities in the curves (such as the bump at 110 ft) reflect some of the complex turbulent wavelengths generated by different Placer heights and may vary in shape for different wind speeds.

This analysis provides strong support for the 80 ft height being a safe option, leaving another 10 to 20 ft buffer before wind speed percentiles rise rapidly.

Figure 8. Percentiles of Wind Speed Within the Cluster Zone by the height of the Placer trees (X-axis)

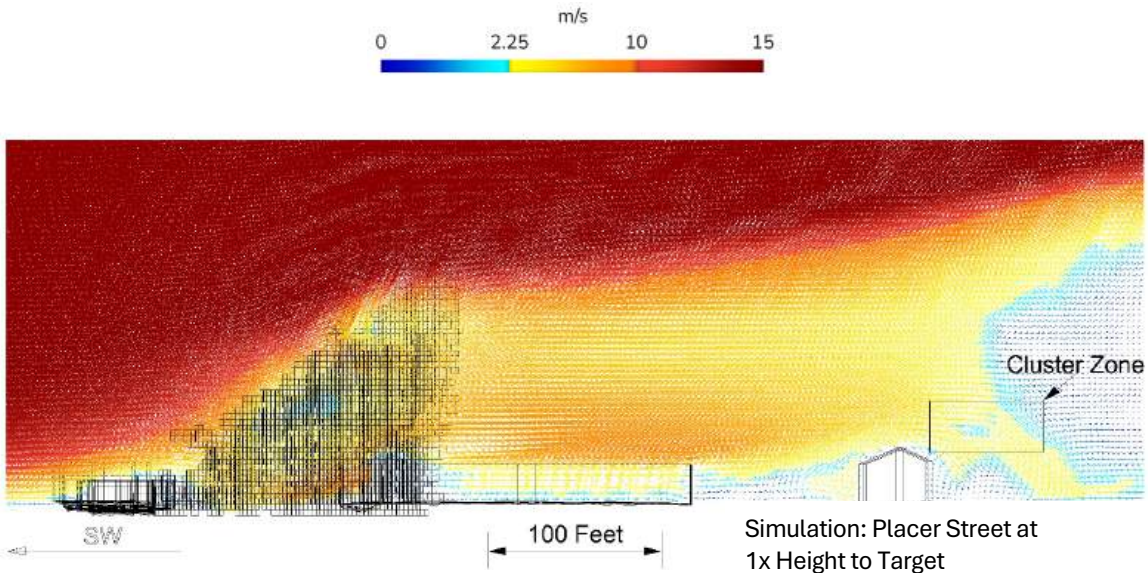


Scenario 2: Placer Street Windbreak at 1x Height to Target

This scenario models wind if the Placer trees were cut in a gradient below heights capable of striking buildings along Placer Street. The canopy geometry modeled is based on a selection of vegetation volume that does not account for actual tree structure and is strictly based on a 45-degree angle from the base of occupied buildings on Placer Street.

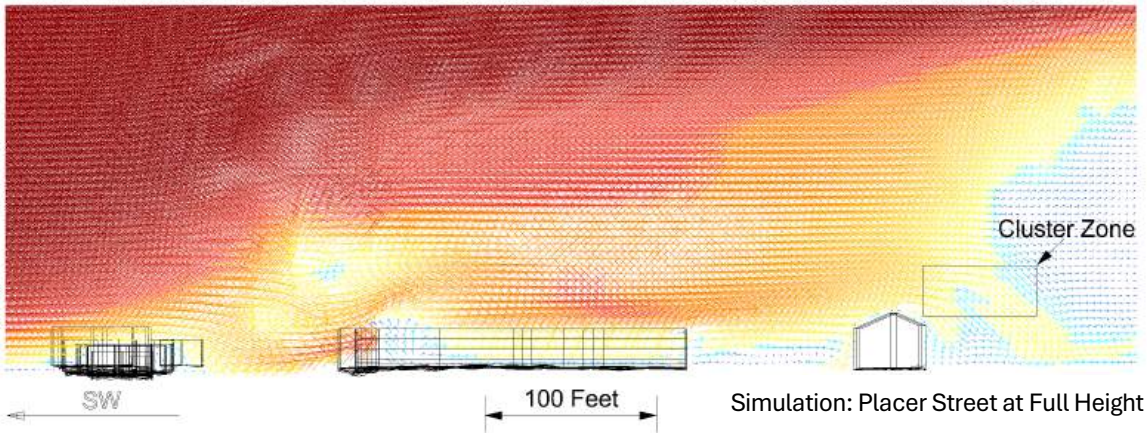
This scenario (9A) produces subtle changes from current conditions (9B). Those differences within the cluster zone are best viewed in Figure 10 below.

Figure 9A Vertical Wind Profile with 1x Height to Target Scenario



Simulation: Placer Street at 1x Height to Target

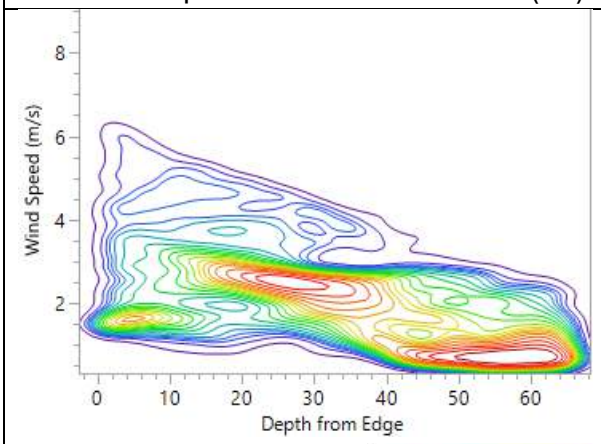
Figure 9B Vertical Wind Profile Current Conditions (same as Figure 5A)



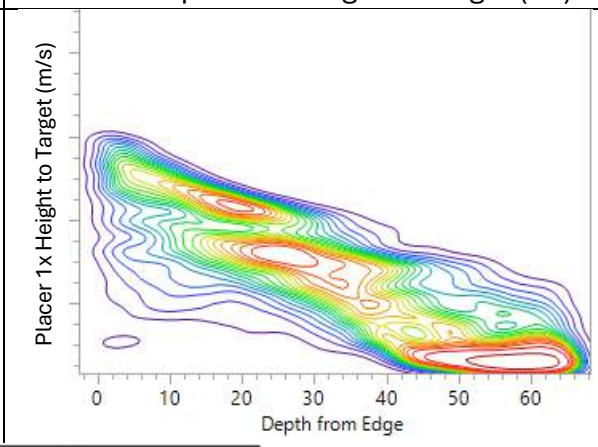
Simulation: Placer Street at Full Height

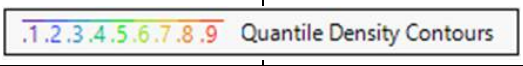
Figure 10. 1x Height to Target Scenario Statistics

10A. Wind Speed Current Conditions (9B)

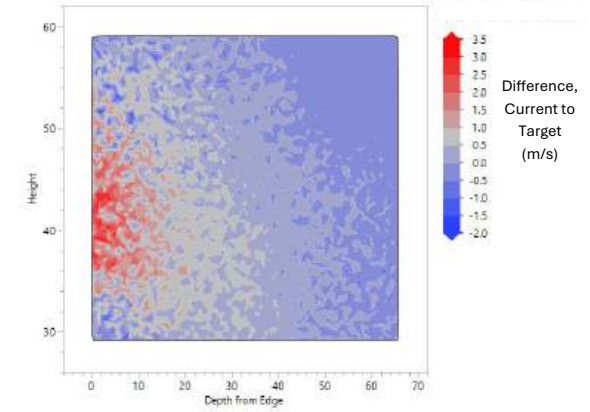


10B. Wind speed 1x Height to Target (9A)

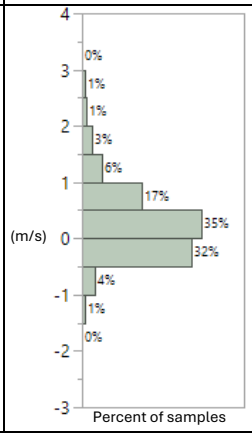




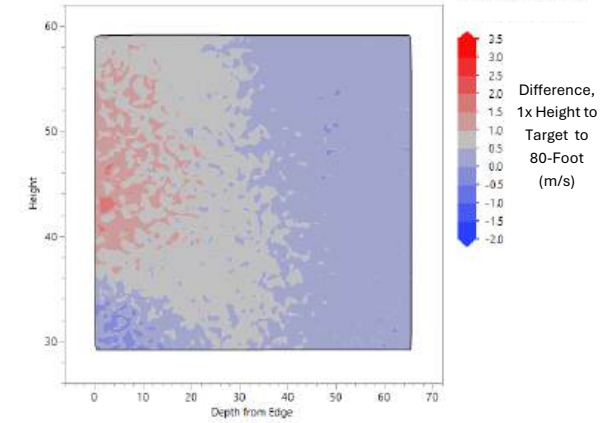
10C. Difference from Current



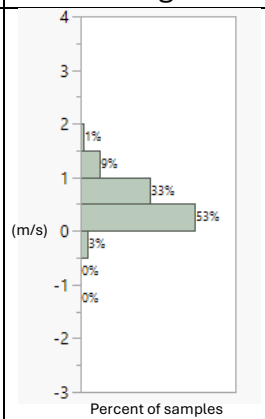
10D. Difference 1x Height to- Histogram



10E. Difference 1x Height to- vs 80 ft Placer



10F. Histogram 1x Height to- vs 80 ft Placer



In the 1x Height to Target scenario, the only areas with wind below 2 m/s are greater than 40 ft depth (10B). The main impacts are within 20 ft of the edge, between heights of 35 to 50 ft (10C). The sites beyond 40 ft from the edge are little affected Compared with the 80 ft Placer scenario, 1x Height to Target mainly changes in that same zone by ~1.5 m/s (10E).

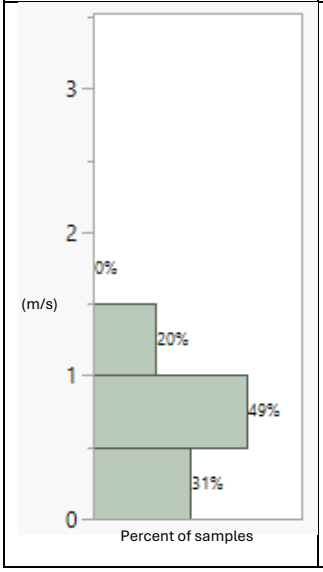
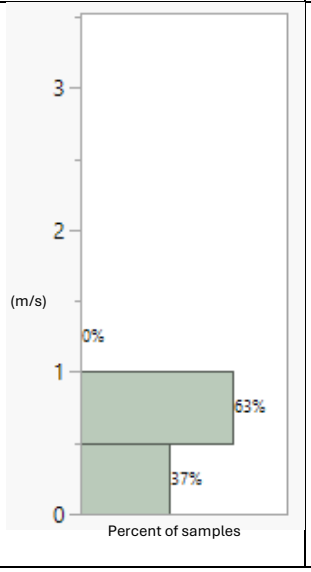
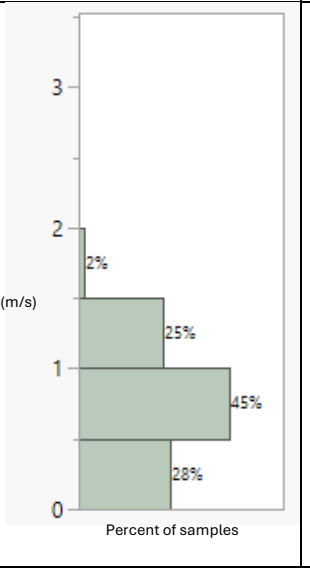
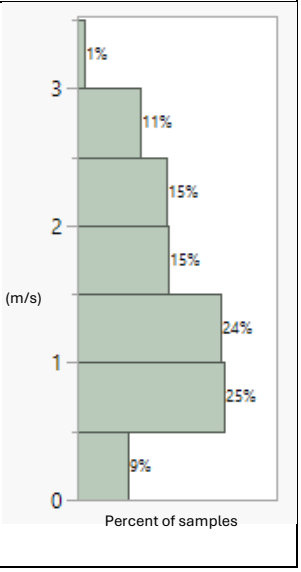
Scenario 3 & 4: Complete Removal of Southern Groves

The set of scenarios referred to as 3&4 includes the complete removal of groves south of the trees immediately sounding the sanitation yard. This includes the Southeast Groves, South Lakeside, and North Lakeside. In the simulations we iterated through removing the groves in the order mentioned above.

The effect of these changes was tested using an incoming 10 m/s wind direction of 200°. This wind direction puts the southern groves directly in line with the main cluster site. This allows us to establish the maximum amount of protection provided by the southern groves. We set the Placer trees at the critical 80 ft height.

The current conditions of the North Lakeside, South Lakeside, and Southeast groves provide excellent 200° (SSW) wind protection for the cluster zone, with only 20% of the volume greater than 1 m/s and none greater than 2 m/s. Removal of the SE and S groves does not create areas of higher winds. The only scenario that creates wind speeds greater than 2 m/s is complete removal of the three groves in question, an extreme scenario; 27% of the cluster zone volume has wind speeds greater than 2 m/s.

Figure 11. Histograms of Absolute Wind Speed in Cluster Zone for 200° 10m/s Wind.

11A. Current, Placer 80	11B. Cut 1 SE removed	11C. Cut 2 SE and S removed	11D. Cut 3 SE, S, and N Lakeside removed
			

Scenario 5: 70-foot Canopy Height at Southern Groves

This scenario is designed to test the effects of reducing the southern groves to a height of approximately 70 ft. These are the same groves as discussed in scenarios 3&4 – North Lakeside, South Lakeside, and Southeast Groves.

Conditions in this scenario do not result in excessive wind for monarchs in the cluster zone. In the vertical wind profile below the majority of the cluster zone are estimated to stay below 2.25 m/s.

Fall roosting sites

Fall roosting sites are not limiting for monarchs. When monarchs arrive at an overwintering site in October and early November, the weather is usually mild prior to the first storms of the season. During these mild periods, the butterflies may roost in a wide variety of sunny sites and are not constrained by winds. Many options are available, and the use of any particular microsite is largely a matter of chance, as some butterflies start roosting and attracting others. When the first strong winds occur, from any direction, they abandon wind-exposed microsites and start to concentrate in wind-sheltered areas that receive full or dappled sunlight.

At Moran Lake, the numerous trees around the lagoon (North Lakeside, South Lakeside, Southeast Groves) can serve as fall roosting sites at a height of 70 ft. The linear stands of trees also serve to "gather" monarchs as they pass by. As winds occur with the first storm fronts of the year, the monarchs then tend to move to sunny Creekside cluster sites, until SE winds drive them to the main cluster zone NE of the yard. But strong northerly winds can penetrate through the gap along the access road/trail and drive the butterflies back to Creekside, or into more sheltered microsites within the main cluster zone.

Figure 12. Vertical Wind Profile with Scenario 5 Height Reduced to 70 Feet

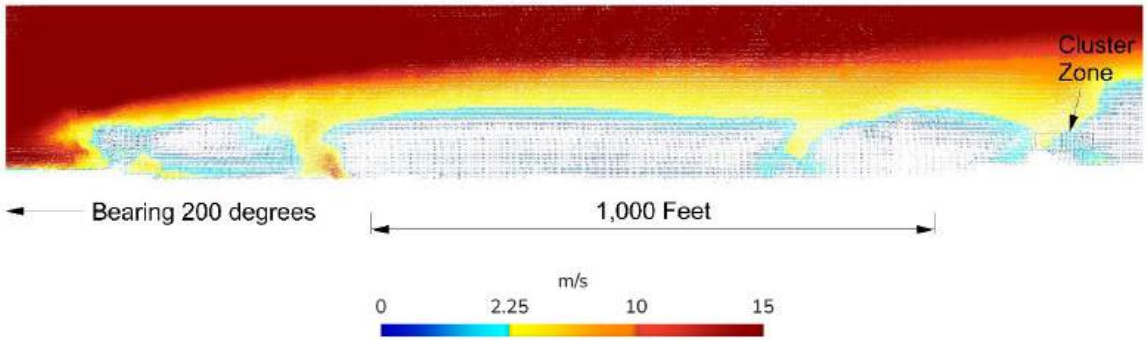


Figure 13. Overhead View of Scenario 5, Sampled 30 Feet Above Ground

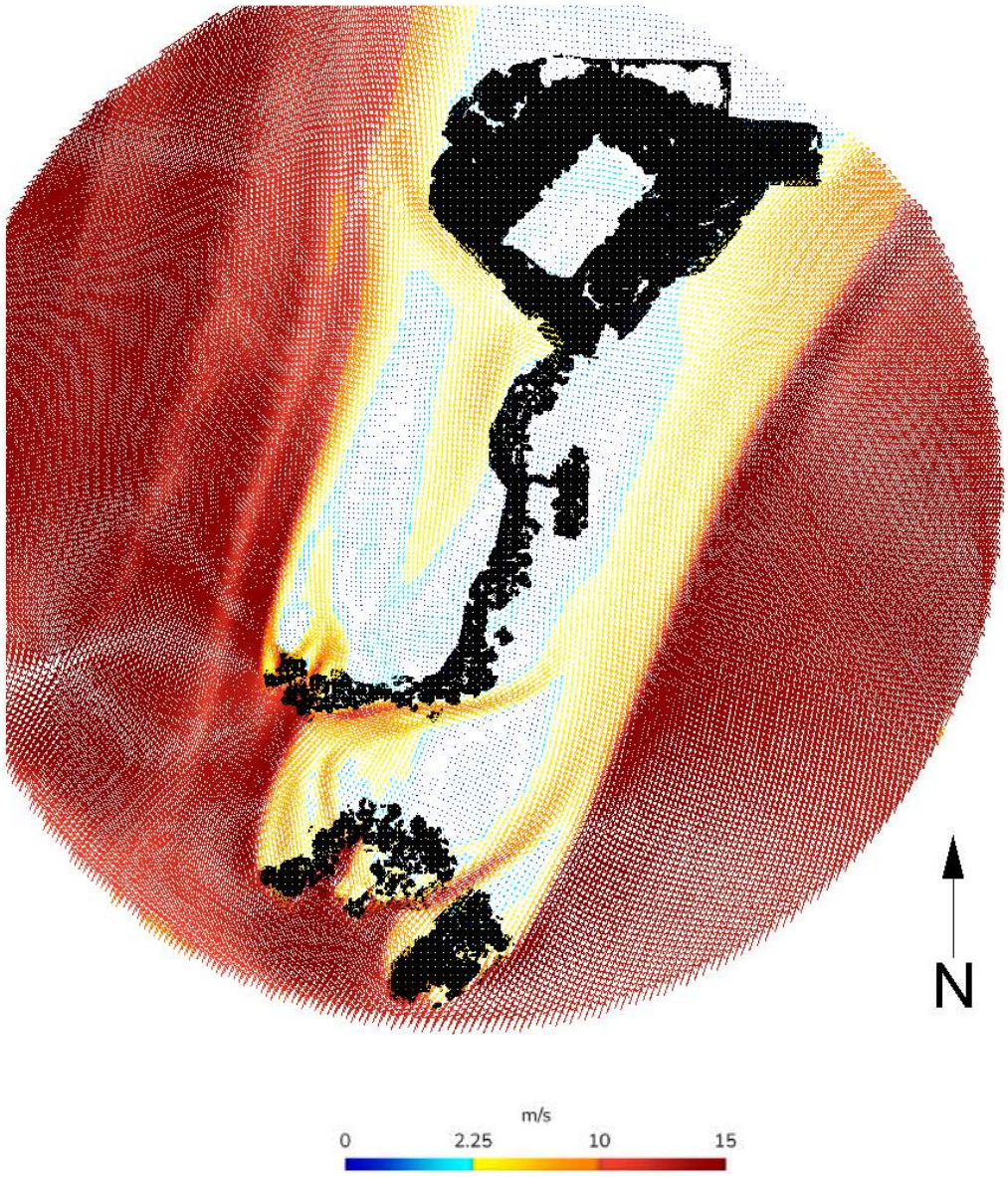
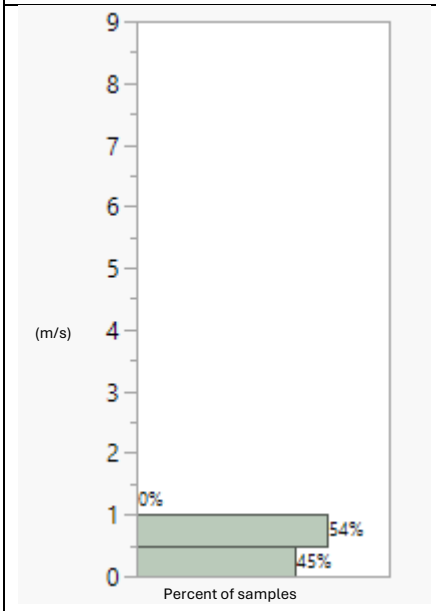
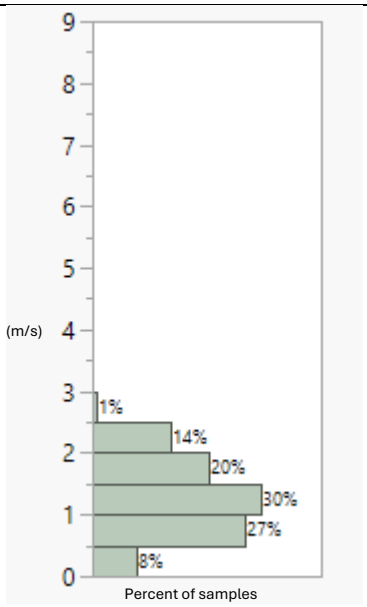
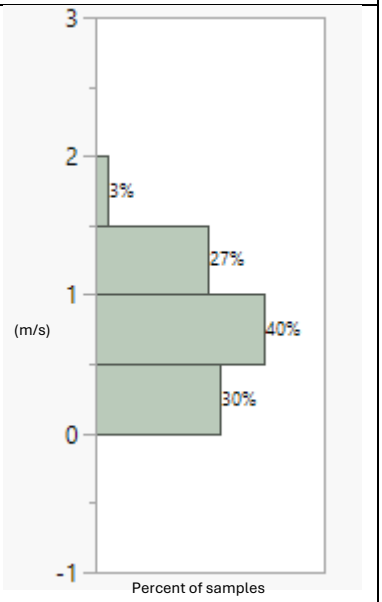
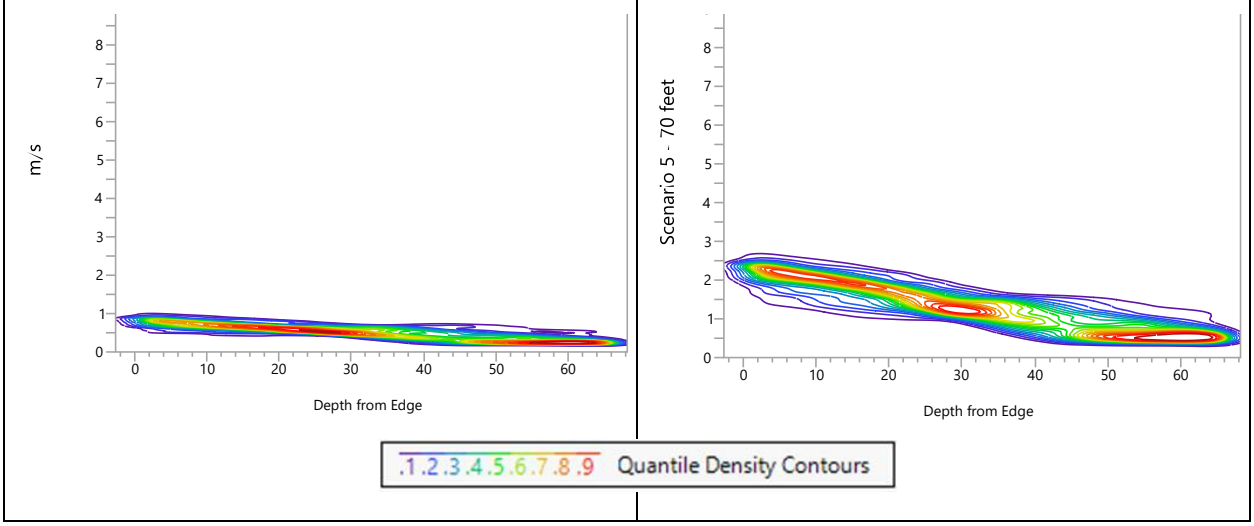
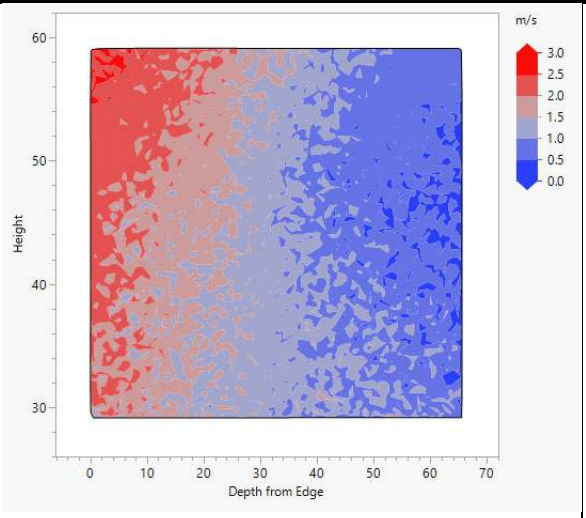
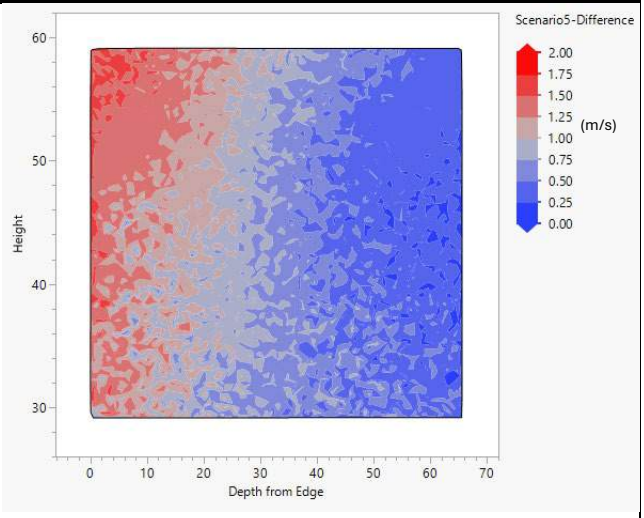


Figure 14. Scenario 5 Windspeed Distribution Graphs

14A. Current Conditions, 200° Wind	14B. Scenario 5, 200° Wind	14C. Scenario 5 – Current Difference
		

14D. Current conditions 200° wind 10 m/s	14E. Scenario 5, 200° wind 10m/s
	

14F. Scenario 5 Absolute Wind Speed – note that scale is different from other scenarios	14G. Scenario 5 Difference – note that scale is different from other scenarios
	

Scenario 6: North Edge 1x Height to Target

This scenario uses the same approach as scenario 2, except for with buildings nearest to the North Edge grove. The buildings on this northern side of the groves are farther from the North Edge grove than those buildings along Placer Street, with the "Boneyard" occupying most of the space between buildings and North Edge trees. The modifications result in minor changes to the canopy of the North Edge. Cutting would be limited to the highest sections of the trees.

Figure 15 shows a vertical slice for current and 1x Height to Target. The wind is N (0°) at 10 m/s. In the current configuration, there is a "wind tunnel" along the road opening (the jet of yellow/red near the ground). This opening can be seen in Photo 2, 949 as the near-horizon gap to the NE. This wind vulnerability, which drives the monarchs away from the NE cluster zone during strong northerly winds, was confirmed with actual wind measurements in the habitat assessment (Weiss 2022). Sealing this gap with new cypress trees in the Boneyard across from the opening was a key recommendation in that report.

The 1x Height to Target modification results in minimal changes to wind conditions in the cluster zone - in fact they are almost indistinguishable both visually (Figure 15) and in the histograms (Figures 16 A, B). The slight differences are captured in a difference histogram (Figure 16C). The distribution of wind with height along the NW-SE canopy edge (Figures 16 D, E) shows the wind tunnel along the road opening clearly in the lower left corner between 0 and 20 ft and below 40 ft height.

The actual trimming would be high in the canopy, well above the cluster zone, with several rows of trees to provide wind shelter. Combined with sealing up the wind tunnel with Boneyard cypress plantings, the north edge of the grove will be more secure for both monarchs and building safety.

Figure 15A. North-Edge Current Conditions

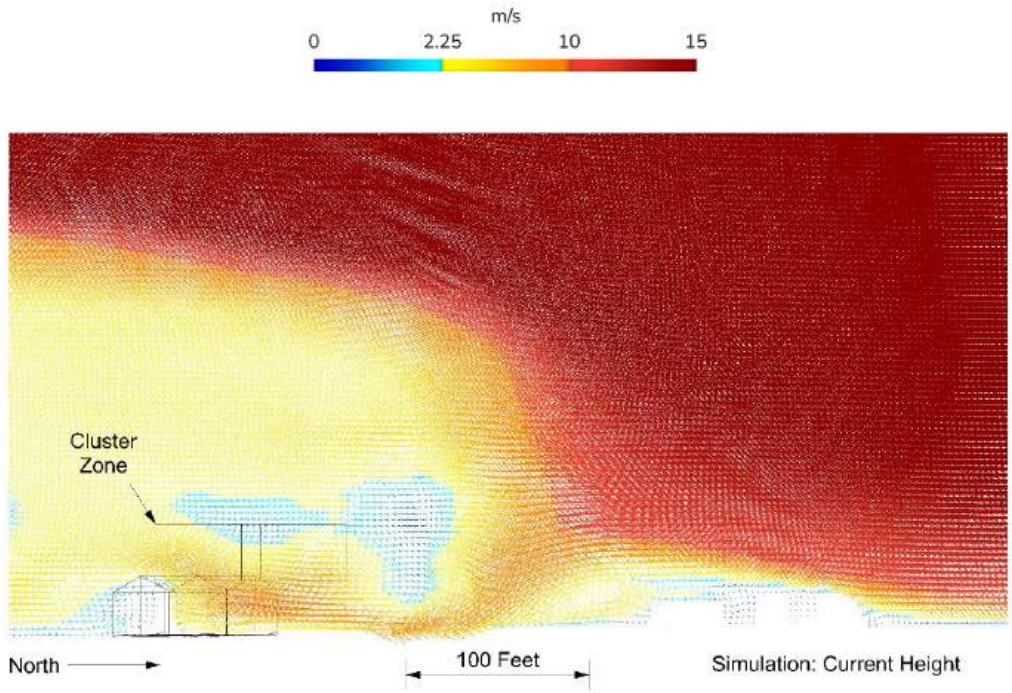


Figure 15B. North-Edge 1x Height to Target

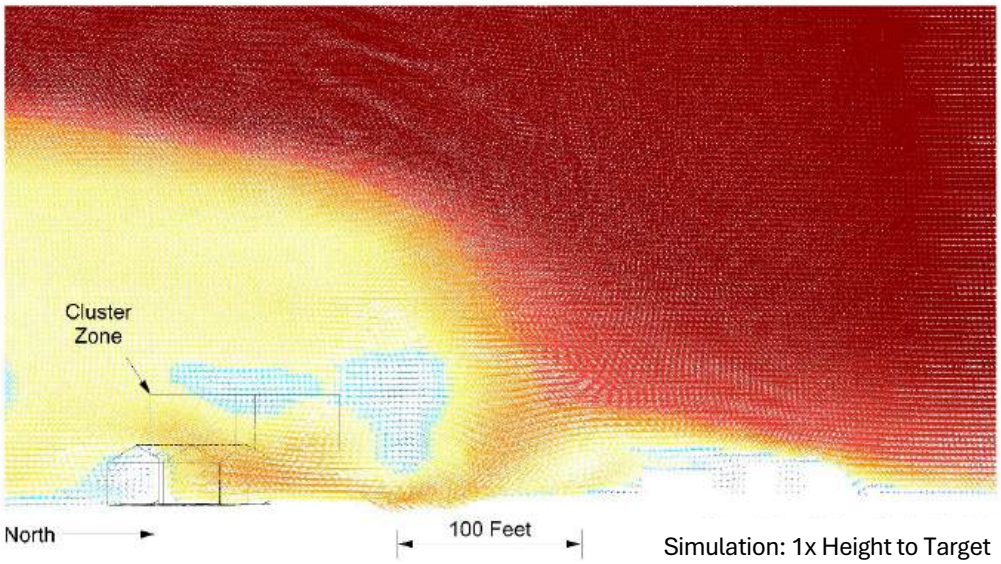
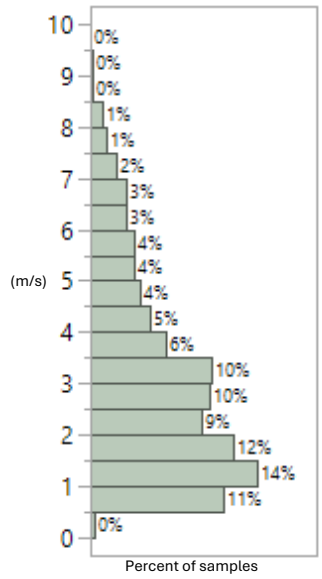
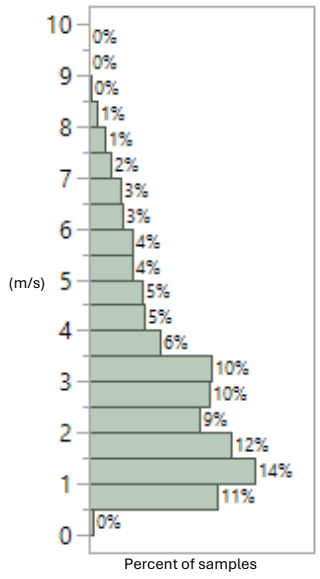
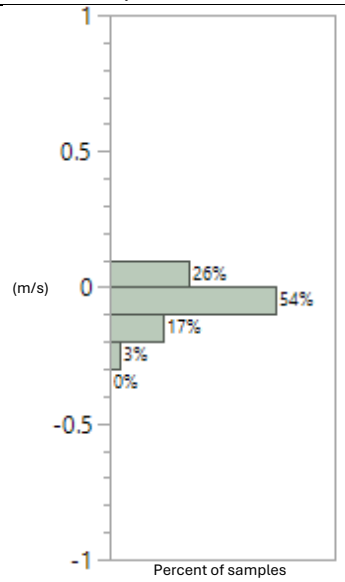
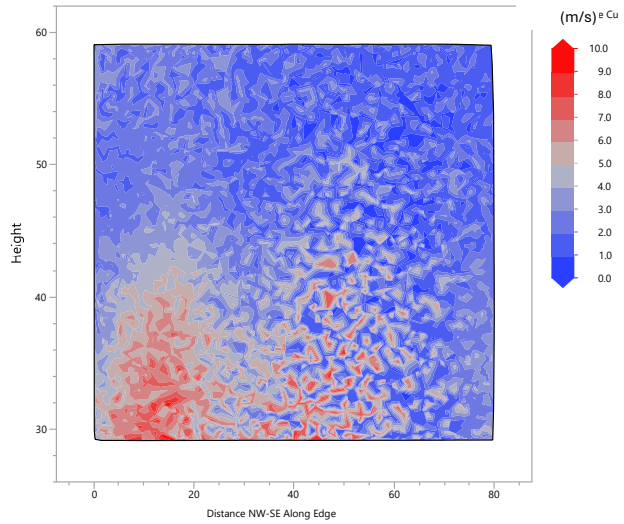
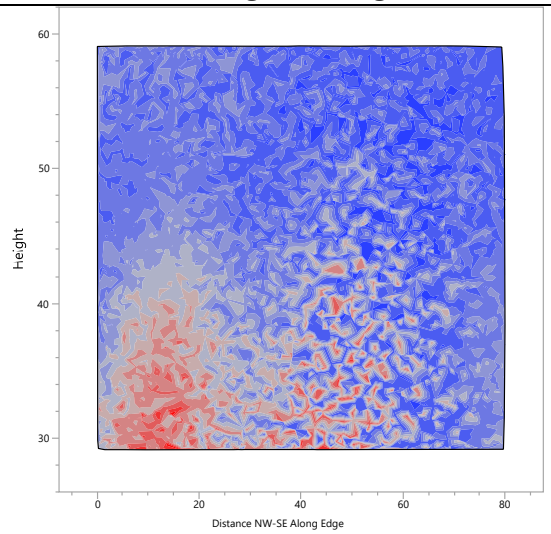


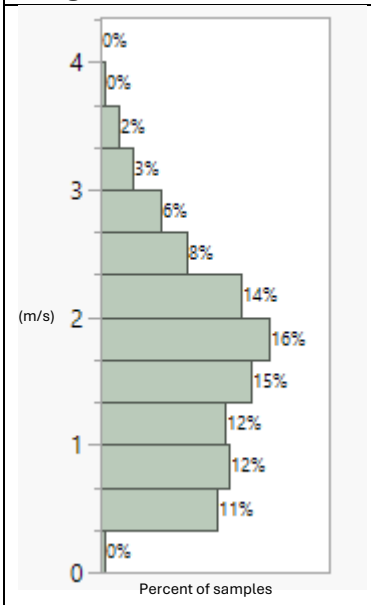
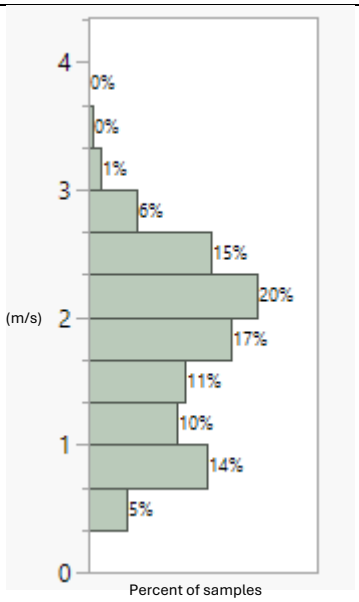
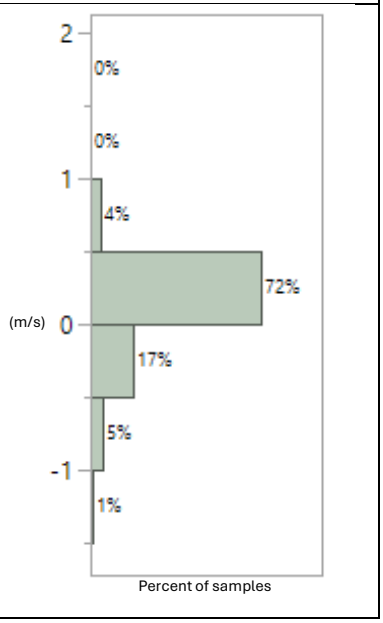
Figure 16. 1x Height to Target on North Edge Histograms

16A. Current Conditions North Wind	16B. North 1x Height to Target	16C. Difference (mean = -0.05 m/s)
		

16D. Current Conditions	16E. North 1x Height to Target
	

Scenario 7: South Creekside at Critical Height

Figure 17 Histograms of Wind Speed for Creekside Height Reduction

17A. Creekside at Full Height, Placer at 80 ft.	17B. Creekside at 80 ft. Placer at 80 ft.	17C. Difference mean = 0.11 m/s
		

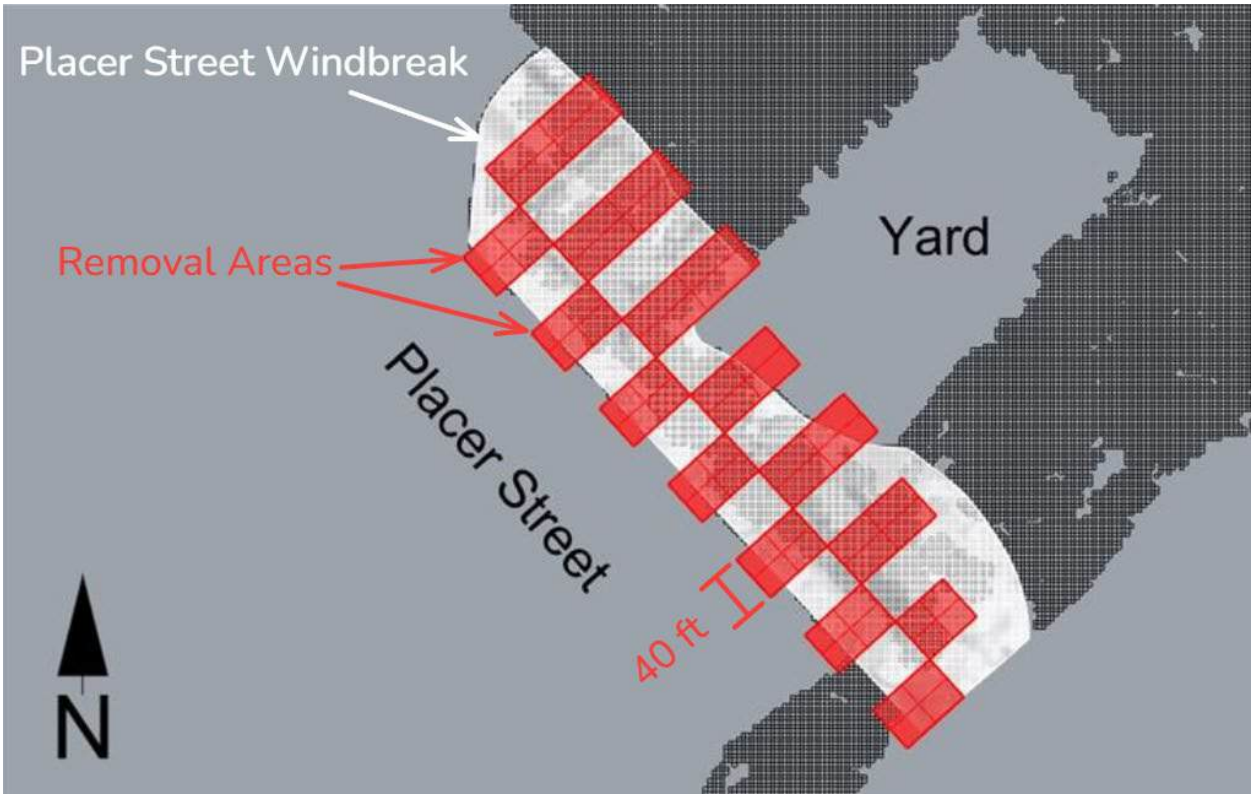
Reducing the height of the Creekside trees to 80 ft has a small effect on the cluster zone, a mean increase of 0.11 m/s. It actually decreases the very maximum wind speeds (> 3 m/s) slightly.

This treatment is not a realistic option for monarchs because of the presence of consistent cluster trees in this area. Those cluster sites would likely be disrupted by height reduction.

Appendix A. Scenario 8: Sectional Removal of Placer Street Windbreak

This scenario models the Placer Street Windbreak with sections of canopy removed. Roughly half of the Placer Street Windbreak is modeled as being removed, in order to approximate conditions in a long-term plan to replace the eucalyptus trees. The sections of removal are designed to allow for tree plantings to grow in the areas of removal. The removal areas are also placed in such a way that they alternate between removing the southwest edge (closest to Placer Street) and the northeast edge (closest to the yard). The axis on which the removal zones alternate runs northwest to southeast, splitting the thinnest part of the Placer Street Windbreak roughly in half. This is an attempt to maintain the greatest minimum canopy width at the thinnest section of the Placer Street Windbreak given the canopy removal scenario. The removal sections are all 40 ft wide, with varying depths from canopy edge. The remaining canopy of the Placer Street Windbreak is modeled at the previously established critical height, 80 ft.

Figure 18. Scenario 8 Removal Areas

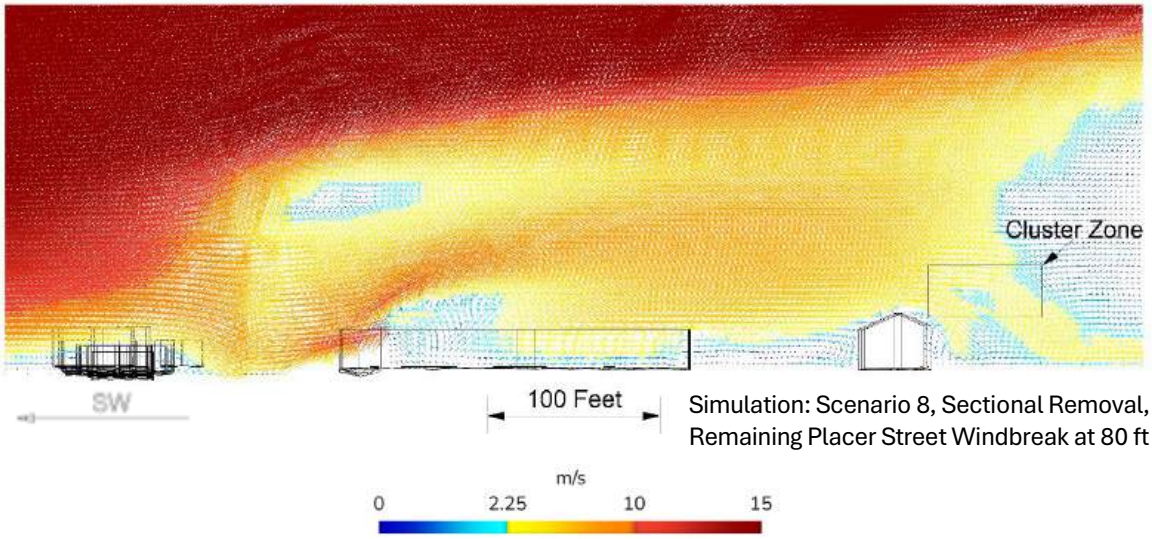


This approach is limited in how well it can approximate a realistic execution of a tree replacement plan because the LiDAR data available does not identify individual trees. So a less precise approach in which larger sections of canopy are removed is designed to approximate a similar practice. The actual tree removal would likely differ from the exact

areas of removal established in this scenario. The general approach of removing approximately half of the canopy is still achieved.

The results of modeling scenario 8 suggest an average increase of 0.3 m/s when compared to the results of the placer street windbreak at 80 ft tall (critical height) without sectional removal. The figure 19 below shows that the southwest edge of the cluster zone has windspeeds greater than 2.25 meters per second, but the protection offered by the Placer Street Windbreak provides enough of a barrier to allow the canopy directly around the cluster zone to slow windspeeds and maintain pockets of windspeeds slower than 2.25 m/s deeper in the canopy. These calm pockets are more concentrated in the northeast sections of the cluster zone.

Figure 19. Scenario 8 Vertical Slice Side Profile



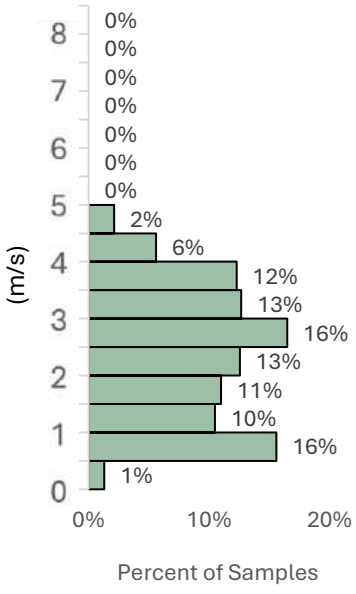
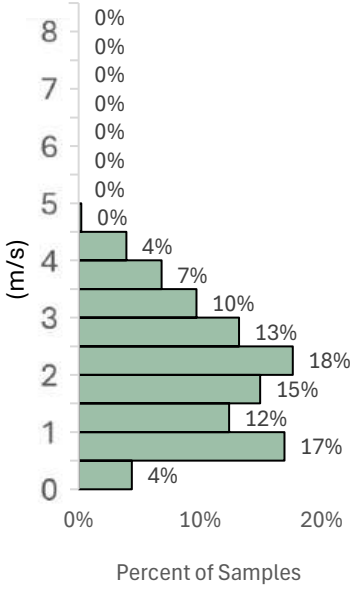
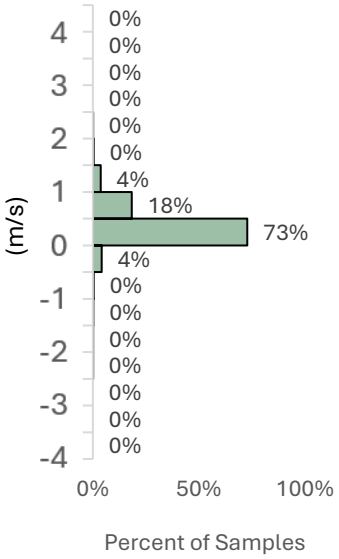
Simulation: Scenario 8, Sectional Removal, Remaining Placer Street Windbreak at 80 ft

Examining the figure 20 histograms shows that scenario 8 is suggested to result in a similar histogram structure as placer street at critical height. 91% of sample points in the cluster zone show an increase in wind speed of 0 to 1 meter per second. Which, while showing a trend toward higher windspeeds, 96% of sample locations still predict speeds lower than 4 m/s, while in the critical height scenario, 98% of samples predict speeds less than 4 m/s. The 90th percentile wind speed in scenario 8 is 3.9 meters per second, which is most similar to the 50 ft tall Placer Street windbreak condition previously estimated, which also had a 90th percentile value of about 3.9 meters per second. The 50 ft scenario of the Placer Street on figure 8 is at the base of a steep slope that indicates rapid increase in windspeed starting at that canopy height as canopy height decreases. Seeing a similar 90th percentile value in scenario 8 suggests that the scenario is on a threshold that is vulnerable to further increase to windspeeds given further reduction of wind protection. However, the plastic

epicormic response of the eucalyptus canopy would likely fill in gaps relatively quickly, leading to increased protection.

One potential challenge with the removal scenario is the increased amount of canopy edge, which increases the exposure of previously protected trees to increased windspeeds and will present increased stresses on those trees.

Figure 20. Scenario 8 Histograms

20A. Scenario 8 - Sectional Removal Windspeeds	20B. 80 ft Critical Height, No Removals Windspeeds	20C. Windspeed Difference, Critical Height Before and After Removals
		

References

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CREEKSIDE SCIENCE

Addendum to Management Recommendations from Moran Lake Habitat Assessment



Monarchs clustering on blue gum eucalyptus in Creekside Area

Stuart B. Weiss, Ph.D.

January 2024

Introduction

This document is an addendum to the "Assessment of Moran Lake Overwintering Monarch Habitat" produced in October 2022. It modifies the management recommendations based on feedback from various stakeholders, especially Dr. John Dayton.

Management recommendations

The management recommendations are modified as follows:

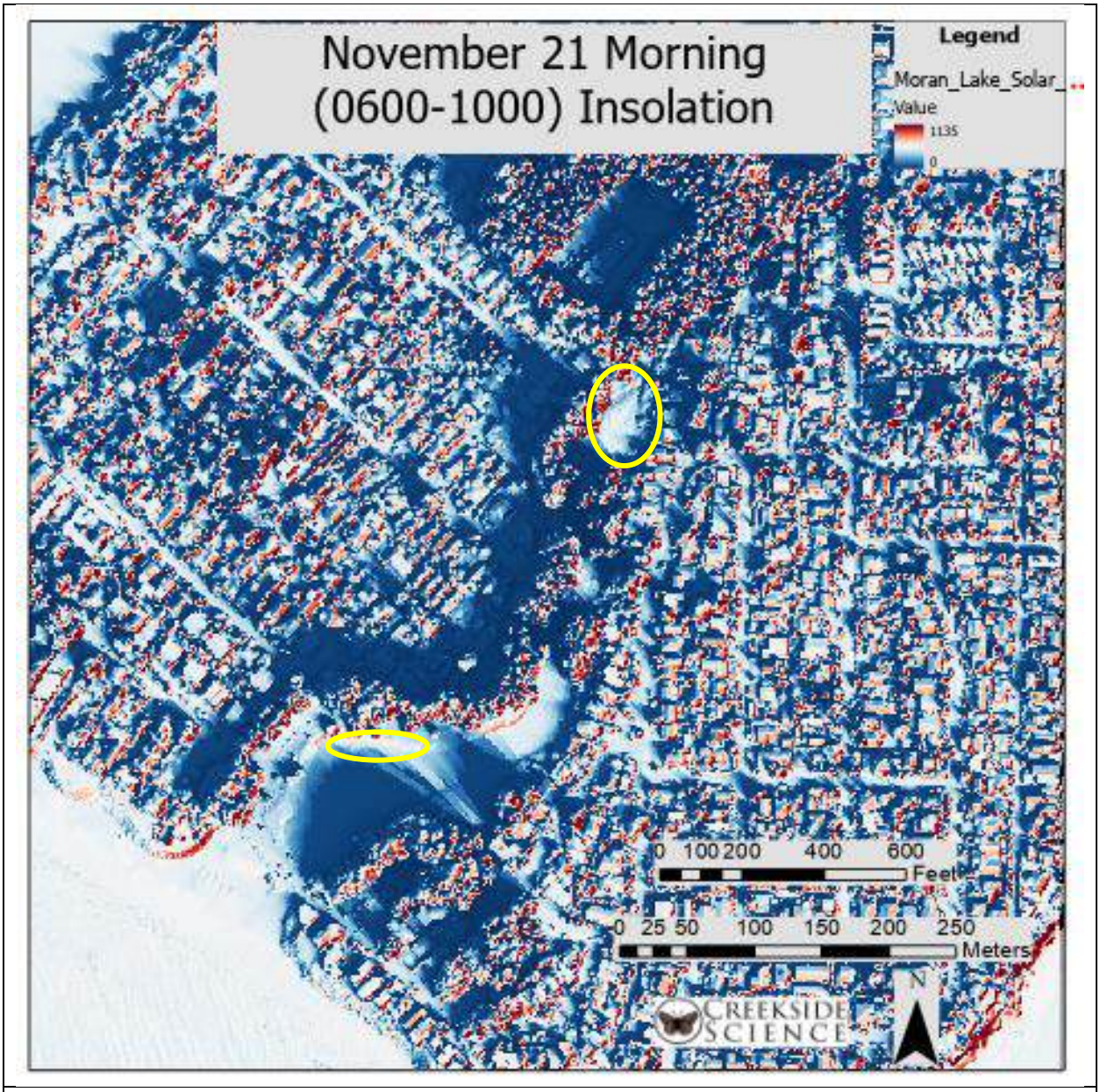
1. Seal up the outer NE and NW edges of the grove surrounding the pump station yard, using Monterey cypress planted to fill the gaps between eucalyptus rows. Originally, California bay and coast live oak trees were recommended, but they have not done well in these shady locations. There is some concern about maintaining sightlines into the grove to detect occupancy by unhoused people so close coordination with public safety agencies is important.
2. Plant a small stand of Monterey cypress at the SW side of the Boneyard opposite the trail opening to seal against northerly winds that penetrate into the grove along the trail and drive the monarchs away from the interior cluster site.
3. Encourage blue gum saplings within the main stand when they serve to seal up the open row spaces.
4. Maintain a partially open canopy south of the main cluster area NE of the Yard so that direct insolation can penetrate from the Yard edge.
5. The SW side of the main grove poses issues with tree hazards to the neighbors. Maintaining wind shelter along this edge is crucial for the monarchs clustering on the opposite side of the yard. Topping trees and removing hazard branches in this area may be necessary and should be done with a light touch. Reinforcing the wind shelter with plantings on the Yard side of the drainage ditch – currently there are several redwoods that are not doing well - is important. Eucalyptus and cypress may be better choices than redwoods here.
6. In the Creekside Zone, maintain and fill in the row of trees SE of the creek. The public property is dominated by shrubs including blackberries and other shrubs – interplanting trees such as redwoods will reinforce existing wind shelter. However, care should be taken over the long run to not deeply shade the cluster sites along the creek.
7. The private property S of the public parcel has had trees trimmed, but new plantings and other management here depend on a cooperative landowner, so there are no guarantees of implementation.
8. Upon closer examination, the SE gap at the Yard does not require new trees – existing trees appear to be filling in the gap. Monitoring their progress is recommended.
9. Trees south of the pump station complex provide early season roosting but are abandoned once storms bring substantial winds. The viability of the site is much less dependent on trees in these areas, which are used opportunistically. The upper canopies do provide some shelter for the pump station complex, but the under- and mid-stories are of lesser importance.
10. Nectar plants of various species (listed in 2010 draft plan, and in the Xerces Society lists) should be planted primarily in areas that receive morning sun (Addendum Map), or in spots with dappled light. The prime area for nectar is just S of the main grove, in the sunny grassy area at the head of the lagoon (larger yellow ellipse). The moist soil here allows for many species to thrive, and on a microscale, the variety of habitats available including marshy areas, creekbanks, and open grassy fields. Other narrow zones between the trail and water on the W side of the

lagoon should be considered. Monarchs are less likely to use nectar plants in deep shade, so the forest understory near the main clustering sites are poor places for nectar plants. The most important nectar plants are those that bloom in the fall (Oct-Nov) because they help retain monarchs at the site, which in turn attracts more butterflies that are passing by. A concentrated pollinator garden for many species besides monarchs, should be considered in various areas, even those that do not receive morning insolation.

11. Management of hazard trees and branches is essential in publicly accessible areas. If hazards are identified on the NE side of the Yard, near the cluster zone, then special care should be taken in assessing urgency and targets of falling trees/branches, as well as potential for opening the cluster sites to wind. In other parts of the habitat, removal of single branches and individual trees should be routine if hazards are identified.
12. Keeping the future option of selective surgical thinning of parts of the main grove is important. Maintaining individual tree health in the face of aridification may require reduction of basal area. The remaining trees will fill in the canopy as water and light availability allow.



Close up of monarchs clustering in the interior of the main grove, NE of the Yard, December 2023.



Addendum Map. Nov 21 morning insolation from 0600-1000 h, as a guide for nectar plantings. The white areas in the yellow ellipses are the best places for nectar plantings that can be accessed by monarchs in the morning, when flowers tend to have the most nectar.

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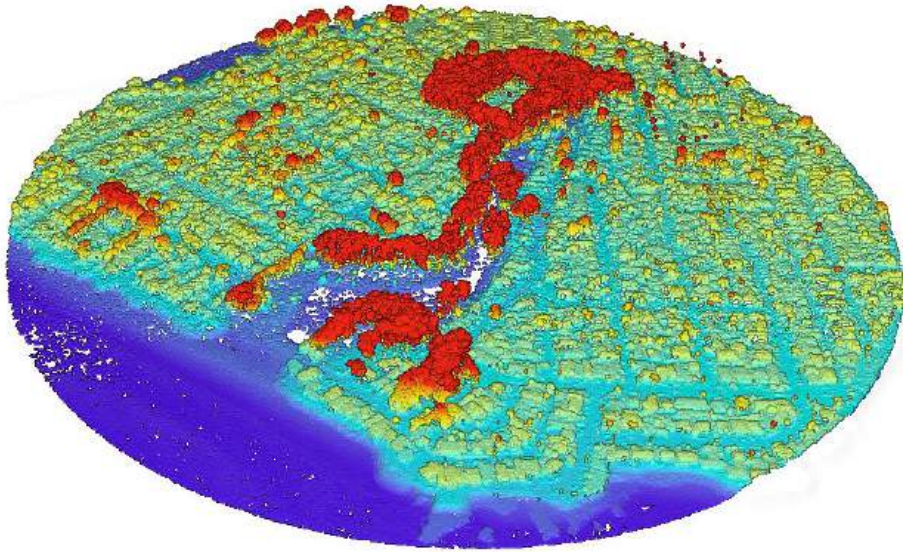
Assessment of Moran Lake Monarch Overwintering Habitat



Hemispherical photo at main cluster site



Monarchs clustering on blue gum eucalyptus



Oblique LiDAR view from South

Stuart B. Weiss, Ph.D. October 2022

Moran Lake Monarch Assessment October 2022

Executive Summary

Monarch butterflies overwinter in groves of trees, primarily blue gum eucalyptus, near Moran Lake, Santa Cruz County. This assessment provides a structural analysis of the microclimate of the groves, using hemispherical photography, LiDAR, and wind measurements, that documents wind and insolation patterns that provide the conditions that allow monarchs to successfully overwinter. The assessment includes the following elements:

1. A site map with LiDAR-based elevation to delineate key zones for monarchs
2. Oblique LiDAR views that identify key structures and vulnerabilities
3. An explanation of how to interpret a hemispherical photograph (hemiphoto).
4. Sixteen example hemiphotos showing key sites and exposure from different directions
5. A map of ISFU (Visible Sky) in the habitat surrounding the pump station Yard.
6. A series of maps of direct insolation below the canopy derived from hemiphotos
7. Insolation at the outer canopy envelope derived from LiDAR and insolation modeling in GIS.
8. A map of hemiphoto exposure in eight directions, and a close-up map of the cluster areas NE of the Yard.
9. Relative wind exposure at the outer canopy envelope, at a 10-meter scale across the Yard and across the entire site and surrounding urban areas, derived from LiDAR and wind modeling using the program WindNinja.
10. A series of wind measurements near ground level (1.75 m) on three days with differing wind directions, and a standardized wind attenuation map at the sample points.
11. A section on detailed methods of processing LiDAR and hemiphotos.

Monarch Habitat and Vulnerabilities

Monarchs seek sites with wind shelter and some direct and dappled light. These conditions are met in certain parts of the grove surrounding the Yard, especially the NE and NW sectors. The tall trees provide wind shelter, and the Yard opening provides high insolation forest edges, where canopy gaps allow dappled light into the forest interior. The tall trees across the Yard provide wind shelter, especially at cluster heights. But the open NE and NW edges of the grove allow wind to penetrate along rows and through openings.

Monarchs will shift distributions according to wind, particularly. The main NE cluster site is consistently used, but monarchs will temporarily abandon it when northerly winds penetrate through the opening. At those times, the wind-shadowed SE zone can be heavily used by flying monarchs, and some clusters may form on the SE edge of the grove until the wind shifts again.

Major vulnerabilities that decrease habitat suitability include:

1) Northerly wind penetration into the cluster area NE of the Yard, from the open NE edge.
2) Southerly wind penetration into the NE cluster area, a combination of penetration over the Yard, and around the corner from the creek.
3) Northerly wind penetration into the NW side of the grove along the rows of trees and the access road.
4) The inside edges of the Yard are generally well sheltered from wind by the tall trees on opposite sides. But the SE gap produces a wind tunnel that allow some wind to penetrate the Yard.

Moran Lake Monarch Assessment October 2022

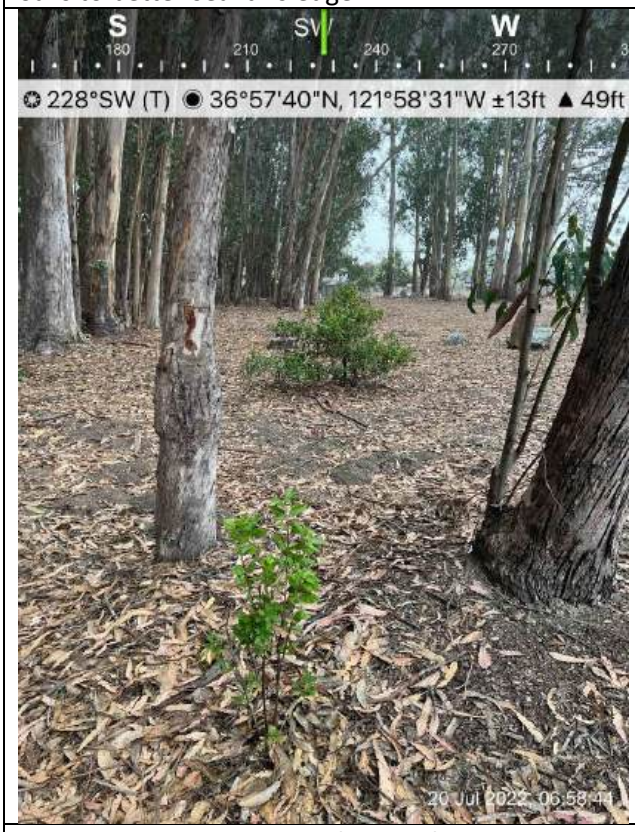
Management recommendations

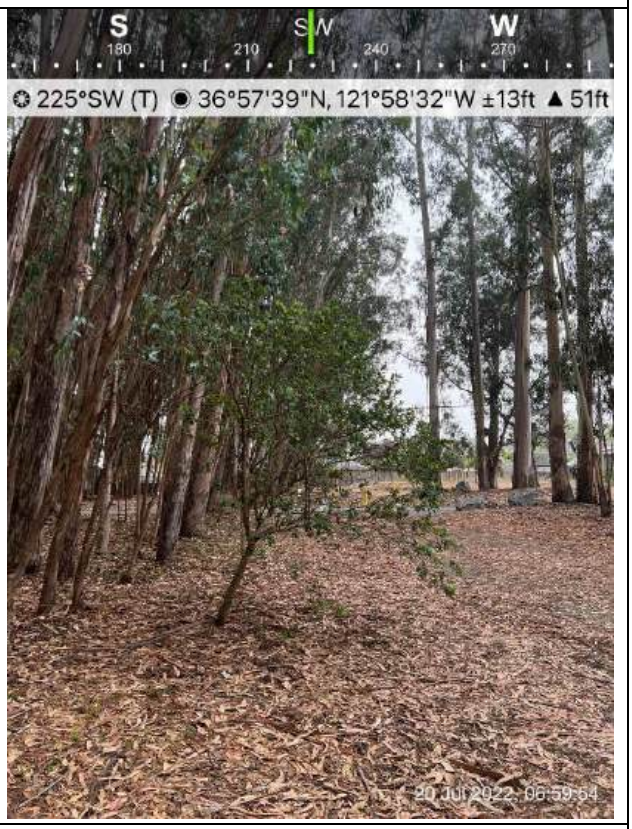
A series of management recommendations based on the above analyses includes:

1. Seal up the outer NE edge of the grove surrounding the pump station Yard, using bay trees, live oaks, and/or Monterey cypress planted to fill the gaps between eucalyptus rows.
2. Seal up the NW edge of the grove by planting more bay and live oak trees
3. Encourage blue gum saplings within the main stand when they serve to seal up the open row spaces.
4. Maintain a partially open canopy south of the main cluster area NE of the Yard so that direct insolation can penetrate from the Yard edge.
5. Plant a small stand of Monterey cypress at the SW side of the Boneyard opposite the trail opening to seal against northerly winds.
6. Maintain and fill in the row of trees SE of the creek. Property boundaries here will require consideration.
7. Plant a tall-growing eucalyptus tree (species TBD) to eventually fill in the SE gap at the Yard.
8. Trees south of the pump station complex provide early season roosting but are abandoned once storms bring substantial winds. The viability of the site is much less dependent on trees in these areas, which are used opportunistically.
9. Nectar plants of various species (listed in 2010 draft plan, and in the Xerces Society lists) should be planted primarily in sunny areas, or in spots with dappled light. Monarchs will fly hundreds of meters to use nectar plants, so there are a variety of habitats available including marshy areas, creekbanks, and open grassy fields. A concentrated pollinator garden could be considered in various areas. Monarchs are less likely to use nectar plants in deep shade, so the forest understory near the main clustering sites are poor places for nectar plants. The most important nectar plants are those that bloom in the fall (Oct-Nov) because they help retain monarchs at the site, which in turn attracts more butterflies that are passing by.
10. Management of hazard trees and branches is essential in publicly accessible areas. If hazards are identified on the NE side of the Yard, near the cluster zone, then special care should be taken in assessing urgency and targets of falling trees/branches, as well as potential for opening up the cluster sites to wind. In other parts of the habitat, removal of single branches and individual trees should be routine if hazards are identified.

Georeferenced Photographs of Recent Plantings and Retained Saplings

NW Edge of grove, with bay trees planted. Recommended to increase the number of bay trees and live oaks to better seal this edge





Interior blue gum saplings flagged for retention NW of Yard. Recommend using saplings to seal up the row spaces here and in other areas (SE edge of Yard and slope below).



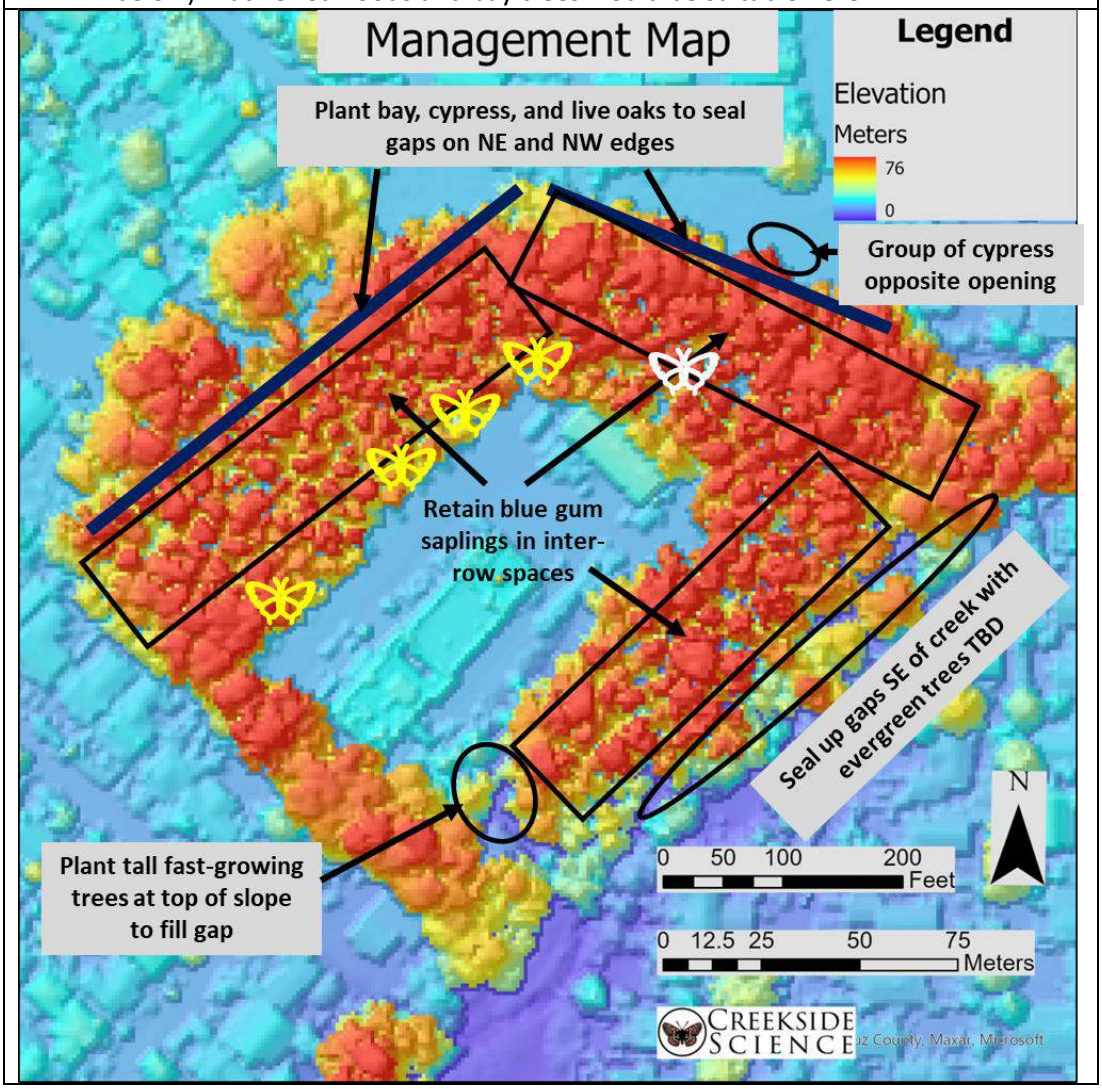


Moran Lake Monarch Assessment October 2022

Management Summary Map

Major management actions, primarily planting trees of various species to provide more wind shelter. Key areas include the open NE and NW edges, the SE gap, and the creek.

1) The 2021-2022 cluster site is the white butterfly outline, historical sites described by S. Marcum are in yellow.
2) Some bay trees and live oaks are already planted along the NW edge, add more for a complete seal (see photo above).
3) Plant additional bay, oaks, and cypress to seal NE edge
4) Retain blue gum saplings in the interior in inter-row spaces to seal against wind, on NW, NE, and SE sides
5) The gap along the NE edge at the trail into the grove sealed up with a small grove of cypress planted across the fence in the Boneyard.
6) The S gap around the Yard sealed up with a fast-growing tree (eucalyptus of some species TBD) planted at the top of the slope
7) Seal up gaps in the trees SE of the creek. Some of the SE creek bank is on private property and arrangements need to be made for access (see property maps below). Native redwoods and bay trees would be suitable here.



Moran Lake Monarch Assessment October 2022

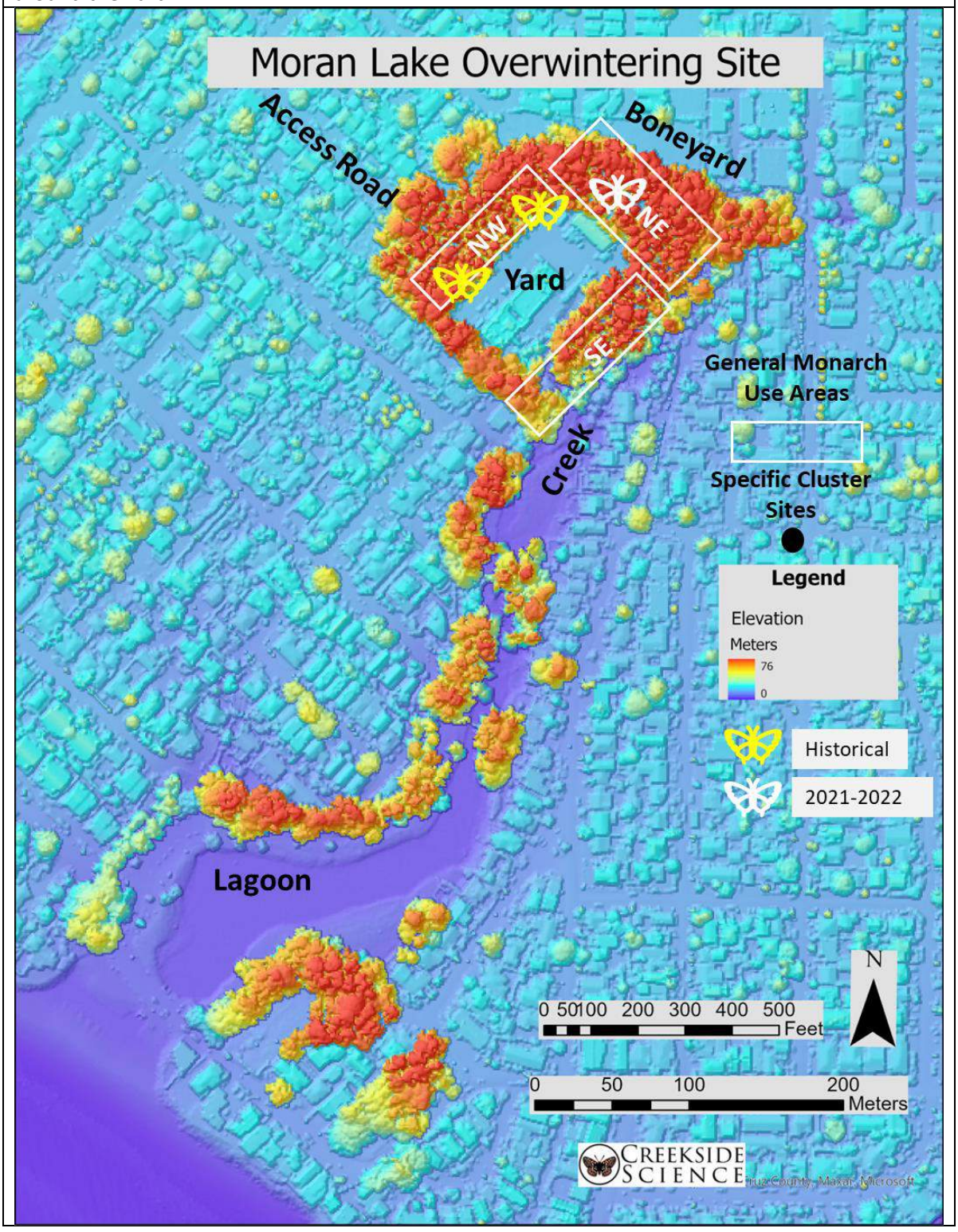
Property Parcel Maps (from Santa Cruz County GIS)

Parcel map SE of creek. This parcel 02829157 is County-owned.	Parcel map SE of creek. This parcel 02829161 is private and arrangements would need to be made with the owners for tree plantings
	
	

Moran Lake Monarch Assessment October 2022

Site Map

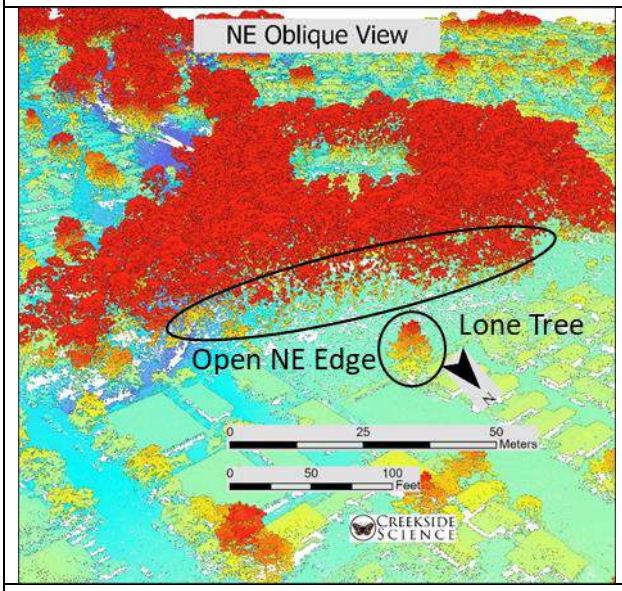
This map shows the forest canopy (red and yellow, and other features of the overwintering site. The primary cluster sites (observed in 2021-22 and pointed out by S. Marcum) and activity areas are around the "Yard" (the pump station facility). Most of the detailed analyses focus on this area around the Yard.



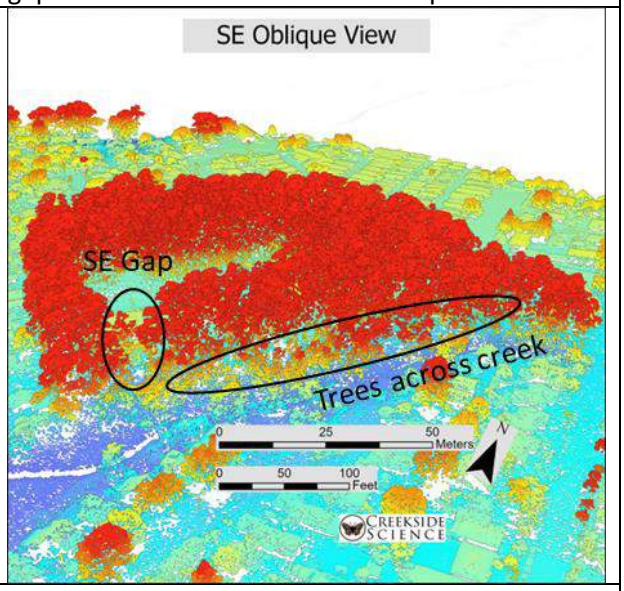
Oblique Views of Monarch Habitat Around the Yard

These oblique views show key features mentioned in various maps below. Views are **from** the direction in title.

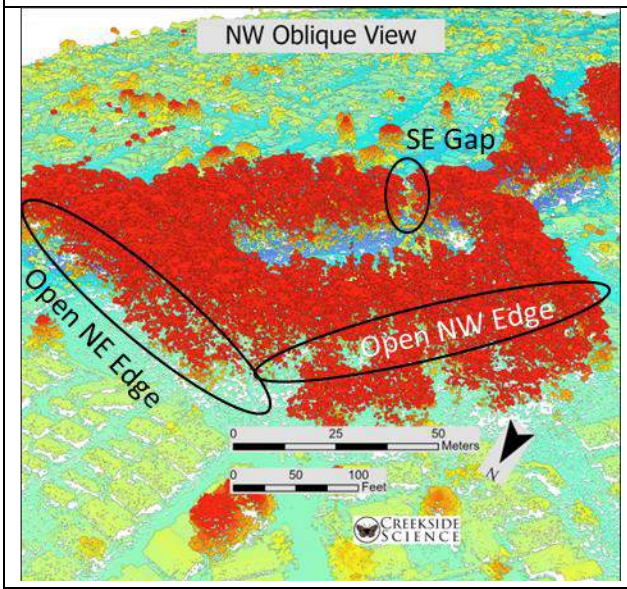
The view from the NE shows the open cano[py edge along the "Boneyard" fence, and the lone tree observed in Photo 909 below.



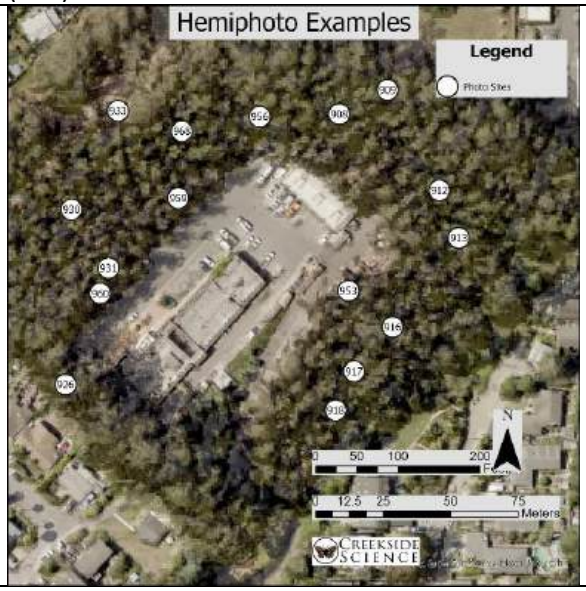
The view from the SE shows the row of trees across the creek from the main grove, and the SE gap at the S corner of the Yard complex.



The view from the NW shows the open NW and NW canopy edges and the SE gap. A row of trees farther NW from the open edge provides some additional wind shelter.

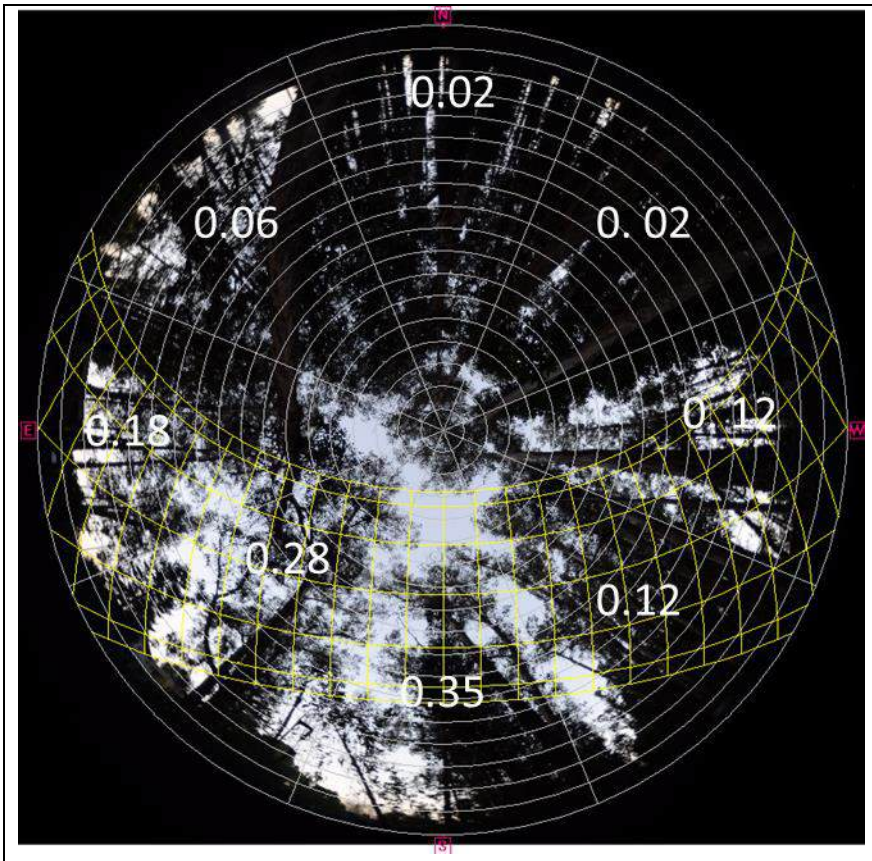


Example Hemiphoto Locations. Hemiphoto examples were chosen to represent a range of situations and include observed cluster location (908) from 2021-2022



Moran Lake Monarch Assessment October 2022

How to interpret a Hemispherical Photograph (Hemiphoto)



The hemiphoto is overlain with a sky grid, with 45° azimuth wedges and 5° increments of zenith angle. The sun grid consists of monthly sunpaths (Dec 21 is the lowest arc, Mar 21 is the center arc, and Jun 21 is the highest arc), divided into half hour increments from E (left) to W (right) [E and W are reversed in upward looking hemiphotos].

ISFU	0.14
DSFU	0.26
October	295 MJ m^{-2} $month^{-1}$
November	192 MJ m^{-2} $month^{-1}$
December	205 MJ m^{-2} $month^{-1}$

This photograph (913) is from the E corner of the main stand. ISFU (Visible Sky in all directions) is concentrated in the southern half of the image. Insolation is concentrated in the morning, mainly dappled. Little direct insolation is received after ~ 1400 h.



Directional exposure is greatest S (0.35) and SE (0.28) looking across the creek, and lowest N and NE looking back into the dense forest. The openings near the horizon to the NW are across the Yard opening. The “Wind Rose” is a graphical representation of the directional exposure, size of arrows proportional to value, and color coded (aqua = <0.20, yellow 0.20-0.30, red >0.30)

Example Hemiphotos (with wind roses showing exposure)

Photo 908. Cluster Site N-side. Openings to S and SW across Yard, and moderate shelter from N and NE. Dappled insolation from late morning through mid-afternoon ISFU = 0.16 DSFU = 0.16



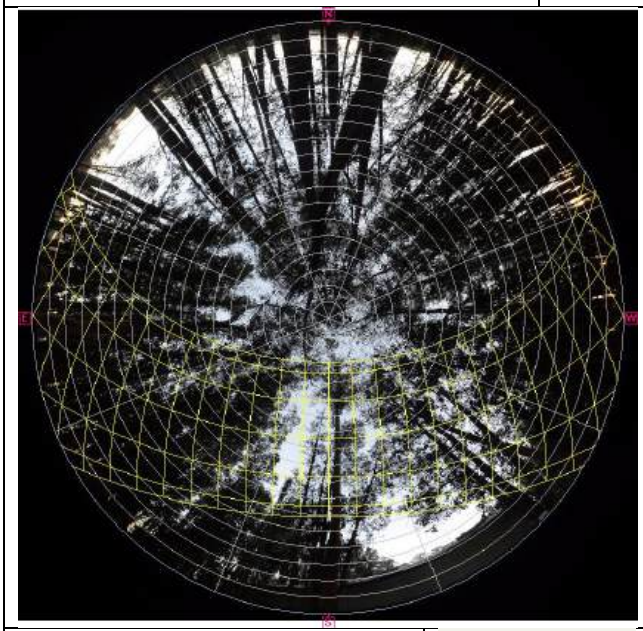


Photo 913. Wind Site with S SE opening, toward SE end of the "mesa" before descending toward creek. Dappled morning insolation ISFU = 0.14 DSFU = 0.26



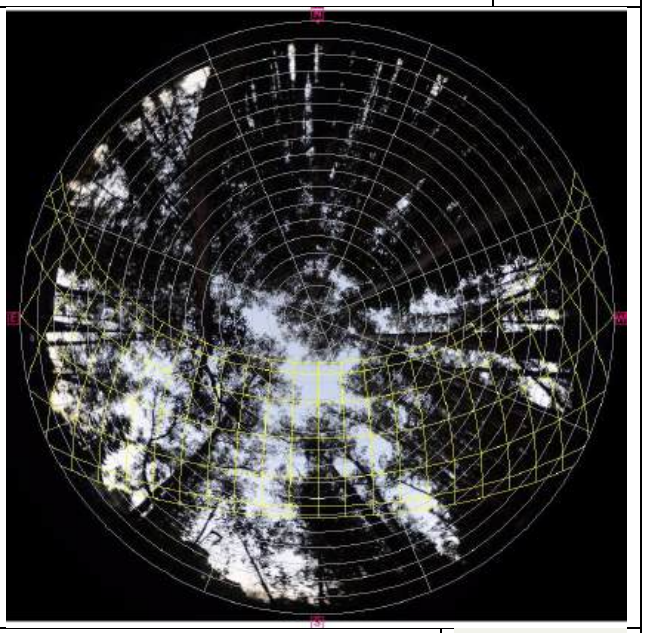


Photo 931. Wind Site near cluster site along access road (vertical gap toward WNW). Large opening over Yard, SE gap (see NW and SE Oblique views) visible. ISFU = 0.28 DSFU = 0.37



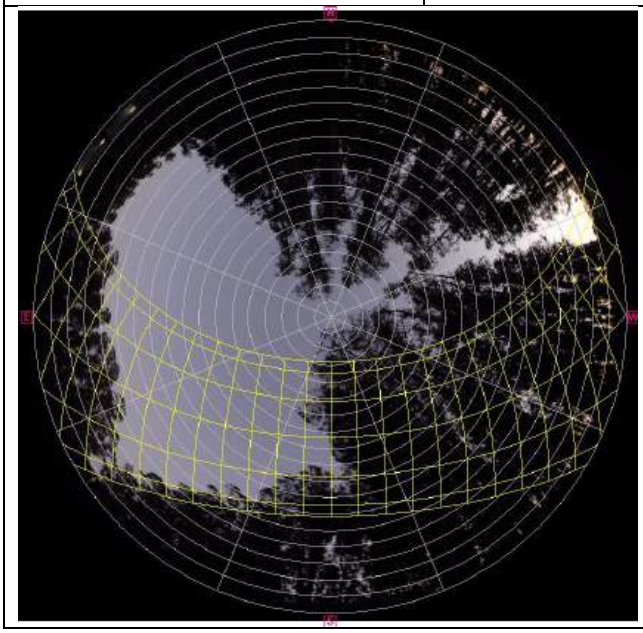
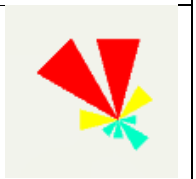


Photo 909. Wind Site at edge of grove at N end of trail, (note irregular opening along trail to SW) open to Boneyard to NE with the Lone Tree to NNE (see NE Oblique View). ISFU = 0.25 DSFU = 0.09



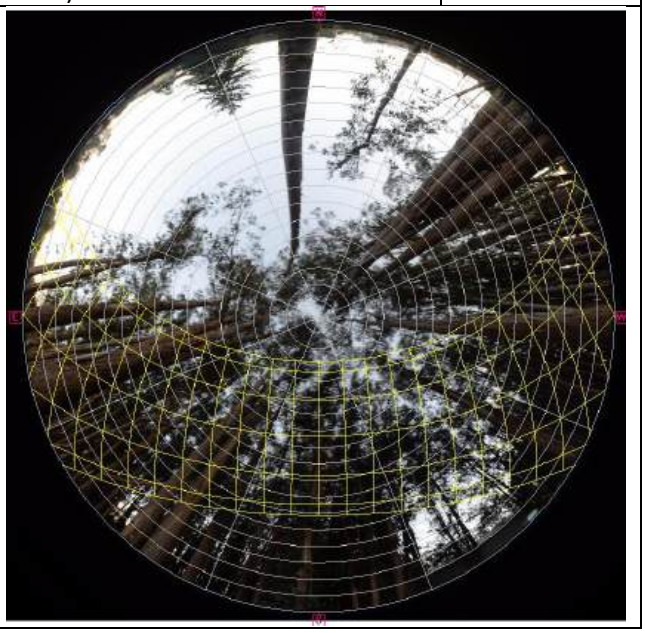


Photo 916. Wind Site SE Edge, just NW of trail. One gap in trees across the creek to SE (see SE Oblique view). Dappled morning insolation. ISFU = 0.12, DSFU = 0.20



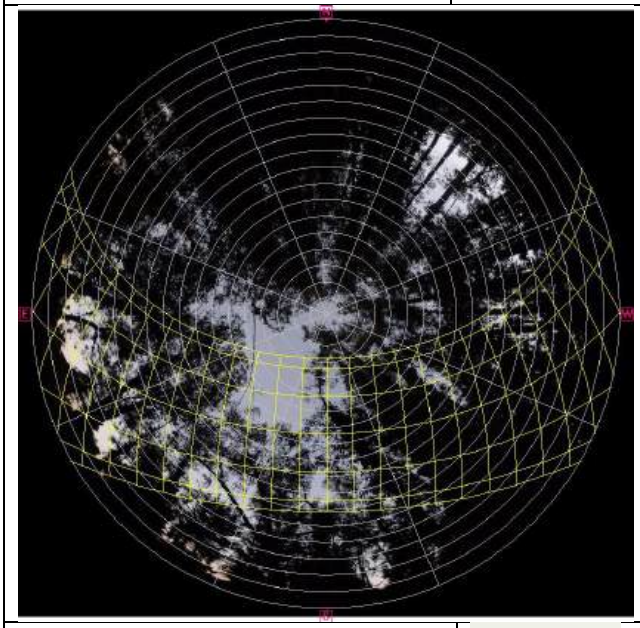
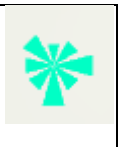


Photo 917. Wind Site SE edge just NW of trail. Trees across creek show few gaps. Largely shaded except for short periods of dappled insolation. ISFU = 0.11, DSFU = 0.15



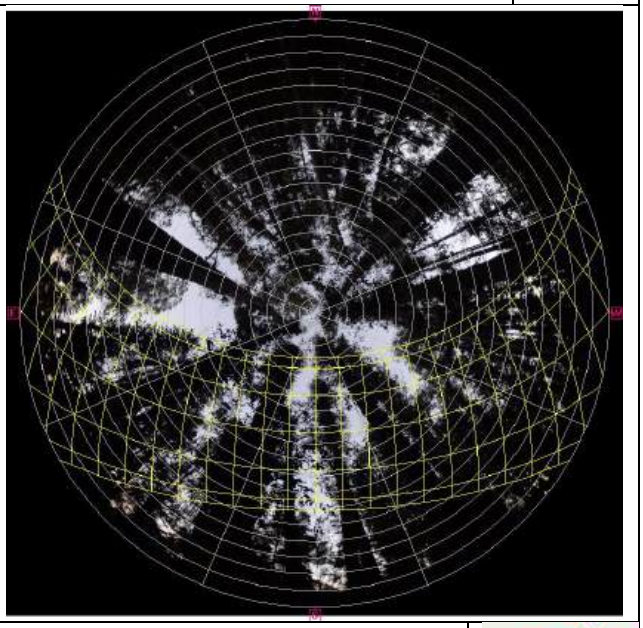


Photo 918. Wind Site SE Edge just NW of trail. Gap to SE and E across the creek. ISFU = 0.14 DSFU = 0.27



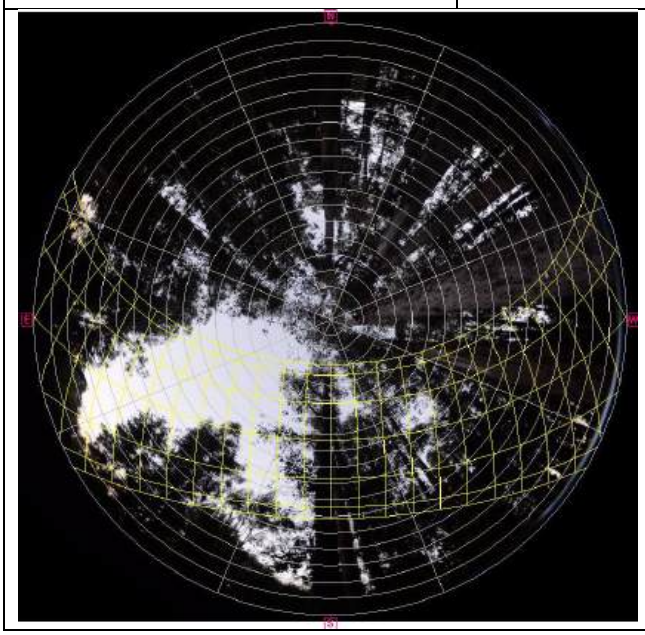


Photo 953. SE edge of Yard. Dense canopy from NE to SW, opening over the Yard from N to W. Dense shade for most of the day. ISFU = 0.20 DSFU = 0.10



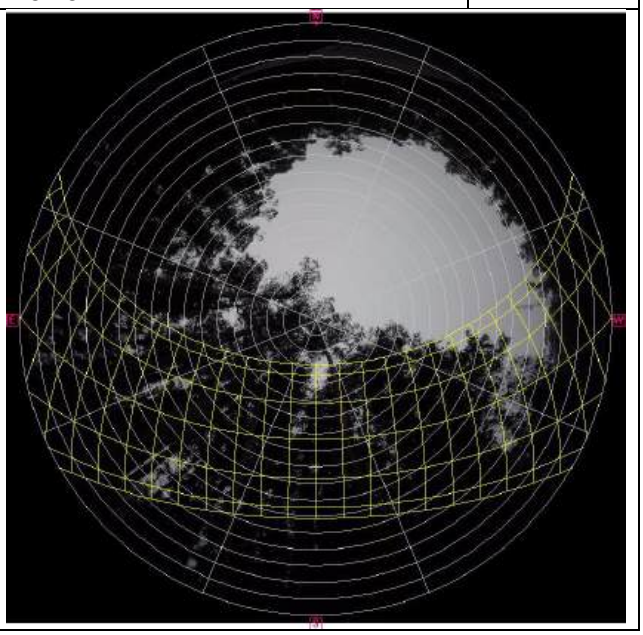


Photo 960. Historical cluster site on NW fence line of Yard. Note vertical gap to SE (circled). Exposed to SE, E and NE winds across Yard. Morning insolation. ISFU = 0.24 DSFU = 0.36

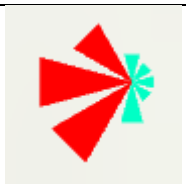
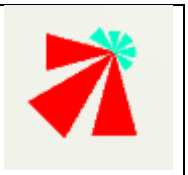
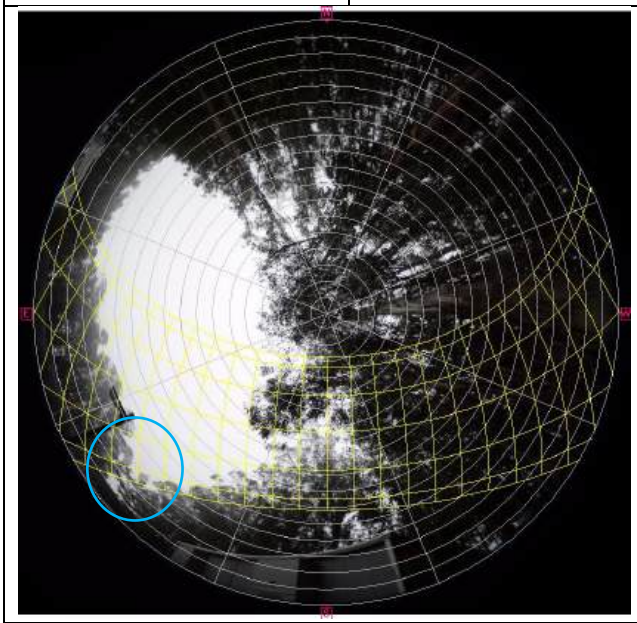


Photo 959 Historical cluster site along NW fence line of Yard, 46 m (150') NE of 960. The vertical gap noted in Photo 960 has shifted to S. ISFU = 0.21 DSFU = 0.43





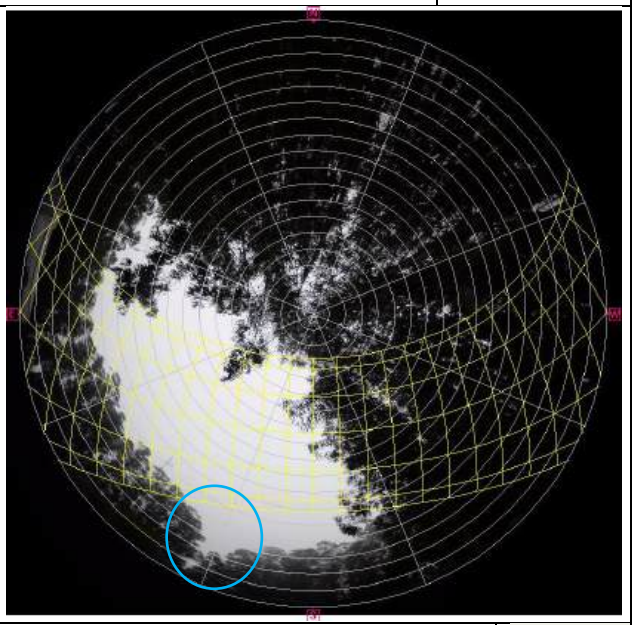


Photo 956. N corner of Yard. Gap over Yard to S, note the vertical gap (circled) from Photos 960 and 959 due south ISFU = 0.12 DFSFU = 0.18

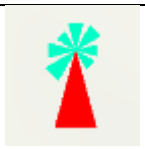
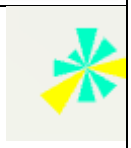
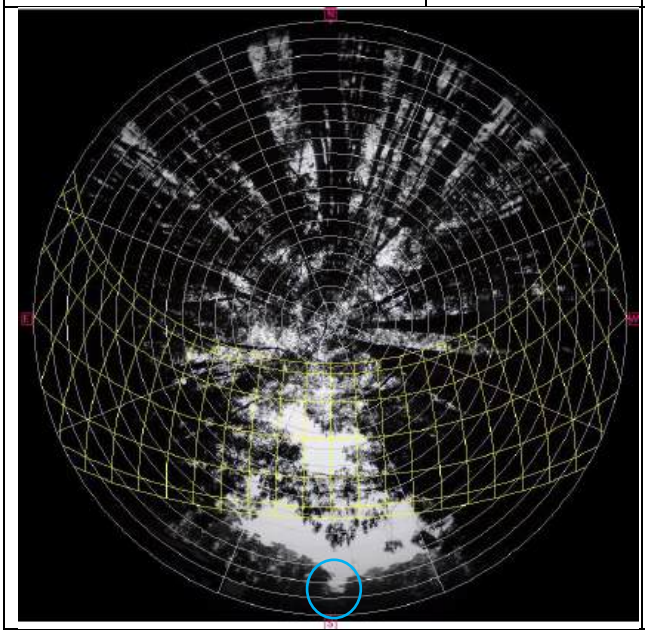


Photo 930. 26 m (84') NW of Yard. Vertical gap to SE is between the tree rows, with gap on opposite side of Yard still visible. ISFU = 0.15 DSFU = 0.21





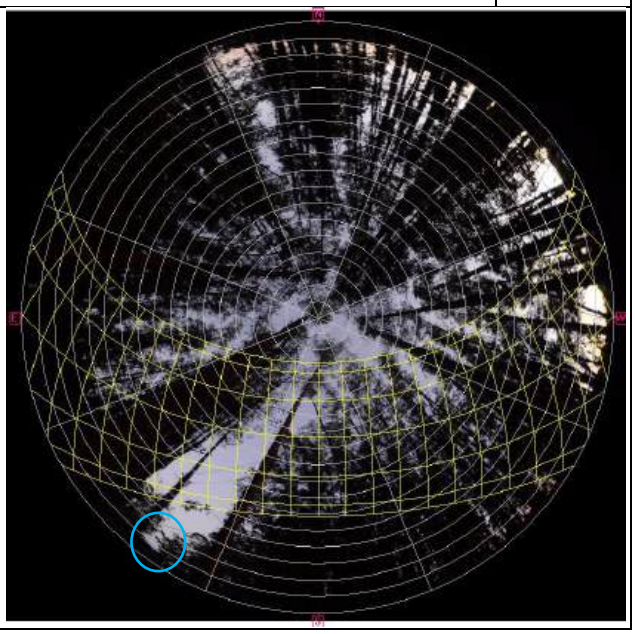
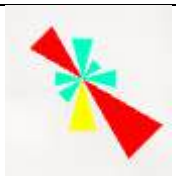
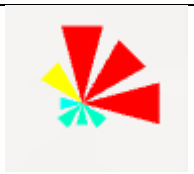
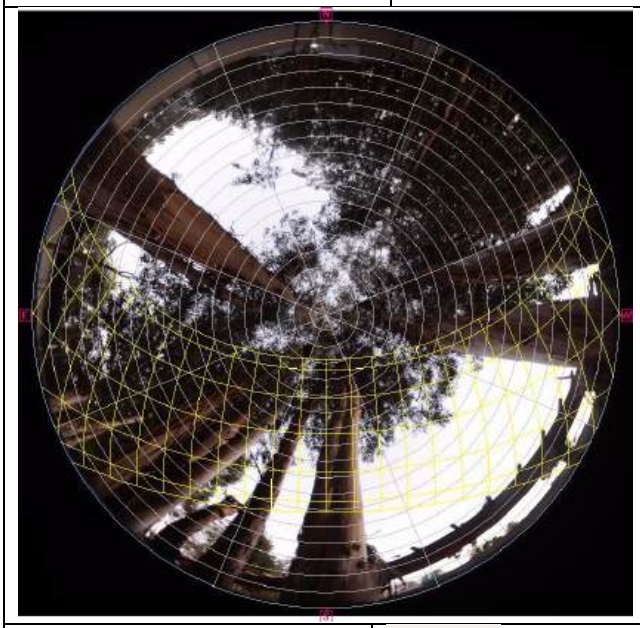
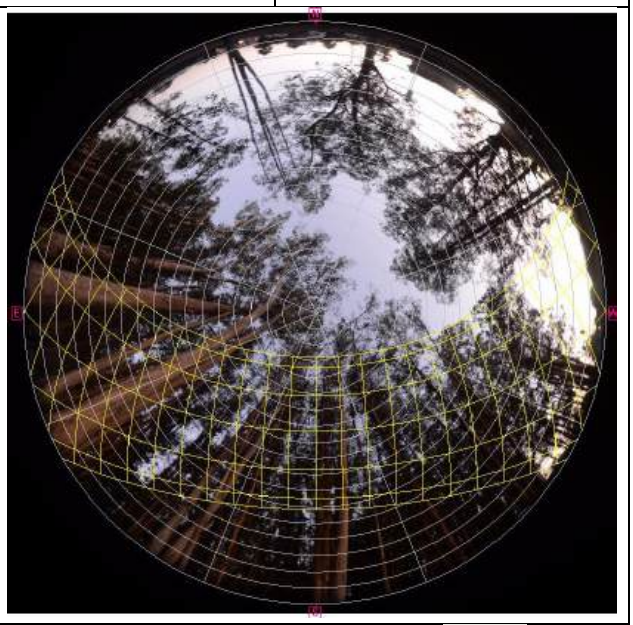
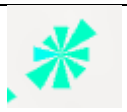
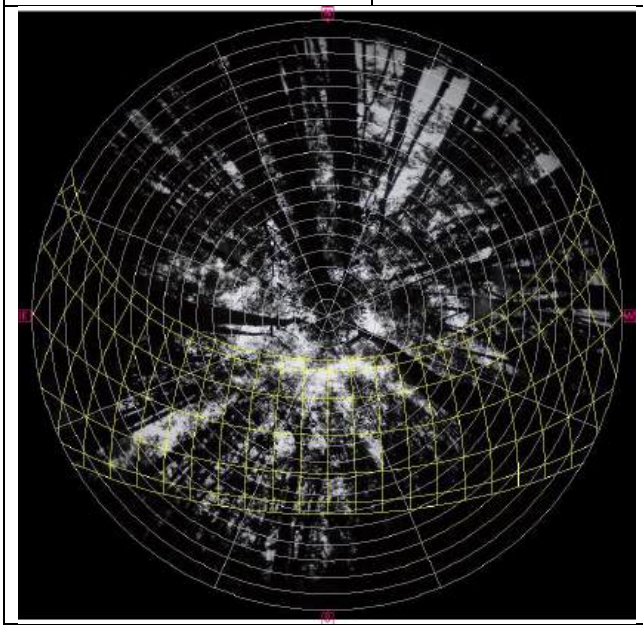
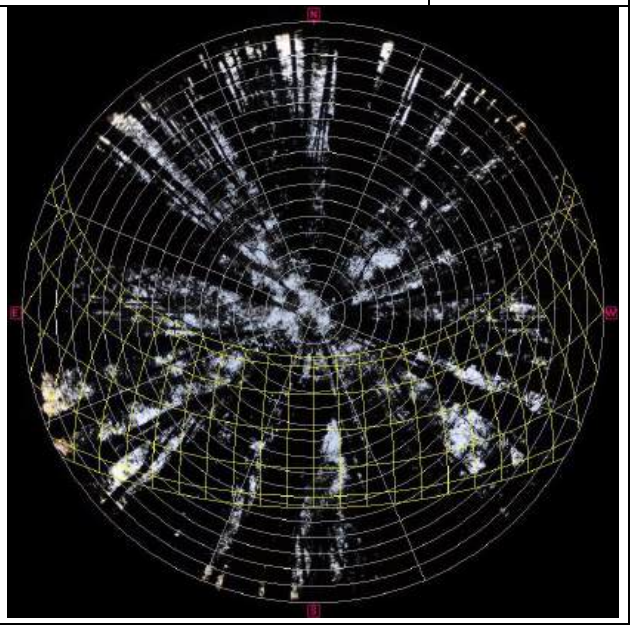
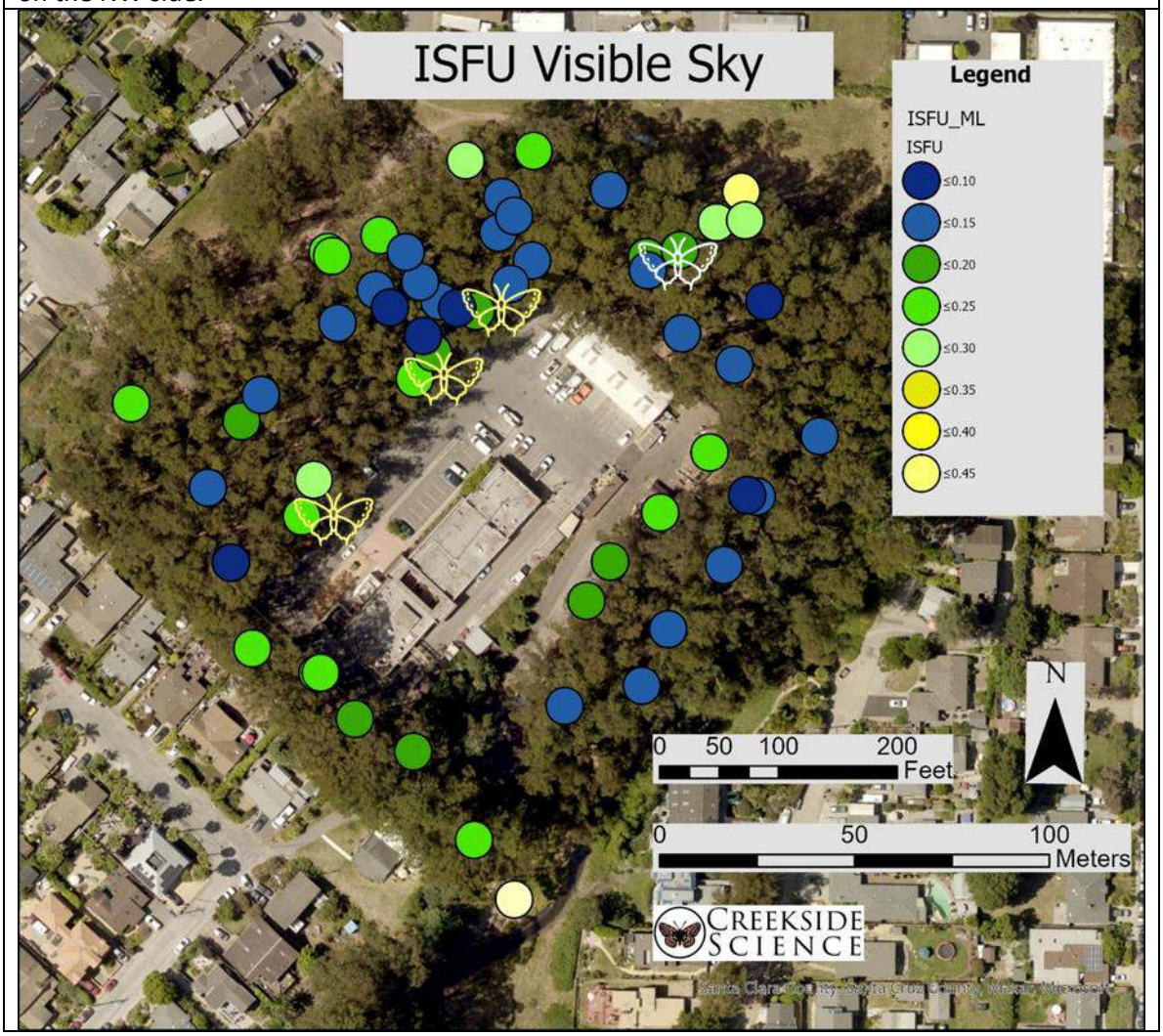


Photo 926. Gap along SW edge, penetrating from SW to NE through the stand. ISFU = 0.21 DSFU = 0.25		**Photo 933.** NW edge of grove. The row of trees 25 m (85') to the NW help shelter the edge. ISFU = 0.22 DSFU =0.11	
			
Photo 968. Interior of NW stand. Well-sheltered from all directions. Low insolation. ISFU = 0.10 DSFU = 0.15.		**Photo 912.** Interior site near E corner of Yard. Dense canopy, well sheltered from all directions Low insolation, ISFU = 0.10 DSFU = 0.07	
			

ISFU (Visible Sky) The vast majority of monarch cluster sites have ISFU between 0.15 and 0.30, which are shown in green. The blue sites are too closed, and the yellow sites are too open. The observed cluster sites (white circle) on the NE side of the Yard are in that range, as are the sites on the NW side.

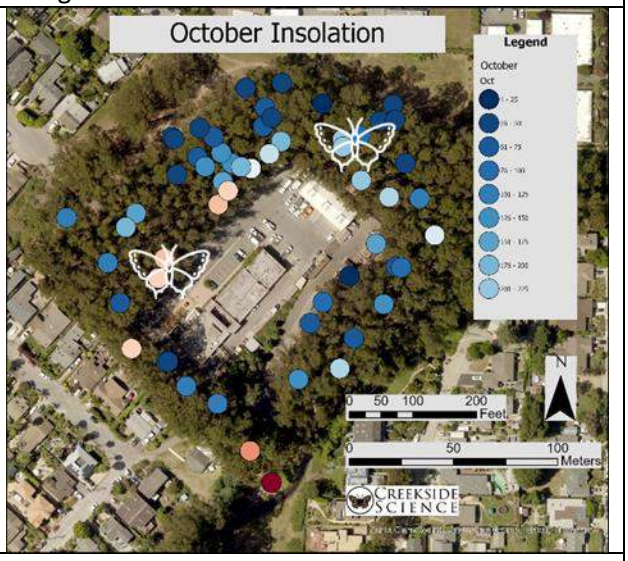


Direct Below Canopy (1.75 m) Insolation from Hemiphotos

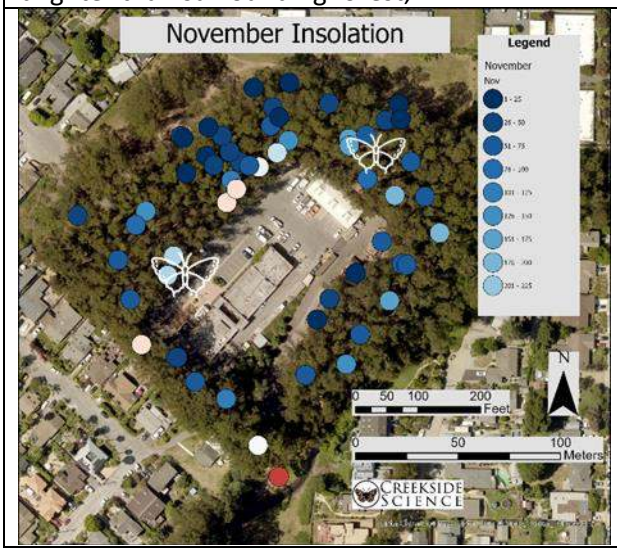
DSFU is the fraction of potential annual insolation, and includes sunpaths for all months, and can approximate insolation exposure higher in the canopy Cluster sites are white circles.



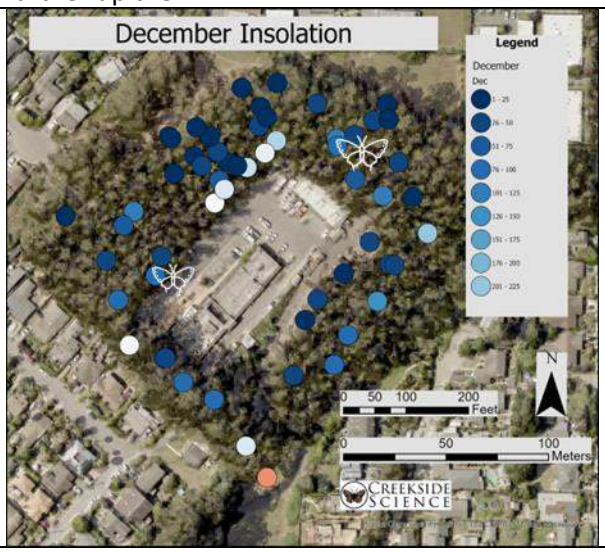
October insolation shows the relatively brighter conditions at the NE cluster site (Photo 908), where direct sun penetrates through the forest from the S. High insolation also at the NW site along the access road.



November insolation has a similar pattern to October, but values are lower because the sun tracks lower in the sky. Cluster sites still relatively brighter than surrounding forest,

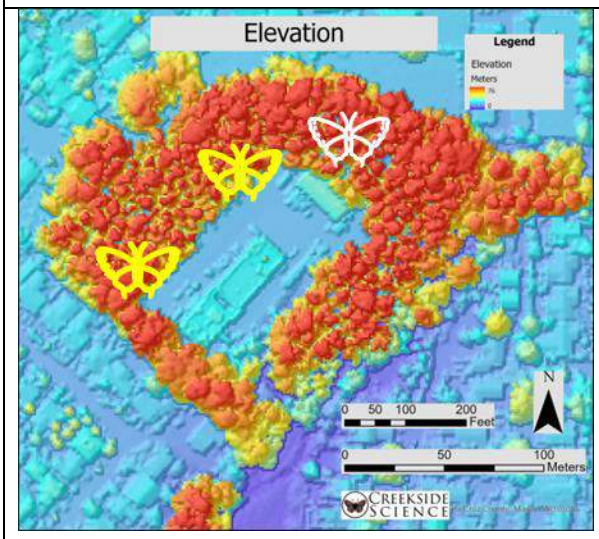
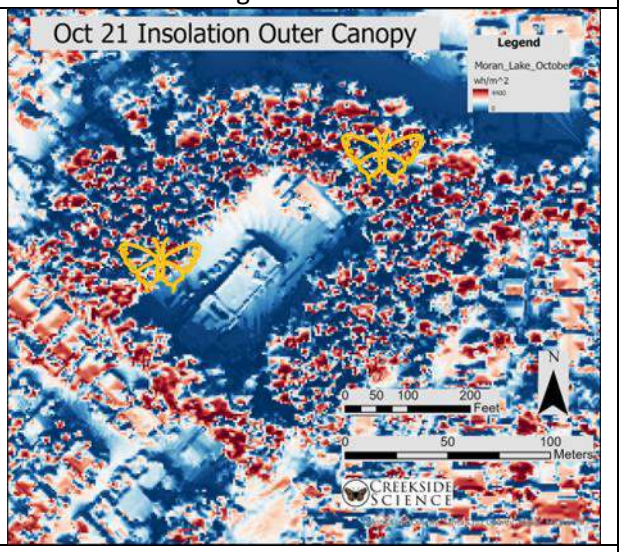
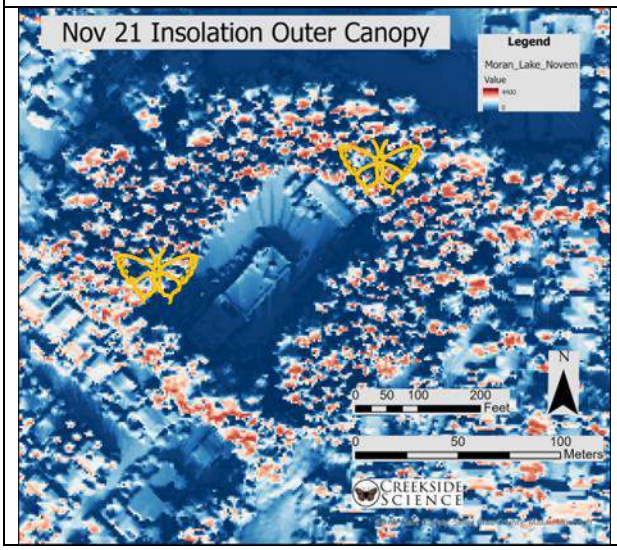
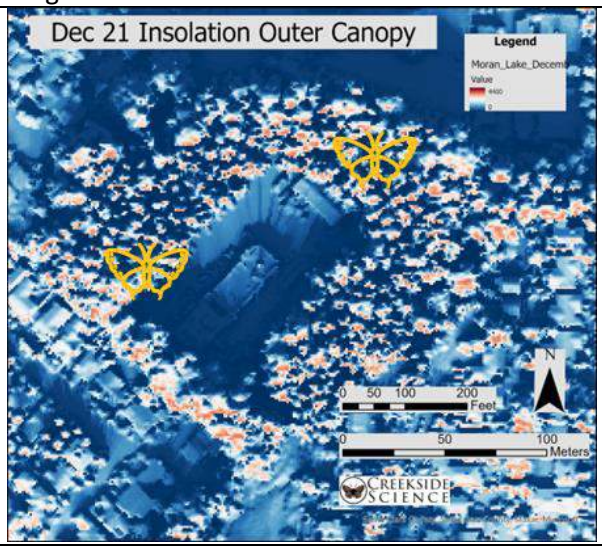


December insolation still shows relatively brighter cluster sites than surrounding forest. Sites along the creek trail SE of Yard are brighter than sites farther up the hill.



Moran Lake Monarch Assessment October 2022

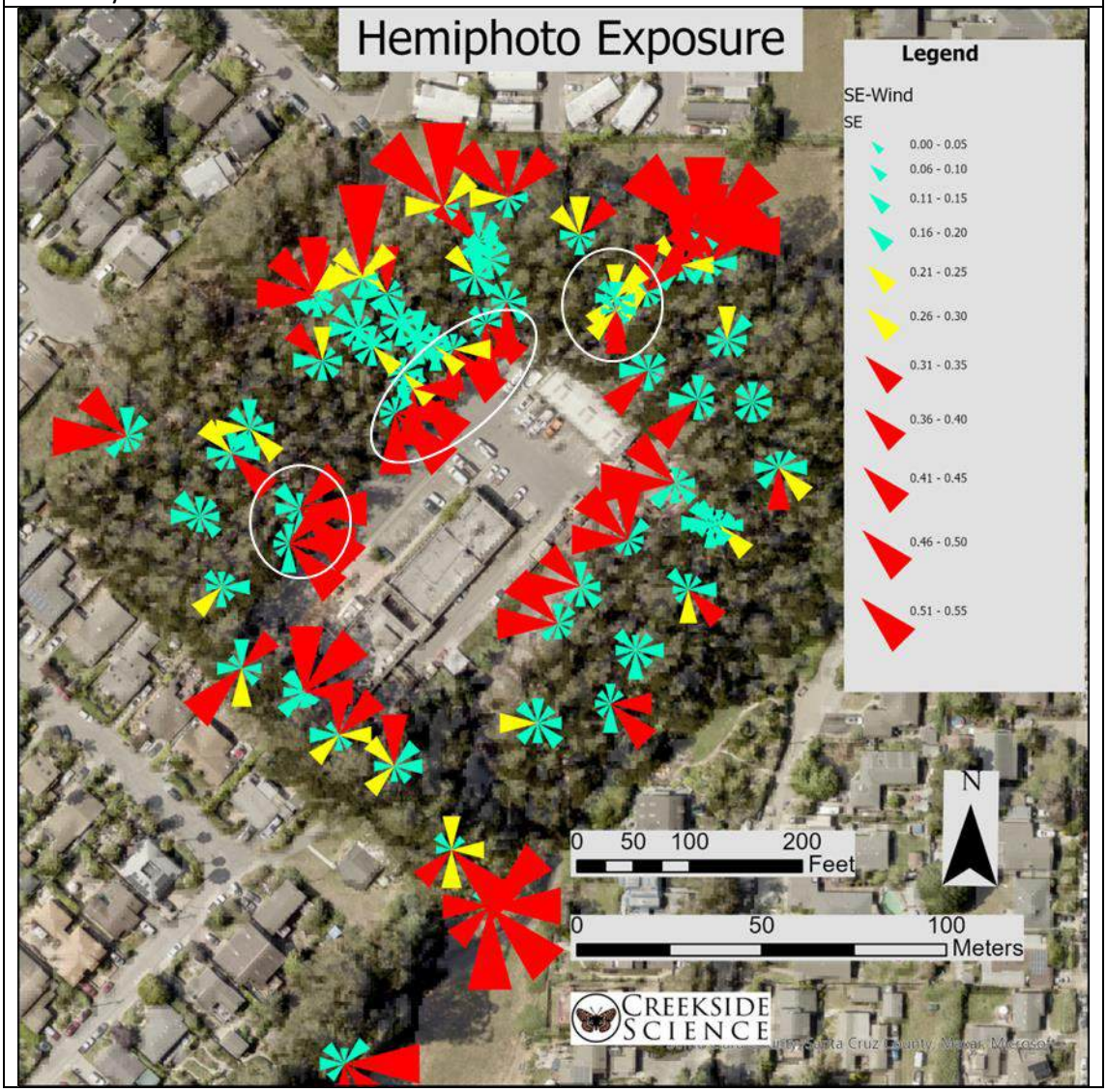
Outer Canopy Insolation from ARCGIS Solar Radiation Calculator

Digital Surface Model (DSM) of the grove surrounding the Yard, with current and some historical cluster sites shown.	**October 21 insolation** at outer canopy surface. The south-sides of trees receive the highest insolation. Canopy gaps in the high insolation (red) areas allow penetration to potential cluster sites. Note the shade cast into the open Yard and to the north of the grove.
	
November 21 insolation at outer canopy surface. Values are lower than in October, bit patterns remain similar. More shade is cast north of trees.	**December 21 insolation** at outer canopy surface. Similar to November 21, but lower values and longer shadows
	

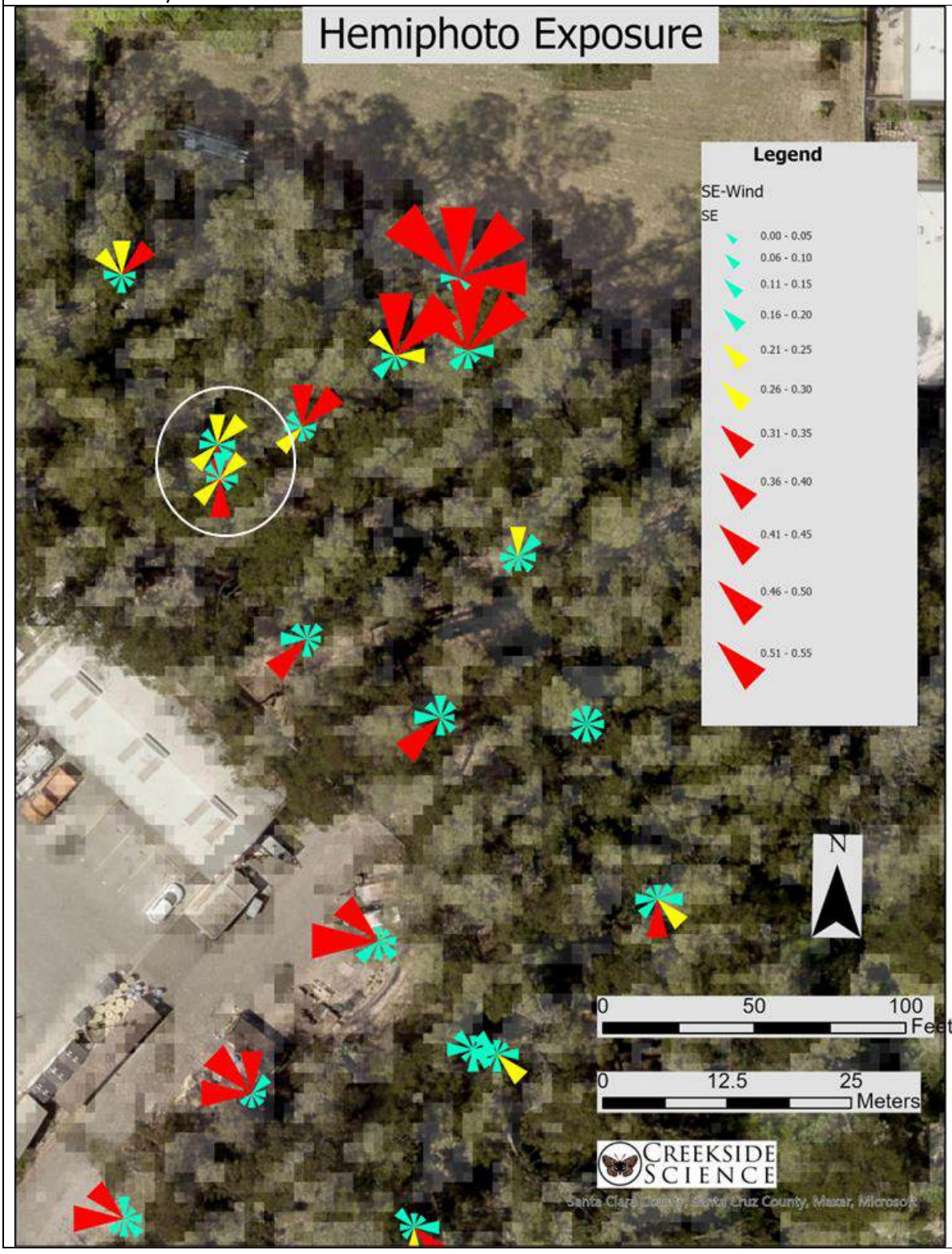
Moran Lake Monarch Assessment October 2022

Hemiphoto Exposure in Eight Directions

The exposure (proportion of visible sky) in each direction is represented by the size of the arrows. Cyan are < 0.20, yellow are 0.20-0.30, and red are >0.30. The “exposure roses” are shown in the example photos above, so one can see what different values mean visually. Forest interior sites are generally well sheltered, but open edges and roads/trails expose more sky. Current and historical cluster sites are within the circles.



Close-up of the NE cluster zone. The 2022 cluster site is circled, note the mix of cyan and yellow arrows with only one red to the S.

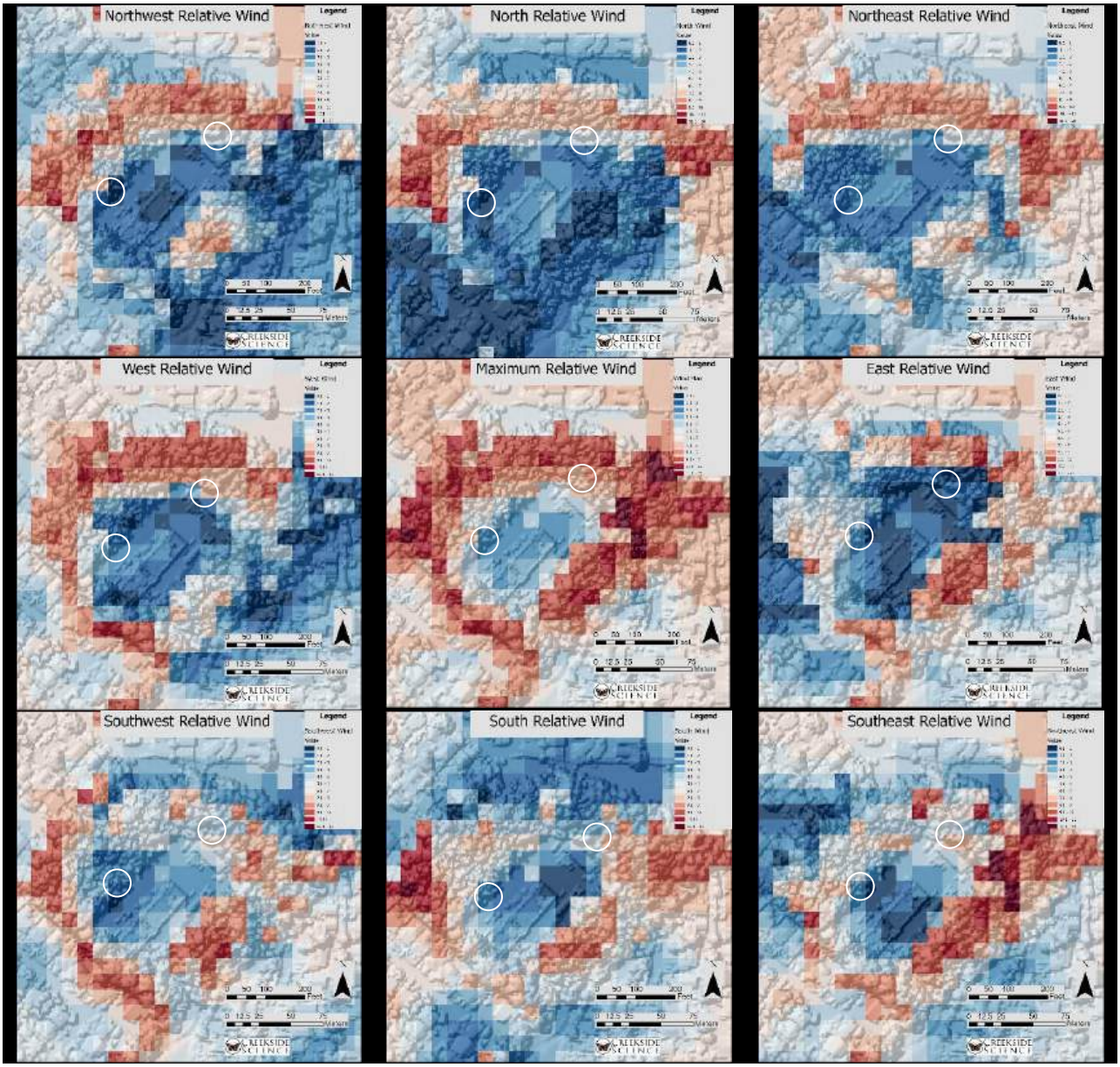


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Relative Wind Exposure at Canopy Surface (WindNinja)

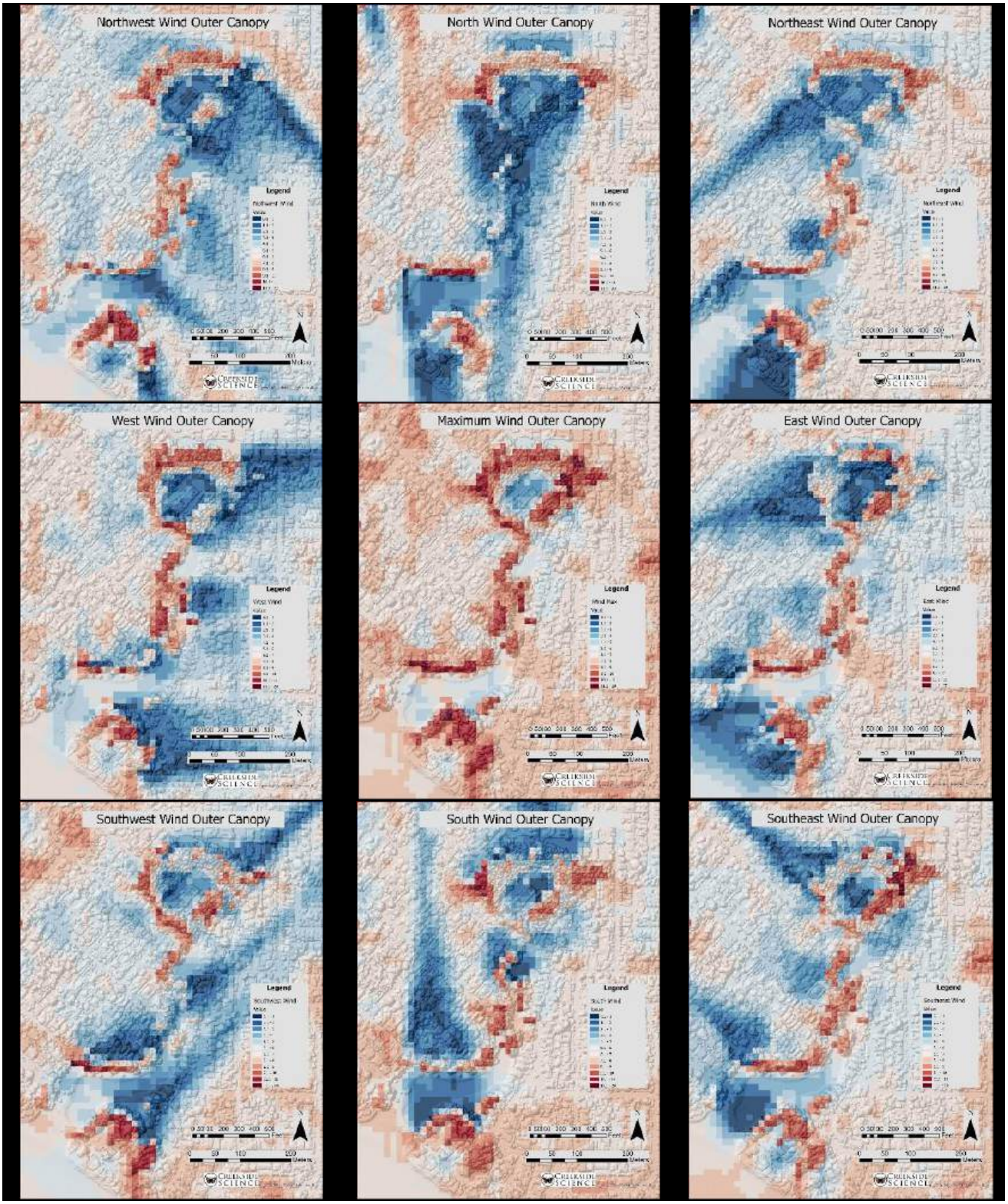
The outputs of WindNinja are at a 10-meter scale at the outer canopy surface and capture the effects of larger structures such as stands of trees or buildings. These maps assume a 10 m/s (22.4 mph) wind coming from the indicated direction and provide a measure of relative wind exposure based on features at the 10 m spatial scale. The analyses do not account for small gaps in the canopy that lead to the interior (that is the realm of hemiphotos). The tops of trees on windward edges have the highest relative wind (dark reds). The Yard interior has wind shelter from most directions (blues), but the interior edges of the Yard sometimes have moderate shelter (white or light red).

The smallest structural element that is captured is the SE gap around the Yard, which can be see seen best in the Maximum map in the center, where the band of high exposure at the treetops surrounding the Yard (dark red) is interrupted by a 10 m wide band of lower wind (white).



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Maps of the entire site show sheltering effects of tall trees extending well downwind. But the trees extending S along the creek and lagoon appear to have minimal effects around the Yard, even with S wind. Management efforts, therefore, should concentrate on the immediate surroundings of the Yard.



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Wind Measurements

Wind measurements (2-minute average at each point) on three dates demonstrate some of the vulnerabilities. The maximum wind speed among the sites is posted in the title. Arrows are sized by speed and color-coded – blue is <5 mph (~2 m/s), a threshold for site occupancy, yellow are 5-7.5 mph (marginal), and red are >7.5 mph. The direction of the arrows shows how wind directions vary from the overall wind field. Attenuation is the ratio of the wind to the maximum measured at any site.

Measured wind Dec 13, 2021. Strong S winds were attenuated by the forest but penetrated into the cluster area NE of the Yard, through and around the E corner of the grove. The red site due east of the Yard (Photo 913) is at the top of a small rise and has a wind-tunnel facing SSE.



Measured wind July 7, 2022. The low speed of the maximum wind in the area (6.8 mph) meant that all sites were below the 5 mph threshold. The overall low speed around the pump station reflects the shelter provided by the urban matrix.



Measured wind Jan 21, 2022. Northerly winds penetrated into the cluster area through the open NE edge. Monarchs were active in the sheltered areas along the SE edge during these measurements.



Attenuation of maximum wind. The attenuation factors standardize wind speeds. The open NE and NW edges produce wind vulnerabilities in those sectors. The SE edge along the creek is sheltered from all three observed directions.



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Methods

LiDAR Analysis

LiDAR Analysis: LiDAR (Light Detection and Ranging) is an airborne laser scanner that sends pulses and measures the reflections at a density of ~12 points/square meter. Flown in 2020 for vegetation mapping and other purposes in Santa Cruz and San Mateo, Counties (OCM Partners, 2022: 2020 San Mateo RCD Lidar: Santa Cruz County, CA, https://www.fisheries.noaa.gov/inport/item/63258), it provides a three-dimensional "point cloud" that can characterize the structure of the forest canopy and underlying ground surface. In recent years, it has become a useful method for quantifying monarch habitat through insolation and wind modeling, and providing 3-dimensional views of sites.

The LiDAR point cloud is processed and analyzed as follows:

1) Creation of a Digital Surface Model (DSM) of the outer canopy by taking the average height of the first hit averaged over each square meter.
2) The DSM is input into ARCGIS solar radiation modeling tools to create surfaces of daily insolation for October 21, November 21, and December 21. Because insolation is virtually symmetrical around the winter solstice, November 21 is equivalent to January 21, and October 21 is equivalent to February 21. Atmospheric transmissivity is set to 0.65, and 10% of the insolation is diffuse (clear-sky conditions). Radiation units are in watt-hours/m^2. This analysis assumes that the canopy is solid, and is only applicable to the outer canopy surface (where monarchs often cluster) and the open ground such as the Glen center. The interior conditions with more dappled insolation are quantified by hemispherical photography (see below).
3) The DSM is also used as an input surface for wind analysis using WindNinja. This program (developed by the USDA Forest Service Fire Lab in Missoula, MT) distributes a specified wind speed and direction over complex surfaces. In this analysis, a wind speed of 10 m/s (22.3 mph) is specified from eight cardinal directions. The resulting maps are indicative of *relative* wind shelter caused by terrain (i.e., the ridge to the north), upwind trees, and the outer canopy of the grove itself. Like the insolation model, the results are applicable only to the outer canopy surface, not sites within the canopy. The spatial scale of the WindNinja output is 10 meters, so it captures larger structures like shelterbelts, not individual branches. Forest interior conditions and small openings in shelterbelts are quantified by hemispherical photography (see below).
4) To characterize the vertical distribution of canopy, height metrics are extracted on a 5-meter grid. Metrics include mean return height, standard deviation, skew, and kurtosis, which can indicate if the canopy is continuous from the ground to the top (a good wind screen), or skewed toward the top with openings lower down (allows wind to penetrate through the canopy).

Hemispherical Photography

Hemispherical photography has been a standard method for assessing forest canopy structure at monarch overwintering sites. Photographs are taken using a Nikkor 8mm lens on a Nixon D610 camera body, mounted on self-leveling gimbals so that the photograph is pointed straight up at the zenith. A compass is used to orient to north.

Photographs are analyzed with Hemiview 2.0 software (Delta-T Devices). The photographs are aligned, and a gray-scale threshold is interactively selected to differentiate sky from obstructions. Photographs

are best taken under uniform overcast conditions, or at sunrise or sunset, when there is no direct illumination of the canopy (which can be brighter than the sky).

Hemiview overlays a “sky grid” (gray) that divides the upward hemisphere into 5° zenith angle increments (18 total = 90°) and 45° azimuth wedges centered on the eight cardinal directions. The fraction of open sky in each segment is calculated and weighted by the geometry of the segment depending on the analysis. Hemiview also overlays a “sun grid” (yellow) based on site latitude, with monthly increments through the year, and half-hourly increments over the day. The December 21 sunpath (winter solstice) is the lowest path, the middle path is March 21, and the highest path is June 21. The fraction of open sky in each of the segments is calculated, and the specified solar model is used to calculate insolation. The example photographs show both grids.

The following “site factors” are extracted:

1) ISFU – Indirect Site Factor Uncorrected, the fraction of visible sky in all directions.
2) DSFU – Direct Site Factor Uncorrected, the fraction of potential radiation across all months.
3) Nov/Feb and Dec/Jan potential direct insolation – calculated from fraction of unobstructed monthly sunpaths assuming clear skies.
4) Directional Exposure – the fraction of sky visible in eight compass directions, a measure of relative wind exposure.

The hemiphoto data are mapped as points because the photo grid was not dense enough to create an interpolated surface.

Appendix B

Moran Lake Restoration Project Arborist Report



Moran Lake Restoration Project

Arborist Report

prepared by

Rincon Consultants, Inc.
2511 Garden Road, Suite C-250
Monterey, California 93940

August 22, 2022

RINCON CONSULTANTS, INC.
Environmental Scientists | Planners | Engineers
rinconconsultants.com

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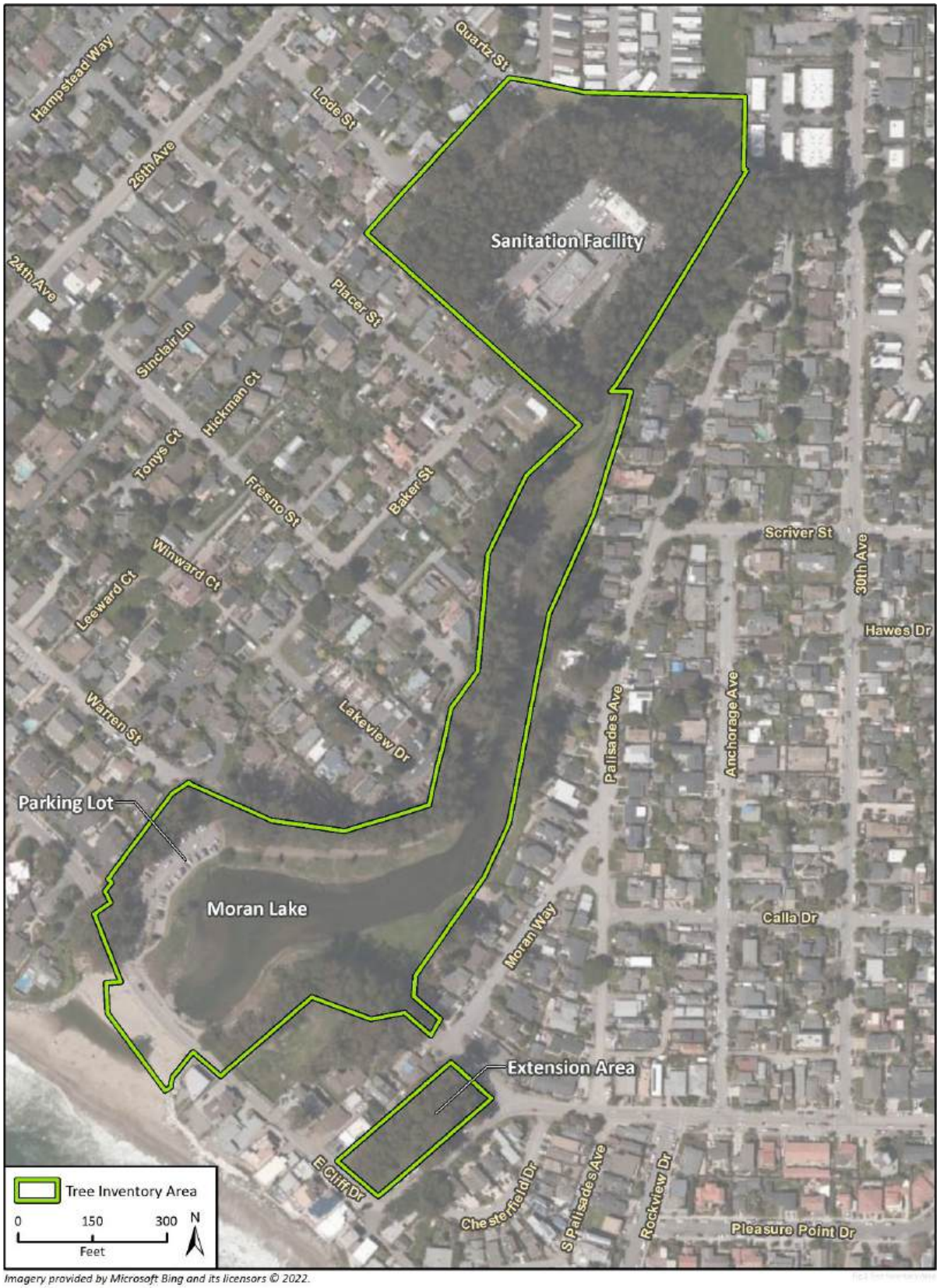
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Appendix B Tree Inventory Figures

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1 Project Overview

Rincon Consultants, Inc. (Rincon) was contracted through Santa Cruz County to prepare an Arborist Report (report) to assist in the preparation of the Moran Lake Restoration Plan (Project) and the Monarch Butterfly Habitat Management Plan Update for Moran Lake County Park (Park), which is located at 22775 East Cliff Drive in Santa Cruz, California. The Project will involve the restoration and enhancement of wetland habitat to improve its functionality and the water quality within Moran Lagoon, will enhance the lagoon and the surrounding areas climate change resilience, and improve public access and urban green space for the parks neighboring communities. As shown in Figure 1, the tree inventory area is located entirely within Park parcels owned and maintained by the County of Santa Cruz and includes portions of developed land and forested undeveloped land on an approximately 18.5-acre site.

Figure 1 Tree Inventory Area



2 Scope of Report

This report is intended to provide tree information to inform planning and design of the Project and the Monarch Butterfly Habitat Management Plan Update. More specifically, this report details the findings from the tree survey (survey), which was conducted by International Society of Arboriculture (ISA) Certified Arborist Casey Clark and Rincon Biologist Kate Ludwig on June 7 and June 8, 2022. During the survey a tree tag was assigned to each tree surveyed and the location, species, diameter at breast height (DBH), height, canopy spread, general health condition, and any relevant notes (particularly pertaining to structural integrity) were recorded for each tree.

3 Survey Methods

All newly planted native trees in the park, landscape/ornamental trees, and all naturally occurring trees with a diameter at breast height (DBH) of 4 inches or greater were surveyed if they had any portion of their canopy in the Park. All newly planted native trees and landscape/ornamental trees, regardless of size, were surveyed to collect data on their establishment success. The number of trunks, DBH, location, height, canopy spread, general health condition, and any relevant notes (particularly pertaining to their structural integrity) were recorded for each tree. DBH measurements were taken with a diameter tape or Biltmore stick and were taken in accordance with American Forests Champion Tree Measurement Guidelines (American Forests 2015). All trees with a DBH of greater than 60" were recorded as "60+" due to equipment limitations. A Global Positioning System (GPS) device with submeter capability was used to collect the location of each tree's trunk. Tree tags were affixed to the tree's trunk approximately 6 feet above the ground, primarily facing north. Each tree's unique tag number was sequential along the survey path. Numerous trees had tree tags with numbers from past surveys. To avoid confusion from previous tree inventories, tree tag numbers for this survey began at 1001 and concluded at 1348 within the main Park area. The Parks extension area, sanitation facility, and remnant landscape/ornamental trees surrounding the parking area were surveyed separately and tagged with numbers beginning at 3001 and concluding at 3095. Tree height and canopy spread were visually estimated in the field. The health condition of each tree was evaluated by using a basic visual inspection method, and the arborist assigned one of the following general condition ratings to each tree:

- **Good:** Overall good tree vigor[1], healthy foliage and cambium[2] with no significant defects[3] or pest infestations. The location is optimal for the tree, and the tree is expected to survive long term.
- **Fair:** Overall moderate tree vigor, moderately healthy foliage and cambium with no serious defects or pest infestations. The tree's location may not be optimal for that species, but further decline is not anticipated.
- **Poor:** Overall poor tree vigor, declining foliage and cambium health due to abiotic and/or biotic factors. Notable defects or pest infestations may be present. Typically, poor vigor results when a tree is outcompeted by other plants, or the tree is in the wrong location.
- **Dead:** The tree is dead or very close to death and will not recover.

Individual tree ratings consider a variety of factors, including overall tree vigor, foliage condition, cambium condition, evidence of decay, insect or disease infestations, and any other notable structural defects. The survey was limited to visual examination of accessible parts without dissection, excavation, probing, or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies regarding the trees discussed in this report may not arise in the future.

Hazardous structural defects and any other relevant information were recorded for each tree when detected.

[1] Vigor refers to the force of healthy growth in any living matter or organism.

[2] Cambium is the cellular plant tissue in woody plants from which phloem, xylem, or cork grows by division, resulting in secondary growth. Cambium is the layer just inside the tree's bark.

[3] Defect refers to any physical abnormality that indicates poor tree health (e.g., exfoliating bark, epicormic growth, fire scars).

Due to time constraints, only priority trees (i.e., dead, dying/“Poor”, newly planted trees, and hazards trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). Additionally, notes on the grove’s average diameter and diameter range, average height and canopy height range, average canopy spread and total canopy coverage, and overall health notes were taken.

4 Survey Results

Six different species and a total of 443 trees were documented during the survey. Table 1 lists the total number of each species documented and their origin (i.e., native or introduced).

Table 1 Trees Documented by Species within the Park

Tree Species	Origin	Count
Blue gum eucalyptus (*Eucalyptus globulus*)	Introduced	411
Coast redwood (*Sequoia sempervirens*)	Introduced	7
Mexican fan palm (*Washingtonia robusta*)	Introduced	1
Monterey Cypress (*Hesperocyparis macrocarpa*)	Introduced	21
New Zealand christmas tree (*Metrosideros excelsa*)	Introduced	2
Strawberry tree (*Arbutus unedo*)	Introduced	1

A summary of all 443 trees inventoried is provided with this report in Appendix A. Appendix A lists each tree sequentially by number and includes its species, the number of trunks, DBH, height, canopy spread, general health condition rating, and any relevant notes (particularly pertaining to their structural integrity). The summarized information of the sanitation facility grove, including its DBH range, height range, canopy spread range, overall health condition, and relevant notes are documented at the bottom of the table. A map depicting each trees location, tag number, species, health condition (Poor or Dead only), and potentially hazardous trees is presented in Appendix B.

5 References

American Forests. 2015. American Forests Champion Tree Measurement Guidelines. Available online at https://www.americanforests.org/wp-content/uploads/2014/12/AF-Tree-Measuring-Guidelines_LR.pdf. Accessed July, 2022.

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Appendix A

Tree Survey Results Summary

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1001	Monterey cypress (*Hesperocyparis macrocarpa*)	1	16	45	20	Good	
1002	Monterey cypress	1	34	40	35	Good	
1003	Monterey cypress	1	6	20	15	Poor	
1004	Monterey cypress	1	8	25	10	Fair	
1005	Monterey cypress	1	17	30	15	Good	
1006	Monterey cypress	1	21	35	25	Good	
1007	Monterey cypress	1	17	35	15	Good	
1008	Blue gum (*Eucalyptus globulus*)	1	35	50	30	Good	
1009	Blue gum	1	22	45	20	Good	
1010	Blue gum	1	47	60	30	Good	
1011	Blue gum	1	25	40	30	Good	
1012	Blue gum	3	14, 23, 10	35	15	Good	
1013	Blue gum	1	23	35	20	Fair	
1014	Blue gum	2	16, 12	40	25	Good	
1015	Blue gum	1	10	30	15	Fair	
1016	Blue gum	1	21	30	10	Good	
1017	Blue gum	1	27	30	10	Good	Significant amount of epicormic shoots present.
1018	Blue gum	1	17	35	15	Fair	Branch dieback.
1019	Blue gum	1	44	50	30	Good	
1020	Blue gum	1	19	30	10	Fair	
1021	Blue gum	1	29	25	15	Good	
1022	Blue gum	1	26	30	15	Good	
1023	Blue gum	1	23	40	15	Poor	Severe English ivy infestation. Branch dieback.
1024	Blue gum	1	30	50	30	Good	
1025	Blue gum	1	23	35	20	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1026	Blue gum	1	26	50	15	Good	
1027	Blue gum	2	11, 15	40	10	Fair	
1028	Blue gum	1	18	40	15	Fair	
1029	Blue gum	1	21	50	15	Good	
1030	Blue gum	1	21	50	15	Good	
1031	Blue gum	1	42	50	15	Fair	
1032	Blue gum	1	21	55	20	Good	
1033	Blue gum	1	41	50	15	Good	
1034	Blue gum	1	36	45	10	Fair	Tree was previously topped.
1035	Blue gum	1	25	55	30	Good	
1036	Blue gum	1	17	25	15	Good	
1037	Blue gum	1	40	35	15	Good	
1038	Blue gum	1	22	35	20	Good	
1039	Blue gum	1	19	35	30	Good	
1040	Monterey cypress	1	13	30	30	Good	
1041	Monterey cypress	1	14	25	30	Good	
1042	Monterey cypress	1	15	30	35	Good	
1043	Monterey cypress	1	17	35	35	Good	
1044	Monterey cypress	1	17	35	35	Good	
1045	Blue gum	1	54	65	50	Good	Potentially hazardous tree. Long heavy branches leaning over trail.
1046	Blue gum	1	50	70	35	Good	
1047	Blue gum	1	55	100	45	Good	
1048	Blue gum	1	60+	100	40	Good	
1049	Blue gum	1	36	80	40	Good	
1050	Blue gum	1	55	90	50	Good	
1051	Blue gum	1	43	110	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1052	Blue gum	2	40, 35	90	60	Good	
1053	Blue gum	1	41	90	60	Good	
1054	Blue gum	1	38	80	20	Good	
1055	Blue gum	1	27	80	30	Good	
1056	Blue gum	1	60+	100	65	Good	
1057	Blue gum	1	60+	110	40	Good	
1058	Blue gum	1	32	100	30	Good	
1059	Blue gum	1	27	60	20	Fair	
1060	Blue gum	1	51	100	35	Good	
1061	Blue gum	1	23	80	30	Good	
1062	Blue gum	1	32	90	20	Good	
1063	Blue gum	1	36	75	15	Good	
1064	Blue gum	1	51	100	20	Good	
1065	Blue gum	1	28	100	40	Good	
1066	Blue gum	1	18	90	30	Good	
1067	Blue gum	1	13	70	20	Good	
1068	Blue gum	1	12	60	15	Good	
1069	Blue gum	1	41	100	25	Good	
1070	Blue gum	1	54	120	45	Good	
1071	Blue gum	1	56	100	40	Good	
1072	Blue gum	1	29	80	45	Good	
1073	Blue gum	1	34	90	45	Good	
1074	Blue gum	1	28	60	15	Fair	
1075	Blue gum	1	60+	100	60	Good	
1076	Blue gum	1	22	90	20	Good	
1077	Blue gum	1	47	100	20	Good	
1078	Blue gum	1	41	80	25	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1079	Blue gum	1	48	90	25	Good	
1080	Blue gum	1	36	95	35	Good	
1081	Blue gum	1	33	115	50	Good	
1082	Blue gum	1	48	120	60	Good	
1083	Blue gum	1	24	60	15	Good	
1084	Blue gum	1	56	90	35	Good	
1085	Blue gum	1	25	75	25	Good	
1086	Blue gum	1	36	110	50	Good	
1087	Blue gum	1	60+	100	45	Good	
1088	Blue gum	1	25	70	20	Good	
1089	Blue gum	1	52	110	50	Good	
1090	Blue gum	1	18	110	50	Good	
1091	Blue gum	1	19	70	20	Good	
1092	Blue gum	1	37	110	40	Good	
1093	Blue gum	1	24	85	20	Good	
1094	Blue gum	1	60+	100	55	Good	
1095	Blue gum	1	45	110	35	Good	
1096	Blue gum	1	30	100	45	Good	
1097	Blue gum	1	34	110	55	Good	
1098	Blue gum	1	37	90	20	Good	
1099	Blue gum	1	40	95	60	Good	
1100	Blue gum	1	25	75	30	Good	
1101	Blue gum	1	43	75	45	Good	
1102	Blue gum	1	5	25	10	Good	
1103	Blue gum	1	36	75	35	Good	
1104	Blue gum	2	11, 7	65	20	Good	
1105	Blue gum	1	38	75	20	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1106	Blue gum	1	41	80	30	Good	
1107	Blue gum	1	9	65	15	Good	
1108	Blue gum	1	27	80	25	Good	
1109	Blue gum	1	19	80	30	Good	
1110	Blue gum	1	22	80	35	Good	
1111	Blue gum	1	24	85	15	Good	
1112	Blue gum	1	35	85	35	Good	
1113	Blue gum	1	41	95	40	Good	
1114	Blue gum	1	29	70	50	Good	
1115	Blue gum	1	23	70	20	Good	
1116	Blue gum	1	19	40	25	Good	
1117	Blue gum	1	31	90	35	Good	
1118	Blue gum	2	14, 14	70	45	Good	
1119	Blue gum	2	7, 12	60	30	Good	
1120	Blue gum	1	52	80	30	Good	
1121	Blue gum	1	31	80	40	Good	
1122	Blue gum	1	51	80	25	Good	
1123	Blue gum	1	25	85	45	Good	
1124	Blue gum	1	24	70	35	Good	
1125	Blue gum	1	28	80	35	Good	
1126	Blue gum	1	14	70	20	Good	
1127	Blue gum	1	34	80	30	Good	
1128	Blue gum	1	20	90	20	Good	
1129	Blue gum	1	38	75	50	Good	
1130	Blue gum	1	13	75	35	Good	
1131	Blue gum	1	22	70	25	Good	
1132	Blue gum	1	38	85	35	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1133	Blue gum	1	14	70	30	Good	
1134	Blue gum	1	14	60	15	Good	
1135	Blue gum	1	17	75	15	Good	
1136	Blue gum	1	11	70	20	Good	
1137	Blue gum	1	21	80	40	Good	
1138	Blue gum	1	18	80	25	Good	
1139	Blue gum	1	23	90	30	Good	
1140	Blue gum	1	23	80	35	Good	
1141	Blue gum	1	39	40	15	Good	Tree was previously topped.
1142	Blue gum	1	44	75	35	Good	
1143	Blue gum	1	30	75	30	Good	
1144	Blue gum	1	32	70	15	Fair	Tree was previously topped.
1145	Blue gum	1	25	75	25	Good	
1146	Blue gum	2	16, 19	65	25	Good	
1147	Blue gum	1	30	80	45	Good	
1148	Blue gum	3	10, 9, 14	70	25	Fair	Three trunks are epicormic shoots from tree stump.
1149	Blue gum	1	51	90	40	Good	
1150	Blue gum	1	31	90	30	Good	
1151	Blue gum	1	22	65	26	Good	
1152	Blue gum	3	13, 19, 9	65	30	Good	
1153	Blue gum	2	9, 4	55	20	Good	
1154	Blue gum	3	7, 4, 4	60	25	Good	
1155	Blue gum	2	16, 6	55	25	Fair	
1156	Blue gum	2	10, 6	50	20	Fair	
1157	Blue gum	3	9, 9, 14	50	20	Good	
1158	Blue gum	1	37	100	35	Good	
1159	Blue gum	1	38	100	50	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1160	Blue gum	1	32	100	50	Good	
1161	Blue gum	1	9	40	15	Good	
1162	Blue gum	1	36	90	35	Good	
1163	Blue gum	1	51	110	40	Good	
1164	Blue gum	1	38	110	45	Good	
1165	Blue gum	1	28	90	45	Good	
1166	Blue gum	1	9	60	20	Good	
1167	Blue gum	1	28	80	50	Good	
1168	Blue gum	1	18	50	20	Good	
1169	Blue gum	1	9	50	25	Good	
1170	Blue gum	1	43	90	35	Good	
1171	Blue gum	1	55	90	45	Good	
1172	Blue gum	1	23	100	40	Good	
1173	Blue gum	1	21	70	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1174	Blue gum	1	36	100	45	Good	
1175	Blue gum	1	19	45	35	Fair	
1176	Blue gum	1	52	110	45	Good	
1177	Blue gum	1	34	80	50	Good	
1178	Blue gum	1	20	75	25	Good	
1179	Blue gum	1	29	100	30	Good	
1180	Blue gum	1	20	95	25	Good	
1181	Blue gum	1	40	120	40	Good	
1182	Blue gum	1	26	100	35	Fair	Significant amount of epicormic shoots and branch dieback present.
1183	Blue gum	1	16	70	30	Fair	
1184	Blue gum	1	27	90	30	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1185	Blue gum	1	38	110	30	Good	
1186	Blue gum	1	22	100	40	Good	
1187	Blue gum	1	24	60	30	Good	
1188	Blue gum	1	25	100	20	Good	
1189	Blue gum	1	51	110	50	Good	
1190	Blue gum	1	55	110	45	Good	
1191	Blue gum	1	28	90	35	Good	
1192	Blue gum	1	32	100	35	Good	
1193	Blue gum	1	41	100	20	Good	
1194	Blue gum	1	16	60	20	Good	
1195	Blue gum	1	28	75	30	Good	
1196	Blue gum	1	41	90	30	Good	
1197	Blue gum	1	29	100	30	Good	
1198	Blue gum	1	41	110	50	Good	
1199	Blue gum	1	36	80	10	Poor	Tree was previously topped and has a significant amount of epicormic shoots present.
1200	Blue gum	1	45	70	10	Poor	Tree was previously topped and has a significant amount of epicormic shoots present.
1201	Blue gum	1	24	75	45	Good	
1202	Blue gum	1	9	30	10	Fair	
1203	Blue gum	1	5	30	15	Good	
1204	Coast redwood (*Sequoia sempervirens*)	1	12	40	20	Good	
1205	Coast redwood	1	11	35	15	Good	
1206	Coast redwood	1	16	35	15	Good	
1207	Blue gum	1	12	40	20	Good	
1208	Blue gum	1	9	25	15	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1209	Coast redwood	1	12	30	15	Good	
1210	Coast redwood	1	11	35	15	Good	
1211	Coast redwood	1	6	30	15	Good	
1212	Blue gum	1	17	40	20	Good	
1213	Blue gum	1	11	25	25	Good	
1214	Blue gum	1	9	15	15	Good	
1215	Blue gum	1	9	15	15	Good	
1216	Blue gum	2	16, 18	75	35	Fair	
1217	Blue gum	3	14, 6, 8	75	40	Good	
1218	Blue gum	1	50	90	40	Good	
1219	Blue gum	1	25	80	35	Fair	
1220	Blue gum	1	45	100	45	Good	
1221	Blue gum	1	33	100	45	Good	
1222	Blue gum	1	36	100	20	Good	
1223	Blue gum	1	39	110	50	Good	
1224	Blue gum	1	31	110	20	Good	
1225	Blue gum	1	24	100	30	Good	
1226	Blue gum	1	31	100	20	Good	
1227	Blue gum	1	32	100	30	Good	
1228	Blue gum	1	39	90	20	Good	
1229	Blue gum	1	60+	80	50	Good	
1230	Blue gum	1	29	100	50	Good	
1231	Blue gum	1	11	35	15	Good	
1232	Blue gum	1	26	90	40	Good	
1233	Blue gum	1	53	110	40	Good	
1234	Blue gum	1	16	50	20	Good	Tree was previously topped.
1235	Blue gum	1	16	80	25	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1236	Blue gum	1	37	100	40	Good	
1237	Blue gum	1	25	90	15	Good	
1238	Blue gum	1	51	110	40	Good	
1239	Blue gum	1	21	90	20	Good	
1240	Blue gum	1	20	90	40	Good	
1241	Blue gum	1	31	90	45	Good	
1242	Blue gum	1	33	90	25	Good	
1243	Blue gum	1	19	80	25	Good	
1244	Blue gum	1	32	85	35	Good	
1245	Blue gum	1	40	80	25	Good	
1246	Blue gum	1	31	80	30	Good	
1247	Blue gum	1	32	90	20	Good	
1248	Blue gum	1	36	90	25	Good	
1249	Blue gum	1	26	75	25	Good	
1250	Blue gum	1	36	100	25	Good	
1251	Blue gum	1	55	80	25	Good	
1252	Blue gum	1	41	110	35	Good	
1253	Blue gum	1	40	95	35	Good	
1254	Blue gum	2	9, 9	35	20	Good	
1255	Blue gum	1	39	110	45	Good	
1256	Blue gum	1	16	65	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1257	Blue gum	1	60+	100	35	Good	
1258	Blue gum	3	9, 8, 10	45	35	Poor	Hazardous tree. Significant amount of epicormic shoots present. Broken limb over trail.
1259	Blue gum	1	10	50	40	Fair	
1260	Blue gum	1	38	80	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1261	Blue gum	1	43	90	40	Good	
1262	Blue gum	1	60+	100	55	Good	
1263	Monterey cypress	1	21	20	25	Good	
1264	Monterey cypress	1	17	15	15	Good	
1265	Monterey cypress	1	20	15	20	Good	
1266	Blue gum	1	14	35	30	Good	
1267	Blue gum	1	16	30	20	Good	
1268	Mexican fan palm (*Washingtonia robusta*)	2	22, 22	60	15	Good	
1269	Monterey cypress	1	45	70	40	Good	
1270	Monterey cypress	1	19	40	30	Good	
1271	Monterey cypress	1	14	50	30	Good	
1272	Monterey cypress	1	29	40	30	Good	
1273	Monterey cypress	6	16, 15, 20, 17, 10, 9	40	35	Good	
1274	Monterey cypress	1	21	40	30	Good	
1275	Blue gum	4	23, 27, 12, 21	120	15	Good	
1276	Blue gum	1	12	100	20	Good	
1277	Blue gum	5	33, 17, 26, 19, 29	120	50	Good	
1278	Blue gum	1	60+	120	60	Good	
1279	Blue gum	2	22, 24	120	30	Good	
1280	Blue gum	1	24	120	20	Good	
1281	Blue gum	1	28	100	35	Good	
1282	Blue gum	1	60	100	50	Good	
1283	Blue gum	1	60+	100	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1284	Blue gum	1	33	100	55	Good	
1285	Blue gum	1	60	90	55	Good	Potentially hazardous tree. Heavy leaning codominant stem leaning over trail.
1286	Blue gum	1	36	90	55	Good	
1287	Blue gum	1	60	110	55	Good	
1288	Blue gum	1	27	80	60	Fair	Significant amount of epicormic shoots and branch dieback present.
1289	Blue gum	1	29	100	35	Good	
1290	Blue gum	1	19	75	40	Good	
1291	Blue gum	1	25	100	45	Good	
1292	Blue gum	1	60	120	69	Good	
1293	Blue gum	1	21	85	60	Good	Significant amount of epicormic shoots and branch dieback present.
1294	Blue gum	1	23	90	55	Good	
1295	Blue gum	1	22	75	15	Fair	Significant amount of epicormic shoots present.
1296	Blue gum	1	26	90	55	Good	
1297	Blue gum	1	40	100	60	Good	
1298	Blue gum	1	38	95	65	Good	
1299	Blue gum	1	37	110	60	Good	
1300	Blue gum	1	19	70	35	Fair	Significant amount of epicormic shoots and branch dieback present.
1301	Blue gum	1	41	120	45	Good	
1302	Blue gum	1	24	80	35	Good	
1303	Blue gum	1	52	80	35	Fair	Significant amount of epicormic shoots and branch dieback present.
1304	Blue gum	1	26	90	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1305	Blue gum	1	21	85	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1306	Blue gum	2	9, 7	40	15	Fair	
1307	Blue gum	1	33	100	55	Good	
1308	Blue gum	1	29	110	40	Good	
1309	Blue gum	1	15	75	30	Good	
1310	Blue gum	1	18	80	15	Poor	Significant amount of epicormic shoots and branch dieback present.
1311	Blue gum	1	55	120	50	Good	
1312	Blue gum	1	17	75	35	Fair	
1313	Blue gum	1	40	120	45	Good	
1314	Blue gum	1	20	75	40	Fair	Significant amount of epicormic shoots and branch dieback present.
1315	Blue gum	1	26	100	60	Fair	Significant amount of epicormic shoots and branch dieback present.
1316	Blue gum	1	19	75	25	Fair	Significant amount of epicormic shoots and branch dieback present.
1317	Blue gum	1	27	110	50	Good	
1318	Blue gum	1	14	75	25	Fair	Significant amount of epicormic shoots and branch dieback present.
1319	Blue gum	1	44	120	40	Good	
1320	Blue gum	1	19	60	10	Poor	Tree has a broken trunk with a significant amount of epicormic shoots and branch dieback.
1321	Blue gum	1	33	100	40	Good	
1322	Blue gum	1	13	60	10	Dead	Significant amount of epicormic shoots and branch dieback present.
1323	Blue gum	1	9	60	5	Dead	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1324	Blue gum	1	34	110	35	Good	
1325	Blue gum	1	18	80	15	Poor	Significant amount of epicormic shoots and branch dieback present.
1326	Blue gum	1	21	75	15	Poor	Significant amount of epicormic shoots and branch dieback present.
1327	Blue gum	1	22	80	40	Fair	
1328	Blue gum	1	33	110	55	Good	
1329	Blue gum	1	9	55	10	Poor	Significant amount of epicormic shoots and branch dieback present. Two dead saplings adjacent to this tree.
1330	Blue gum	1	28	120	40	Good	
1331	Blue gum	1	37	110	40	Good	
1332	Blue gum	1	17	90	10	Fair	Significant amount of epicormic shoots and branch dieback present.
1333	Blue gum	1	11	70	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1334	Blue gum	1	14	85	15	Fair	Significant amount of epicormic shoots and branch dieback present.
1335	Blue gum	1	8	50	0	Dead	
1336	Blue gum	1	44	85	40	Good	
1337	Blue gum	1	20	80	35	Good	
1338	Blue gum	1	20	90	40	Good	
1339	Blue gum	1	19	75	25	Fair	Significant amount of epicormic shoots and branch dieback present.
1340	Blue gum	1	10	40	20	Fair	
1341	Blue gum	1	9	25	15	Fair	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1342	Blue gum	1	19	75	20	Poor	Potentially hazardous tree. Significant amount of epicormic shoots and branch dieback present. Dead branches over trail.
1343	Blue gum	1	14	70	25	Good	
1344	Blue gum	1	28	75	45	Good	
1345	Blue gum	2	15, 14	65	45	Good	
1346	Blue gum	1	26	90	45	Good	
1347	Blue gum	1	21	70	35	Good	
1348	Blue gum	1	32	85	35	Good	
3001	Blue gum	10	12 to 30	40	60	Good	
3002	Blue gum	3	9, 6, 7	30	15	Fair	
3003	Blue gum	2	16, 21	50	15	Good	
3004	Blue gum	1	30	50	20	Good	
3005	Blue gum	1	19	50	20	Good	
3006	Blue gum	1	25	50	25	Good	
3007	Blue gum	1	18	60	15	Good	
3008	Blue gum	2	5, 5	70	20	Good	
3009	Blue gum	1	23	70	15	Good	
3010	Blue gum	1	14	50	15	Good	
3011	Blue gum	2	12, 6	70	25	Fair	
3012	Blue gum	4	13, 13, 25, 32	70	50	Good	
3013	Blue gum	2	60+	70	50	Good	
3014	Blue gum	3	17, 19, 25	60	40	Good	
3015	Blue gum	1	60+	70	50	Good	
3016	Blue gum	2	9, 12	50	30	Good	
3017	Blue gum	2	8, 4	40	20	Good	
3018	Blue gum	1	14	70	20	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3019	Blue gum	1	10	70	15	Good	
3020	Blue gum	1	24	70	20	Good	
3021	Blue gum	1	17	70	20	Good	
3022	Blue gum	2	25, 29	70	30	Good	
3023	Blue gum	1	29	80	35	Good	
3024	Blue gum	3	41, 13, 20	80	40	Good	
3025	Blue gum	1	6	55	15	Fair	
3026	Blue gum	2	5, 14	70	30	Good	
3027	Blue gum	2	27, 11	80	20	Good	
3028	Blue gum	2	9, 4	80	20	Good	
3029	Blue gum	2	21, 28	90	25	Good	
3030	Blue gum	2	6	60	15	Good	
3031	Blue gum	4	11, 24, 6, 5	85	40	Good	
3032	Blue gum	1	11	80	15	Good	
3033	Blue gum	1	12	70	30	Good	
3034	Blue gum	1	6	60	20	Good	
3035	Blue gum	1	16	85	20	Good	
3036	Blue gum	2	23, 13	90	25	Good	
3037	Blue gum	2	60+	100	40	Good	
3038	Blue gum	2	11	70	25	Good	
3039	Blue gum	5	41, 30, 17, 9, 7	100	50	Good	
3040	Blue gum	2	22	80	20	Good	
3041	Blue gum	2	28	80	20	Good	
3042	Blue gum	3	9, 24, 17	80	25	Good	
3043	Blue gum	2	30, 23	90	30	Good	
3044	Blue gum	2	17, 9	25	25	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3045	Blue gum	3	11, 9, 9	50	25	Good	
3046	Blue gum	2	22, 24	100	40	Good	
3047	Blue gum	1	23	90	35	Good	
3048	Blue gum	1	9	50	30	Good	
3049	Blue gum	1	15	75	35	Good	
3050	Blue gum	2	18, 11	75	35	Good	
3051	Blue gum	1	11	40	40	Good	
3052	Blue gum	3	9, 6, 14	80	30	Good	
3053	Blue gum	1	29	90	35	Good	
3054	Blue gum	1	31	85	35	Good	
3055	Blue gum	1	31	35	0	Dead	Tree was previously topped.
3056	Blue gum	1	26			Dead	Exfoliating bark. Leaning over sanitation facility.
3057	Blue gum	1	29	30	0	Dead	
3058	Blue gum	1	12	60	0	Dead	Potentially hazardous tree. Tree is significantly leaning
3059	Blue gum	1	4	55	0	Dead	
3060	Blue gum	1	15	55	15	Poor	
3061	Blue gum	1	9	70	0	Dead	
3062	Blue gum	1	8	40	0	Dead	
3063	Blue gum	1	36	100	40	Fair	Potentially hazardous tree. Large heavy overhanging branch with included bark.
3064	Blue gum	1	16	80	10	Poor	Exfoliating bark. Significant amount of epicormic shoots and branch dieback present.
3065	Blue gum	1	6	20	0	Dead	
3066	Blue gum	1	21	75	50	Poor	Trunk is broken and leaning half way up the tree.
3067	Blue gum	1		50	0	Dead	Large leaning and broken trunk half way up the tree.
3068	Blue gum	1	13	55	0	Dead	
3069	Blue gum	1	16	75	15	Poor	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3070	Blue gum	1	9	50	10	Poor	Significant amount of epicormic shoots and branch dieback present.
3071	Blue gum	1	8	40	0	Dead	
3072	Blue gum	1	11	50	0	Dead	
3073	Blue gum	1	7	20	0	Dead	
3074	Blue gum	1	10	55	0	Dead	
3075	Blue gum	1	10	25	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3076	Blue gum	1	10	55	40	Good	Hazardous tree. Tree is significantly leaning over trail (60 degree angle). Will likely topple eventually.
3077	Blue gum	1	11	50	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3078	Blue gum	2	9, 9	70	0	Dead	
3079	Blue gum	2	8, 7	55	0	Dead	
3080	Blue gum	1	7	55	0	Dead	
3081	Blue gum	1	21	90	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3082	Blue gum	1	12	35	5	Poor	Significant amount of epicormic shoots and branch dieback present. Tree previously topped.
3083	Blue gum	1	14	55	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3084	Blue gum	1	9	40	0	Dead	
3085	Blue gum	1	14	15	0	Poor	
3086	Blue gum	2	10, 12	75	20	Poor	Significant amount of epicormic shoots and branch dieback present.
3087	Blue gum	1	12	80	0	Dead	
3088	Blue gum	2	15, 11	80	20	Poor	Trunk is broken and the tree has toppled.

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3089	Blue gum	1	5	40	0	Dead	The tree has toppled.
3090	Blue gum	1	14	15	0	Dead	
3091	Coast redwood	1	2	10	0	Dead	Dead mitigation tree. Outcompeted by blue gums.
3092	Blue gum	1	10	10	5	Poor	Tree previously topped. Significant amount of epicormic shoots and branch dieback present.
3093	New Zealand christmas tree (*Metrosideros excelsa*)	1	3	10	5	Good	
3094	Strawberry tree (*Arbutus unedo*)	1	2	10	0	Dead	
3095	New Zealand christmas tree	1	5	10	10	Good	
Sanitation Facility Grove	Blue gums	Typically one trunk per tree	4-60"+ Average DBH of 18"	Peak grove canopy height ranging from 100 to 140 feet.	Average canopy spread 30 feet. Total grove canopy spread area is ~4.75 acres.	Overall fair to poor besides the NE portion of the grove, which is good.	Trees over a 40-inch DBH have a Good overall health condition. Trees with less than a 40-inch DBH generally have a Fair to Poor overall health condition. The >40-inch DBH trees are generally healthier due to their established nature. Smaller trees are generally being outcompeted for resources by the larger trees. Selective thinning would improve grove health. The largest and healthiest trees are within the northeastern portion of the grove. Most blue gums adjacent to the hiking trail that travels along the southeastern portion of the grove have been topped. Vast amounts of epicormic shoots are present. Hazardous trees and dead and dying trees were surveyed and are included in the results table above (i.e., trees 3055 to 3092).

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Appendix B

Tree Inventory Figures



Tree Inventory Figures

- Tree Inventory Area
- Poor Health Trees
- Dead Trees
- Potentially Hazardous Trees

Tree Species

- Blue gum (*Eucalyptus globulus*)
- Monterey cypress (*Hesperocyparis macrocarpa*)
- New Zealand Christmas tree (*Metrosideros excelsa*)
- Coast redwood (*Sequoia sempervirens*)
- Strawberry tree (*Arbutus unedo*)
- Mexican fan palm (*Washingtonia robusta*)

0 250 500 Feet

N

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Tree Inventory Figures



Moran Lake MBHMP Update Appendix A - Page 125 of 243

Tree Inventory Area

Poor Health Trees

Dead Trees

Potentially Hazardous Trees

Tree Species

- Blue gum (*Eucalyptus globulus*)
- Mexican fan palm (*Washingtonia robusta*)
- Monterey cypress (*Hesperocyparis macrocarpa*)
- New Zealand Christmas tree (*Metrosideros excelsa*)
- Strawberry tree (*Arbutus unedo*)

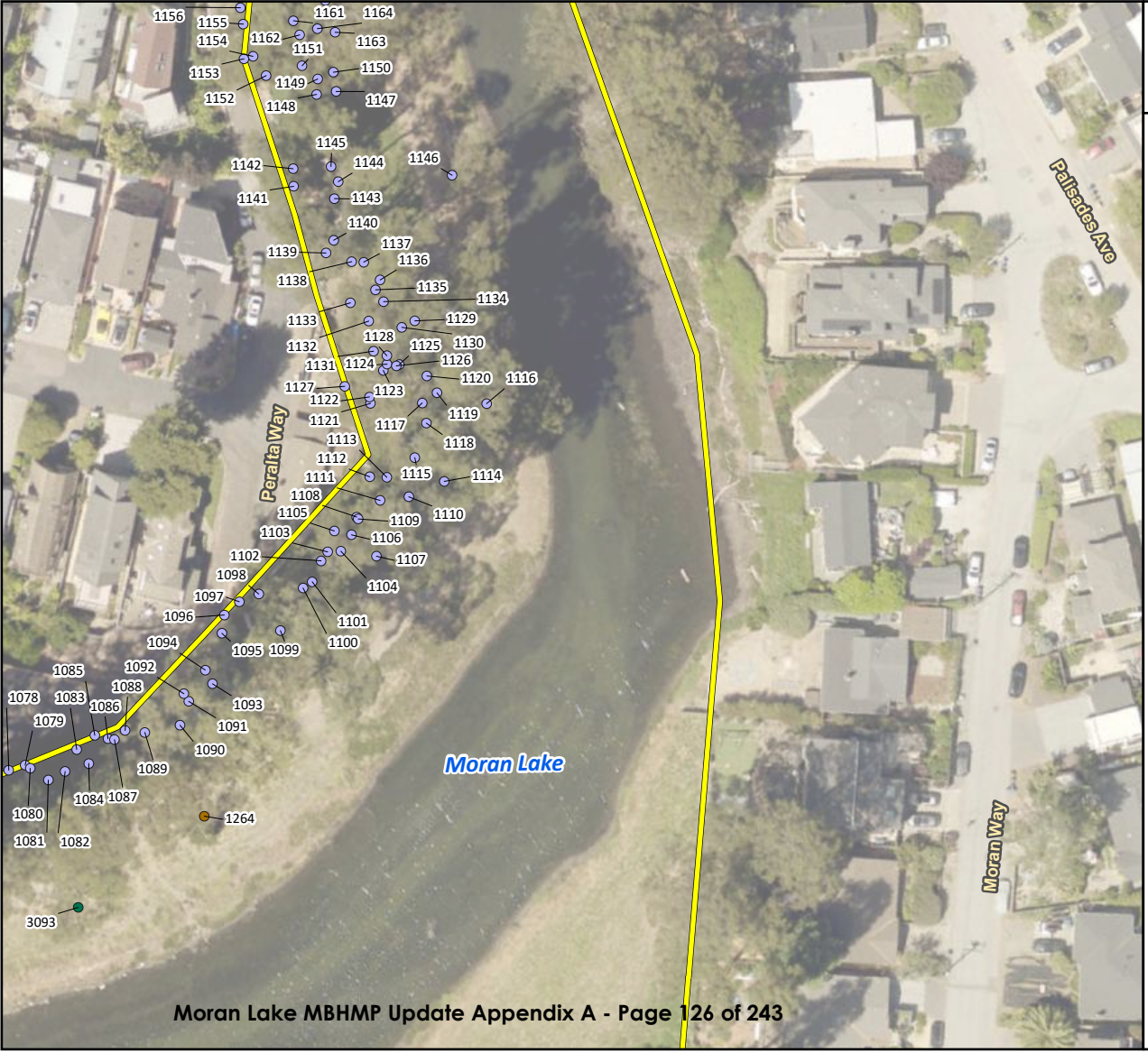


0 50 100 Feet

N

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Tree Inventory Figures



Moran Lake MBHMP Update Appendix A - Page 126 of 243

Tree Inventory Area

Tree Species

- Blue gum (*Eucalyptus globulus*)
- Monterey cypress (*Hesperocyparis macrocarpa*)
- New Zealand Christmas tree (*Metrosideros excelsa*)

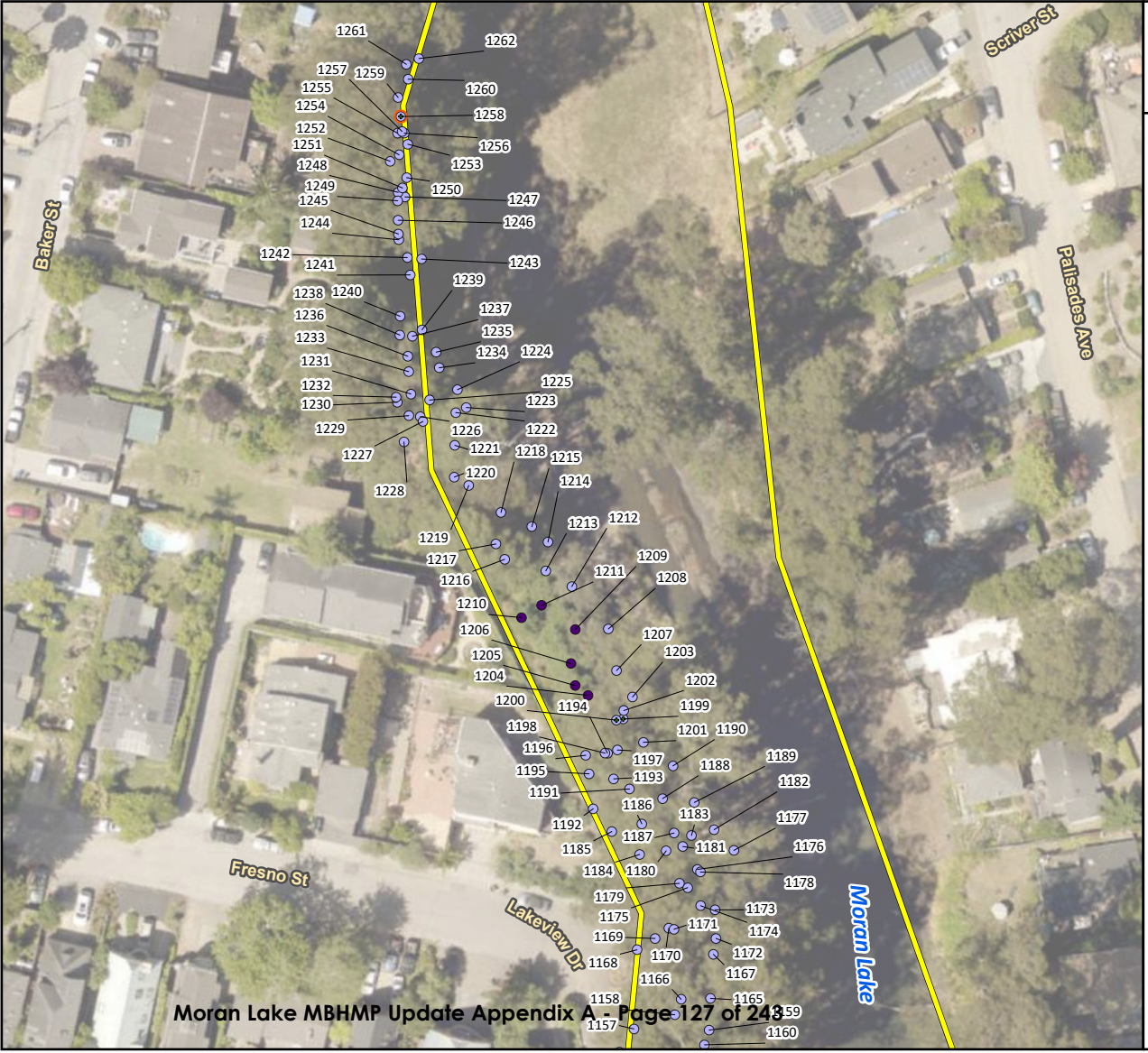


0 50 100 Feet

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Tree Inventory Figures



Moran Lake MBHMP Update Appendix A - Page 127 of 243

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Tree Inventory Area

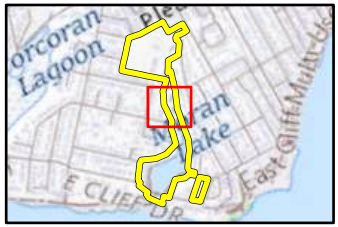
Poor Health Trees

Potentially Hazardous Trees

Tree Species

Blue gum
(*Eucalyptus globulus*)

Coast redwood
(*Sequoia sempervirens*)



0 50 100 Feet

N

Tree Inventory Figures



Moran Lake MBHMP Update Appendix A - Page 128 of 243

Tree Inventory Area

Poor Health Trees

Dead Trees

Potentially Hazardous Trees

Tree Species

Blue gum (*Eucalyptus globulus*)

Monterey cypress (*Hesperocyparis macrocarpa*)

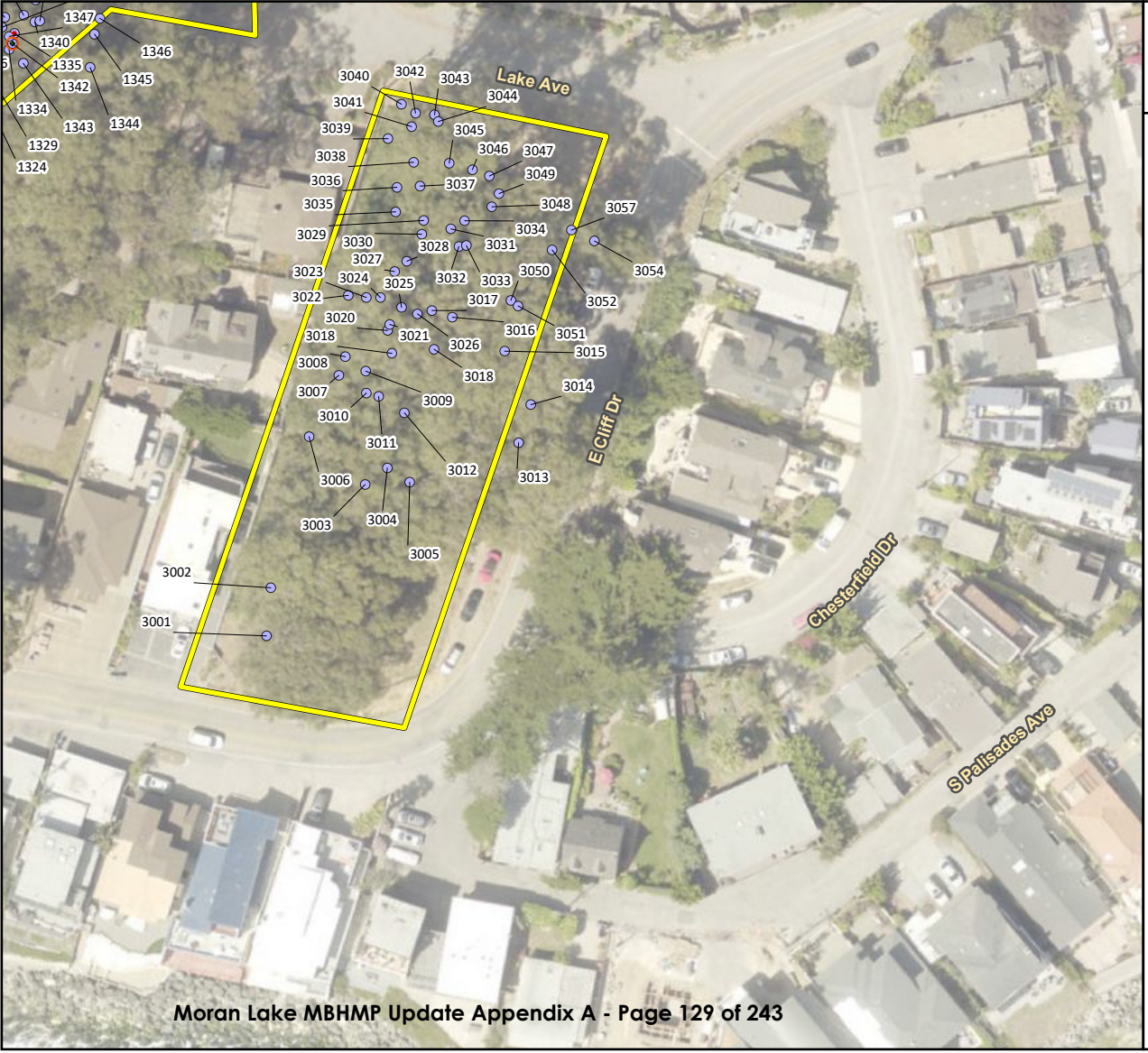


0 50 100 Feet

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Tree Inventory Figures



Moran Lake MBHMP Update Appendix A - Page 129 of 243

Tree Inventory Area

Poor Health Trees

Dead Trees

Potentially Hazardous Trees

Tree Species

Blue gum
(*Eucalyptus globulus*)



0 50 100 N

Feet

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Tree Inventory Figures



Tree Inventory Area

Poor Health Trees

Dead Trees

Potentially Hazardous Trees

Tree Species

Blue gum
(*Eucalyptus globulus*)



0 50 100 Feet

N

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Only priority trees (i.e., dead, dying [i.e., Poor Health trees], newly planted trees, and hazard trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). However, notes on the grove's average DBH and DBH range, average height and height range, average canopy spread, total canopy coverage, and health condition were taken and are included in Appendix A.

Tree Inventory Figures



- Tree Inventory Area
- Poor Health Trees
- Dead Trees

Tree Species

- Blue gum (*Eucalyptus globulus*)
- Coast redwood (*Sequoia sempervirens*)



0 50 100 Feet

N

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Only priority trees (i.e., dead, dying [i.e., Poor Health trees], newly planted trees, and hazard trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). However, notes on the grove's average DBH and DBH range, average height and height range, average canopy spread, total canopy coverage, and health condition were taken and are included in Appendix A.

Appendix C

Moran Lake County Park Improvement Project Biological Resources Assessment



Moran Lake County Park Improvement Project

Biological Resources Assessment

prepared for

Balance Hydrologics, Inc.
224 Walnut Avenue
Santa Cruz, California 95060

and

Santa Cruz County Department of Parks, Open Space, and Cultural Services
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June 2022

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Executive Summary

This document provides the findings of a Biological Resources Assessment prepared by Rincon Consultants, Inc. for the Moran Lake County Park Improvement Project (Project). This report documents existing conditions at the Project site and provides an assessment of potential impacts to sensitive biological resources based upon proposed Project plans.

The Project is located in Moran Lake County Park, in the unincorporated Live Oak area of Santa Cruz County, California. The Project will restore and enhance wetland habitat function and water quality in Moran Lagoon, enhance climate change resilience of Moran Lagoon and the surrounding area, maintain and enhance existing monarch overwintering habitat, and improve public access and urban green space within Moran Lake County Park.

Rincon assessed the potential for 95 special-status species (49 plant species and 46 wildlife species) to occur within the Project Area. No special-status plant species are expected to occur. Twenty-one special-status wildlife species have some potential to occur within the Project Area. The northern tidewater goby (*Eucyclogobius newberryi*, federally endangered) was observed within Moran Lagoon during an aquatic survey conducted in fall 2021. The northern tidewater goby will be referred to as tidewater goby throughout the remainder of this document. The monarch butterfly (*Danaus plexippus*, federal candidate), American white pelican (*Pelecanus erythrorhynchos*, State species of special concern), and double-crested cormorant (*Phalacrocorax auratus*, State watchlist) were also observed on site during biological surveys; however, no nesting colonies of pelicans or cormorants were detected. The California red-legged frog (*Rana draytonii,* federally threatened), Monterey hitch (*Lavinia exilicauda harengus*, State species of special concern), southwestern pond turtle (*Actinemys pallida*, State species of special concern), northern California legless lizard (*Anniella pulchra*, State species of special concern), tricolored blackbird (*Agelaius tricolor*, State threatened), western snowy plover (*Charadrius nivosus,* federally threatened, State species of special concern), black swift (*Cypseloides niger*, State species of special concern), bank swallow (*Riparia,* State threatened), California least tern (*Sterna antillarum browni*, federally endangered, State endangered, State fully protected), pallid bat (*Antrozous pallidus*, State species of special concern), and Townsend's big-eared bat (*Corynorhinus townsendii*, State species of special concern) all have a low potential to occur on site. The white-tailed kite (*Elanus leucurus*, State fully protected), American peregrine falcon (*Falco peregrinus anatum*, State fully protected), and osprey (*Pandion haliaetus*, State watchlist) have a moderate potential to occur. The Cooper's hawk (*Accipiter cooperii*, State watchlist), California brown pelican (*Pelecanus occidentalis californicus*, State fully protected), and yellow warbler (*Setophaga petechia*, State species of special concern) have a high potential to occur within the Project Area. Nesting special-status bird species and/or nesting birds protected under the Migratory Bird Treaty Act and California Fish and Game Code also have potential to occur throughout the Project Area during the nesting season (February 1 through September 15).

As a result of implementation of the Project, special-status species (including nesting birds) within the Project Area could be impacted by the loss of/injury to individuals, disturbance of breeding activities, disturbance to habitat, and/or construction noise and other human disturbances. These impacts could be potentially significant but can be reduced to less than significant through implementation of recommended avoidance and minimization measures. Additional measures may also be required by resource agency permits and agreements.

One sensitive plant community occurs within the Project Area: Pickleweed Mats. Environmentally Sensitive Habitat Areas within the Project Area include: Moran Lagoon and its associated wetlands; Moran Creek and its associated riparian corridor; eucalyptus groves that provide overwintering habitat for monarch butterflies; and marine and estuarine habitat below the high tide line of the Pacific Ocean. Jurisdictional waters and wetlands within the Project Area include Moran Lagoon and its associated wetlands, Moran Creek and its associated riparian corridor, and the Pacific Ocean. Potential impacts to these sensitive biological resources within the Project Area could include grading within wetland areas, changes to water quality, sediment disturbance, and/or the introduction of sediment or pollutants. These impacts could be potentially significant but can be reduced to less than significant through implementation of recommended avoidance and minimization measures. The Project will involve restoration efforts that will result in overall improvements to water quality and wetland habitat within Moran Lake County Park.

Project activities will not have a significant impact on wildlife movement, nor will they conflict with any local or State policies, ordinances, or plans.

1 Introduction

Rincon Consultants, Inc. (Rincon) has prepared this Biological Resources Assessment (BRA) on behalf of Balance Hydrologics, Inc. (Balance) and Santa Cruz County Department of Parks, Open Space, and Cultural Services (County Parks) for the Moran Lake County Park Improvement Project (Project). The Project will restore and enhance wetland habitat function and water quality in Moran Lagoon[1], enhance climate change resilience of Moran Lagoon and the surrounding area, maintain and enhance existing monarch overwintering habitat, and improve public access and urban green space within Moran Lake County Park. This BRA documents existing biological conditions within Moran Lake County Park and provides an assessment of potential impacts to sensitive biological resources that could result from Project activities.

1.1 Project Location

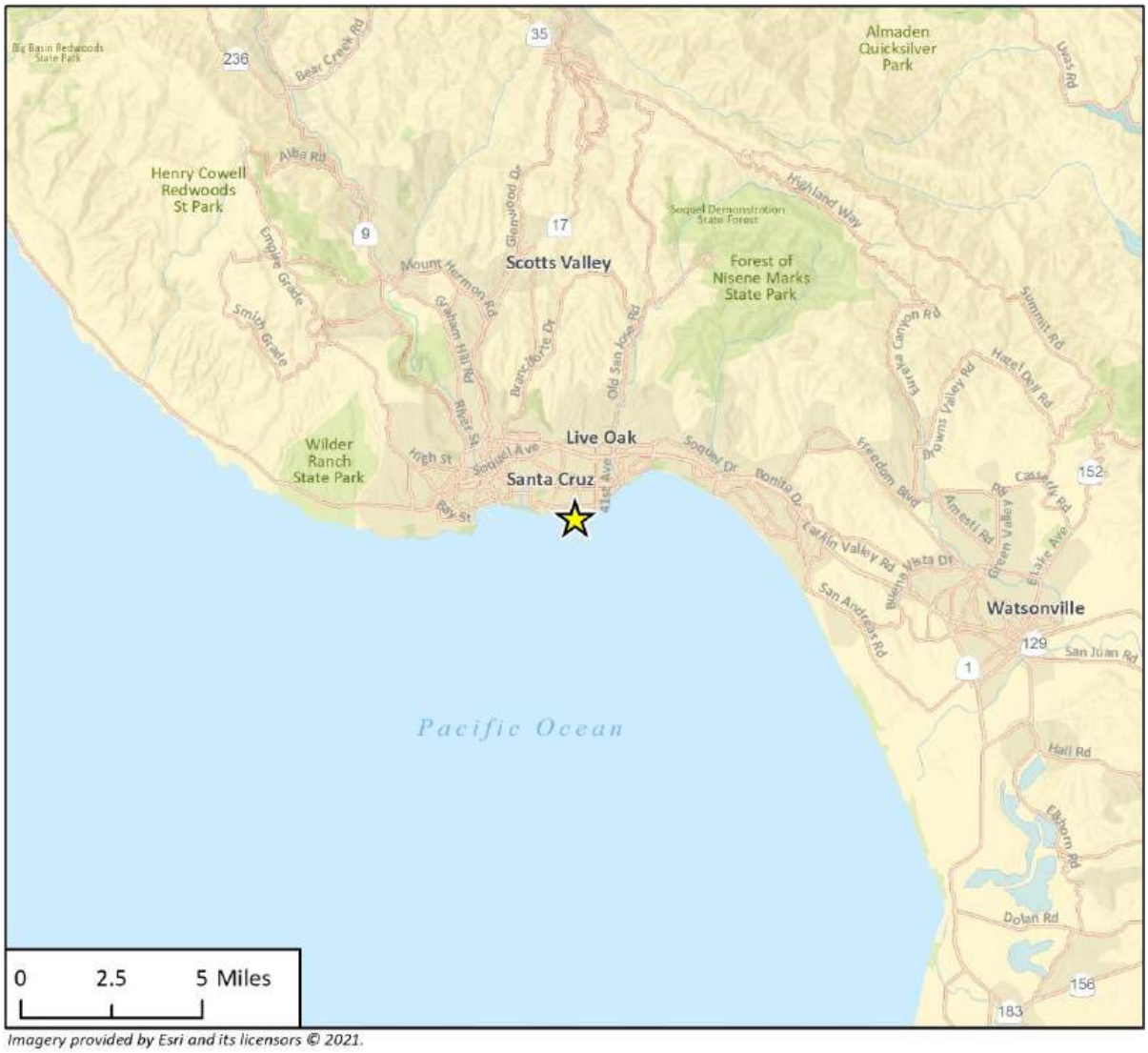
The Project is located in Moran Lake County Park, in the unincorporated Live Oak area of Santa Cruz County (County), California, approximately 0.25 mile west of Soquel Point and directly north of the Pacific Ocean (Figure 1). The Project is surrounded by residential neighborhoods to the west, north, east, and south, as well as Moran Lake Beach to the southwest (Figure 2). Moran Lake County Park includes the following Assessor's Parcel Numbers (APNs): 028-45-101, 028-29-157, 028-29-121, 028-29-149, 028-28-132, 028-48-101, 028-48-102, 028-48-106, and 028-30-204. The Project is depicted on the *Soquel, California* United States Geological Survey (USGS) 7.5-minute topographic quadrangle map and is located in Township 11 South, Range 1 West, Section 21.

1.2 Project Background and Goals

Moran Lagoon is a brackish, coastal lagoon with connectivity to the Pacific Ocean. In the early 1960's, dredge material removed from Wood's Lagoon for the development of the Santa Cruz Yacht Harbor (located approximately 1.4 miles northwest of Moran Lagoon) was deposited in the southern end of Moran Lagoon, effectively reducing the approximately eight-acre surface water area by three acres (Stern and Courter 1980). During this time, a seven-foot diameter drainage culvert was installed at the lagoon outlet approximately five feet above the mean high tide line (HTL). The installation of this culvert effectively cut off connectivity of seawater into the lagoon and transformed the coastal lagoon into an inland lake. In 1981, the seven-foot diameter culvert was replaced with the existing box culvert beneath East Cliff Drive. The bottom of the box culvert is set at one foot below mean sea level, which allows for tidal influence within the lagoon. The culvert and roadbed have stabilized the lagoon inlet, preventing the natural migration of the inlet channel and altering circulation, as well as the timing, frequency, and duration of breach/flushing events in the lagoon. Combined with extensive urban development inland of the lagoon, the engineered outlet structure has resulted in degraded water quality and aquatic habitat conditions in Moran Lagoon (John Gilchrist & Associates and Fall Creek Engineering 2005).

[1] The name "Moran Lagoon" will be used throughout this report to refer to the body of water within the Project Area. While "Moran Lagoon" more accurately describes the coastal brackish water body with connectivity to the ocean, "Moran Lake County Park" is the official name of the Park and "Moran Lake" has been used to refer to the water body since the early 1960's (particularly during the period between the 1960's and 1981 when the lagoon mouth was blocked and replaced with a one-directional culvert that did indeed create a freshwater impoundment). Box culvert construction in 1981 restored connectivity to the ocean and effectively returned lagoon dynamics, .

Figure 1 Regional Location



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Project Location

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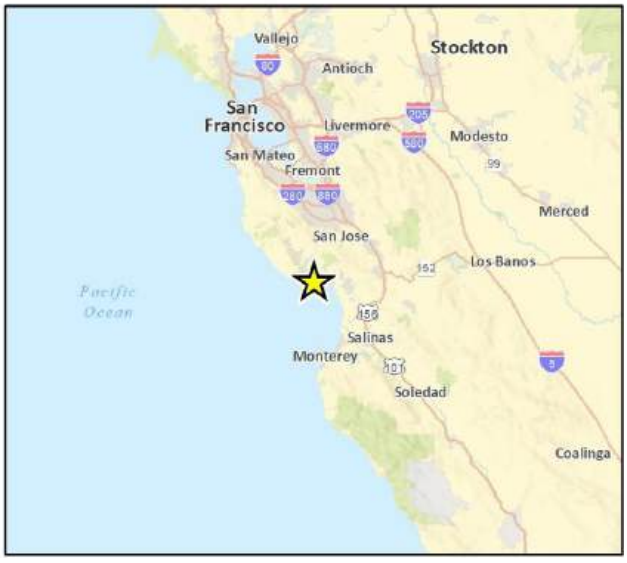


Figure 2 Project Area



Project goals include the following:

- To restore and enhance the wetland habitat function and water quality of Moran Lagoon. The Project seeks to address known problems of degraded habitat and water quality by recontouring, stabilizing, and planting native vegetation along currently eroding banks, restoring wetland habitat, removing non-native vegetation, and implementing biofiltration stormwater Best Management Practices (BMPs) to treat local runoff before it enters the lagoon;
- To enhance climate change resilience of Moran Lagoon and surrounding areas. Lagoons are inherently sensitive to changes in sea level and climate. In order to enhance climate resilience, a targeted set of studies have been proposed to assess existing lagoon hydrodynamics, model lagoon conditions under sea level rise scenarios, and monitor water quality, species, and habitat condition of the site. An improved understanding of existing and future conditions will provide the technical basis for revising site plans and for planning future modifications of the culvert and East Cliff Drive;
- To maintain and enhance the existing monarch butterfly overwintering habitat that exists within eucalyptus groves in Moran Lake County Park; and
- To enhance and improve public access and urban green space for neighboring communities. Moran Lake County Park is for the people, and the Project seeks to engage the public through educational signage, improvements to trails and facilities, and improvements to accommodations for persons with disabilities.

1.3 Project Description

The approximately 19-acre Project Area includes: Moran Lagoon and its associated wetlands; a portion of Moran Creek and its associated riparian corridor; County parking areas and buildings (including the D.A. Porath Sanitation Facility); the open space, trails, and eucalyptus groves surrounding Moran Lagoon and the D.A. Porath Sanitation Facility; and a portion of Moran Lake Beach southwest of East Cliff Drive. A small rectangular parcel at 40 Moran Way is also included in the Project Area (Figure 2). The defined Project Area is extensive enough to include all project components, including anticipated Project options, access points, staging areas, and permanent and temporary disturbance sites. The approximate center of the Project Area is located at latitude 36.958676°N and longitude 121.975499°W (WGS-84 datum).

The Conceptual Site Plan for the Project, dated May 14, 2022, includes the following components:

- Removing non-native plant species around the freshwater lagoon inlet and revegetating with appropriate native riparian plant species;
- Recontouring lagoon banks in several eroded areas, removing non-native plant species from the lagoon bank, and revegetating with appropriate native wetland species;
- Upgrading the existing parking lot layout and paving, including stormwater treatment for the paved area;
- Installing a stormwater treatment area to receive adjacent urban runoff;
- Upgrading a portion of the pedestrian path to an accessible and permeable surface such as permeable concrete or GraniteCrete, locating the stormwater treatment area adjacent to the pedestrian path, shifting the layout of the path away from the lagoon bank edge, and incorporating accessible and informal seating opportunities along the path;

- Keeping a portion of the existing pedestrian path layout and surface (e.g., leaves, wood chips, soil) uncompacted and natural to allow for better drainage and healthier soils around the lagoon;
- Installing nectar/pollinator gardens along the upgraded pedestrian path;
- Maintaining and improving existing monarch overwintering habitat, which may include the following strategies: removal of dead and downed eucalyptus trees, planting of replacement eucalyptus trees and/or native trees strategically for wind protection around known monarch aggregation sites, irrigation for replacement trees to ensure establishment and growth;
- Installing footbridge, culvert, or ford-type crossings over the stormwater treatment areas;
- Strategically installing new native plants throughout the site (including trees, low shrubs, and grasses);
- Strategically installing logs taken from on site for delineation of park areas, animal habitat, and informal seating;
- Installing new informational signage, wayfinding signage/trail markers, and a new park monument sign;
- Replacing existing restroom with updated prefabricated restroom, outdoor shower, drinking fountain, and waste and recycling receptacles;
- Installing new bicycle parking, ADA-compliant benches, and improved beach access with a marked crosswalk and flashers; and
- Installing native plantings at the 40 Moran Way parcel and possibly improve parking, pathways, crosswalks, and signage.

The following construction equipment and methods are likely to be used during Project implementation:

- An excavator will be used to demolish the existing pavement and restroom facilities;
- A dozer will be used to regrade the parking lot and walkways;
- An excavator will be used to install bioretention facilities;
- A sheepsfoot roller and drum roller will be used to compact the base materials and graded areas;
- Mechanical asphalt paving equipment will be utilized for paving at the site;
- A dump truck will be used to transport materials on and off the site;
- The trail paralleling Moran Lagoon will be improved through a combination of hand labor and mechanical equipment;
- A small excavator may be used to grade the drainage features;
- Puncheons will be installed with hand labor and possibly a small excavator for the footings;
- Paver-Liner fords (if any) will be installed with both hand labor and mechanical equipment.
- An excavator, located on the top of the bank, will be used for recontouring eroded lagoon banks and upslope areas prior to revegetation. No recontouring will occur in wetted portions of the lagoon and soil will be pulled back away from the water's edge;
- Invasive plant species removal will be conducted with hand tools and/or a small excavator; and
- Native plantings will be installed with hand tools.

1.4 Regulatory Overview

Regulated or sensitive resources studied and analyzed herein include special-status plant and wildlife species, nesting birds and raptors, sensitive plant communities, jurisdictional waters and wetlands, wildlife movement, regionally protected resources (e.g., from Habitat Conservation Plans [HCPs] and Natural Community Conservation Plans [NCCPs]), and locally protected resources, such as protected trees. Regulatory authority over biological resources is shared by federal, State, and local authorities. Primary authority for regulation of general biological resources lies within the land use control and planning authority of local jurisdictions (in this instance, the County of Santa Cruz).

1.4.1 Definition of Special-status Species

For the purposes of this report, special-status species include:

- Species listed as threatened or endangered under the Federal Endangered Species Act (FESA), including proposed and candidate species;
- Species listed as candidate, threatened, or endangered under the California Endangered Species Act (CESA);
- Species designated as Fully Protected by the California Fish and Game Code (CFGC), and Species of Special Concern or Watch List by the California Department of Fish and Wildlife (CDFW);
- Native Plant Protection Act (NPPA) – State Rare (SR); and
- California Native Plant Society (CNPS) California Rare Plant Ranks (CRPR) 1A, 1B, 2A and 2B, per the following definitions:
  - **Rank 1A** = Presumed extirpated in California and rare or extinct elsewhere
  - **Rank 1B** = Rare, threatened, or endangered in California and elsewhere
  - **Rank 2A** = Presumed extirpated in California but common elsewhere
  - **Rank 2B** = Rare, threatened or endangered in California, but common elsewhere

CRPR 3 and 4 plant species are typically not considered for analysis under the California Environmental Quality Act (CEQA) except where they are designated as rare or otherwise protected by local governments, or where cumulative impacts could result in population-level effects. The County does not provide additional protection for CRPR 3 and 4 plants.

Special-status species and sensitive natural communities are ranked globally (G) and subnationally (S) based on NatureServe (2010) methodologies, as follows:

- **G1 or S1** - Critically Imperiled Globally or State-wide
- **G2 or S2** - Imperiled Globally or State-wide
- **G3 or S3** - Vulnerable to extirpation or extinction Globally or State-wide

1.4.2 Environmental Statutes

For the purpose of this report, potential impacts to biological resources were analyzed based on the following statutes (Appendix A):

- CEQA
- FESA and CESA
- Federal Clean Water Act (CWA)
- California Fish and Game Code (CFGC)
- Migratory Bird Treaty Act (MBTA)
- The Bald and Golden Eagle Protection Act
- Porter-Cologne Water Quality Control Act
- California Coastal Act
- County of Santa Cruz General Plan and Local Coastal Plan

1.4.3 Guidelines for Determining CEQA Significance

The following threshold criteria, as defined by the CEQA Guidelines Appendix G Initial Study Checklist, were used to evaluate potential environmental effects. Based on these criteria, the proposed Project would have a significant effect on biological resources if it would:

a) Have substantial adverse effects, either directly or through habitat modifications, on any species identified as a candidate, sensitive or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.

b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the California Department of Fish and Wildlife or US Fish and Wildlife Service.

c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.

d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors or impede the use of native wildlife nursery sites.

e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.

f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional or state habitat conservation plan.

2 Methodology

2.1 Literature Review

Rincon reviewed the CDFW California Natural Diversity Database (CNDDB) (CDFW 2022a) and the CNPS Online Inventory of Rare and Endangered Plants of California (CNPS 2022) for special-status species with documented occurrences within the *Soquel, California* USGS 7.5-minute quadrangle and surrounding six quadrangles (*Santa Cruz, Felton, Laurel, Loma Prieta, Moss Landing,* and *Watsonville West*)[2]. In addition, Rincon reviewed the Biogeographic Information and Observation System (BIOS) (CDFW 2022b), the USFWS Information for Planning and Consultation (IPaC) (USFWS 2022a), and the USFWS Critical Habitat Portal (USFWS 2022b) for the Project Area and regional vicinity.

Rincon also reviewed the following documents and websites for information on sensitive biological resources with the potential to occur within the Project Area: the County General Plan and Local Coastal Program (County of Santa Cruz 1994), the CDFW Special Animals List (CDFW 2022c), the CDFW Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2022d), the CDFW Wildlife Habitat Relationship System (Zeiner et al. 1988), All About Birds (Cornell Lab of Ornithology 2022a) and eBird (Cornell Lab of Ornithology 2022b). Additionally, Rincon reviewed the following databases for information on existing conditions within the Project Area: United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS) Web Soil Survey (USDA, NRCS 2022a) and USFWS National Wetlands Inventory (NWI) Mapper (USFWS 2022c).

The review also included peer-reviewed journal articles, previous biological studies conducted for Moran Lake County Park (e.g., Sutter 2018, Stern and Courter 1980, Santa Cruz County Parks 2010), standard reference materials (e.g., Bowers et al. 2004, Sawyer et al. 2009, Stebbins 2003), and agency and public databases. Aerial photographs, topographic maps, soil survey maps, geologic maps, and climatic data for the Project Area and vicinity were also reviewed. Preliminary desktop mapping of land cover types was completed based on the review of background literature and aerial imagery and was verified during field surveys.

Rincon compiled the results of the literature review and database queries into a preliminary list of special-status species with potential to occur within the Project Area, which was then reviewed by Rincon's regional biological experts for accuracy and completeness. The list of special-status biological resources evaluated as part of the BRA was determined based on documented occurrences in the seven-USGS quadrangle search area and species known to occur in the region based on the expert opinions of local biologists. The results and analysis of the database queries were compiled into a potential to occur table presented as Appendix D and are discussed in detail in this report.

[2] A seven-USGS quadrangle search was conducted instead of a standard nine-quadrangle search due to the oceanic location of the remaining two quadrangles surrounding the Project location.

2.2 Reconnaissance-level Field Survey

Rincon Senior Biologist Samantha Kehr conducted a reconnaissance-level field survey of the Project Area on November 11, 2021. Ms. Kehr conducted a pedestrian survey of the perimeter of the lagoon and all terrestrial portions of the Project Area to assess the habitat suitability for the potential for special-status flora and fauna to occur, and to document all plant and wildlife species observed. Binoculars (10 X 42) were used to aid in identification and to achieve visual coverage of the entire Project Area.

Photographs were taken to document existing conditions, vegetation communities, species sign, or other notable biological resource observations. Representative site photographs are included in Appendix B. A complete list of all plant and wildlife species observed during the field reconnaissance survey is included in Appendix C.

2.3 Focused Surveys

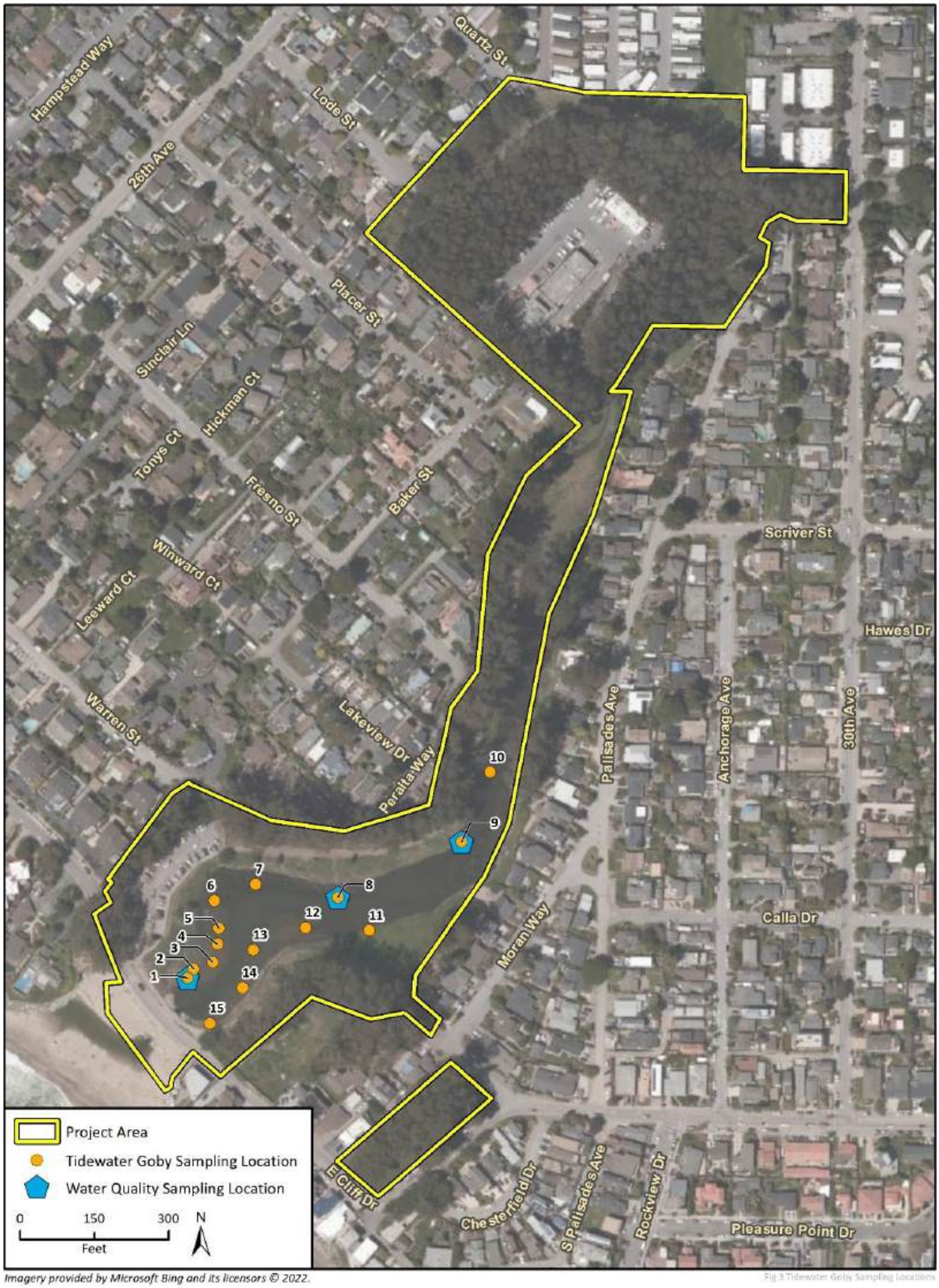
Targeted surveys were conducted by Rincon biologists for special-status aquatic or plant species within appropriate habitat throughout the Project Area. A jurisdictional delineation was also performed to determine the extent of jurisdictional waters and wetlands within the Project Area. The methods of each of these surveys are described in detail below.

2.3.1 Aquatic Survey

A survey for special-status aquatic species was conducted within Moran Lagoon on November 11, 2021 by Rincon Senior Fisheries Biologist Steve Howard and Rincon Biologists Charleen Rode and Heather Price Curran. Mr. Howard holds a 10(a)(1)(A) permit[3] from the USFWS to capture and handle tidewater goby. A 20-foot long by 4-foot-wide brailed seine net with 1/8-inch stretch mesh was used by Rincon biologists to sample the lagoon for aquatic species. Fifteen separate seine hauls were conducted at various locations throughout the lagoon (Figure 3). All fishes observed were counted and identified to the nearest taxonomic group possible. Following identification, all fishes were returned to the lagoon in an aerated 5-gallon bucket filled with lagoon water. The survey was conducted in general accordance with the Tidewater Goby Survey Protocol, outlined in Appendix F of the Recovery Plan for the Tidewater Goby (USFWS 2005). As part of the aquatic survey, water quality measurements (salinity, temperature, dissolved oxygen [DO], conductivity, pH, and turbidity) were taken at three locations within the lagoon using a YSI ProDSS Water Quality Meter (Figure 3) to document habitat suitability for special-status aquatic species. Photographs taken during the aquatic survey are included in Appendix B. Aquatic survey datasheets, which include species counts, sampling locations, and water quality measurements, are included as Appendix E.

[3] Permit number: TE99057B-0

Figure 3 Tidewater Goby Sampling Locations



2.3.2 Jurisdictional Delineation

Current federal and State methods and guidelines were used to identify and delineate aquatic features (Appendix A). Potential wetland features were evaluated for presence of wetland parameters, specifically including positive indicators for hydrophytic vegetation, hydric soils, and wetland hydrology, according to routine delineation procedure (USACE 1987, 2008a). The *Western Mountains, Valleys, and Coast 2020 Regional Wetland Plant List* (Lichvar et al. 2020), used in determining the wetland indicator status of the examined vegetation, uses the following indicator status categories: Upland (UPL), Facultative Upland (FACU), Facultative (FAC), Facultative Wetland (FACW), and Obligate (OBL) (USACE 2020). The Project Area was surveyed for any streams or other drainages that might exhibit positive indicators for an ordinary high-water mark (OHWM) or HTL and which might constitute waters of the U.S. (USACE 2004, 2005, 2008b, 2010), as well as having a defined channel, bed and banks and any adjacent riparian habitat that could be subject to CDFW jurisdiction under the CFGC. The Project Area was also surveyed for indicators of coastal wetland features that could be subject to California Coastal Commission (CCC) jurisdiction, based on the one-parameter CCC wetland definition (Appendix A).

The delineation study began with a literature review of aerial photos and other data sources. After completion of the literature review, a field delineation was completed to identify, describe, and map all potential jurisdictional waters within the Project Area. Fieldwork for this evaluation was conducted by Principal and Senior Ecologist Colby Boggs on November 11, 2021.

The Project Area was surveyed on foot for all aquatic and riparian resources, including potential wetland and non-wetland jurisdictional areas, streambeds, and riparian habitat. General site characteristics and vegetation were documented. Extents of potential jurisdictional features, existing culvert locations, sample points, and photo locations were mapped using a Trimble Geo 7X Global Positioning System (GPS) unit with sub-meter accuracy and were also plotted on aerial photographs.

2.3.3 Botanical Survey

Botanical surveys to detect special-status plant species were conducted within the Project Area on April 1, 2022 and June 8, 2022 by Rincon biologist Casey Clark. The botanical surveys were conducted in general accordance with survey guidelines outlined within the CNPS Botanical Survey Guidelines (CNPS 2001), Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities (CDFW 2018), and Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Plants (USFWS 1996), which state the following:

- Surveys should be conducted at the proper time of year when the species are both evident and identifiable.
- Surveys must be floristic in nature, meaning each species, subspecies, or variety must be identified for every observed plant to determine its rarity status.
- Surveys must be conducted in a manner that is consistent with conservation ethics and accepted plant collection and documentation techniques.

Mr. Clark utilized systematic field techniques and walked the entire Project Area closely examining all suitable special-status plant species habitat (e.g., vegetation community interfaces, areas with unique soils) to ensure thorough coverage. A list of all species observed during the surveys is provided in Appendix C. Plants of uncertain identity were collected and subsequently identified

from keys, descriptions, and illustrations in The Jepson Manual: Vascular Plants of California, Second Edition (Baldwin et al. 2012). If a special-status plant species was observed, its location would be logged individually as a point using a submeter-accurate GPS unit. Larger occurrences or populations would be mapped as polygons. Plant species scientific nomenclature and taxonomy follow the treatments within Baldwin et al. (2012). Common names of plant species follow the Jepson naming convention when available, and Calflora (2022) when Jepson naming information is unavailable.

2.4 Impact Evaluation

Impacts are defined as project-related activities that destroy, damage, alter, or otherwise affect biological resources. This may include injury or mortality to plant or wildlife species, effects on an animal's behavior (such as through harassment or frightening off an animal by construction noise), as well as the loss, modification, or disturbance of natural resources or habitats. Impacts are defined as either direct or indirect, and either permanent or temporary. Rincon analyzed potential impacts to biological resources based on current Project plans and proposed construction methods. A summary of these potential impacts, as well as recommended avoidance and minimization measures, is included in Section 5.

3 Existing Conditions

3.1 Physical Characteristics

3.1.1 Climate, Topography, and Setting

The Project Area is located within the Central Coast geographic subregion of California (Baldwin et al. 2012) in the County of Santa Cruz. The climate in this region is characterized by warm, dry summers and mild, wet winters. The average high temperature during summer months (June through September) is 75 degrees Fahrenheit (°F) and the average low temperature is 50 °F. The average high temperature during the winter months (December through March) is 62 °F and the average low temperature is 40 °F. Average annual precipitation is 29.3 inches, with the majority of rainfall occurring during November through March (Western Regional Climate Center 2022). Topography within the Project Area is generally flat, with elevations ranging from approximately 10 to 50 feet above mean sea level.

The Project Area is located at Moran Lake County Park, and includes the coastal lagoon and associated wetlands, a paved parking lot, restroom, picnic tables, trails, blue-gum eucalyptus (*Eucalyptus globulus*) groves, a portion of sandy beach, a portion of East Cliff Drive, and a portion of Peralta Drive. Buildings and a parking area associated with the D.A. Porath Sanitation Facility are also present in the northwest corner of the Project Area. The facility is the site for all maintenance on the County sewer system and serves as the primary pumping station between the City of Santa Cruz treatment plant and the eastern portion of the County. The facility is surrounded by eucalyptus trees that serve as a monarch butterfly overwintering site. The Project Area also includes a small rectangular parcel at 40 Moran Way, which contains additional eucalyptus grove habitat.

3.1.2 Watershed and Drainages

The Project Area is located within the larger Monterey Bay Watershed (Hydrologic Unit Code 180600150305) (US Environmental Protection Agency [US EPA] 2021). The local watershed that drains directly to Moran Lagoon encompasses approximately 620 acres within the cities of Santa Cruz and Capitola. The watershed extends southward from Soquel Drive in the north to the Monterey Bay National Marine Sanctuary in the south and is bounded by Twenty-sixth and Thirtieth Avenues in the west and by Forty-first Avenue in the east. Moran Creek, an intermittent stream, conveys stormwater runoff from the surrounding neighborhood to the lagoon and flows into the Project Area through a culvert beneath Thirtieth Avenue. The watershed has undergone extensive development and urbanization within the past four decades, leading to a significant increase in impervious surface area. Coupled with the anthropogenic impacts that have limited connectivity with the ocean, this has led to serious runoff, erosion, and pollution issues for Moran Lagoon (Santa Cruz County Parks 2010). A formal jurisdictional delineation of waters and wetlands within the Project Area was performed on November 11, 2021, the results of which are summarized in Section 4.3 and detailed in a Jurisdictional Delineation Report submitted under separate cover (Rincon 2022).

3.1.3 Soils

The USDA, NRCS Web Soil Survey identifies three soil map units within the Project Area: Watsonville loam, 0 to 2 percent slopes; Watsonville loam, thick surface, 0 to 2 percent slopes; and Watsonville loam, thick surface, 2 to 15 percent slopes. Watsonville loam soils are derived from alluvium and formed on marine terraces from 0 to 1,200 feet in elevation. The depth to the water table is more than 80 inches, the frequency of flooding and ponding is none, the available water supply is very low (about 2.9 inches), and the soils are somewhat poorly drained (USDA, NRCS 2022a). Watsonville loam soils are included on the NRCS list of hydric soils (USDA, NRCS 2022b).

3.2 Vegetation Communities and Other Land Cover

Vegetation community characterizations for this analysis were based on the classification system presented in A Manual of California Vegetation, Second Edition (MCV2; Sawyer et al. 2009)[4] but have been modified slightly to most accurately reflect existing site conditions. Preliminary Descriptions of the Terrestrial Natural Communities of California (Holland 1986) is still used for reference and historical perspective, though its classifications are no longer supported by the State of California and have been superseded by Sawyer et al. 2009. Plant species scientific nomenclature and taxonomy follow the treatments within Baldwin et al. (2012). Common names of plant species follow the Jepson naming convention when available, and Calflora (2022) when Jepson naming information is unavailable.

The Project Area includes a coastal lagoon and surrounding wetlands that have been heavily modified by urban development and the introduction of non-native plant species. The following vegetation communities and land cover types exist within the Project Area: pickleweed mats, disturbed riparian scrub, ice plant mats, sandy beach, eucalyptus groves, annual grassland, ruderal, and developed (Figure 4). Representative photographs of the Project Area are included as Appendix B and a complete list of all plant species observed during the biological surveys can be found in Appendix C.

Pickleweed Mats

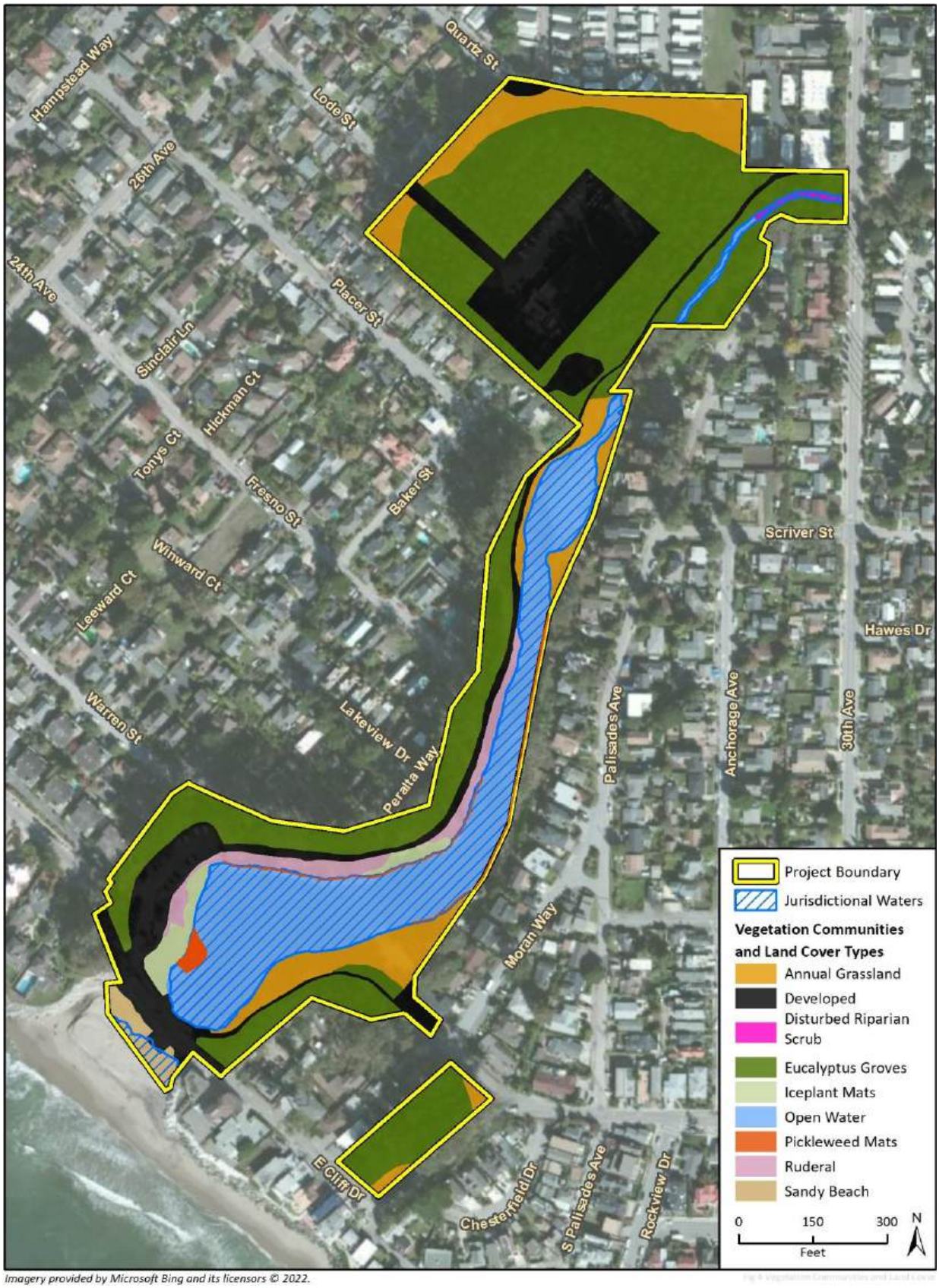
Saline emergent wetland vegetation is present around the perimeter of Moran Lagoon. This community most closely aligns with the Pickleweed Mats (*Salicornia pacifica*[5] [*Salicornia depressa*]) Herbaceous Alliance (G4/S3), and the *Salicornia pacifica – Jaumea carnosa - Distichlis spicata* Association (G3/S3) described by Sawyer et al. 2009. This association is considered vulnerable to extirpation and extinction globally and State-wide and is listed on the CDFW Sensitive Natural Communities List (CDFW 2021). Pickleweed mats consist of native halophytic vegetation and occur in coastal salt marshes and alkaline flats at elevations of 0 to 7 feet.

Within the Project Area, this community is comprised primarily of pickleweed, with some marsh jaumea (*Jaumea carnosa)*, saltgrass (*Distichlis spicata*), and alkali heath (*Frankenia salina*)

[4] The online version of A Manual of California Vegetation, 2nd edition (MCV2, Sawyer et al. 2009) was referenced for this analysis. The online version is updated by CDFW VegCAMP, hosted by CNPS, and available at http://vegetation.cnps.org/.

[5] *Sarcocornia pacifica* and *Salicornia pacifica* are alternate scientific names for the same species of pickleweed. The Manual of California Vegetation refers to *Sarcocornia pacifica* but *Salicornia pacifica* is used in this report.

Figure 4 Vegetation Communities and Land Cover Types



interspersed. This community forms a narrow fringe near the lagoon OHWM[6] throughout brackish portions of the lagoon. Pickleweed mats occur in areas that are periodically inundated with brackish water and cover approximately 0.18 acre within the Project Area. It is likely that this community was once much more extensive around Moran Lagoon and restoration efforts associated with this Project are intended to expand this community of native salt marsh plants along the lagoon banks.

Disturbed Riparian Scrub

This community occurs in the northeastern portion of the Project Area, near Thirtieth Avenue, and surrounds Moran Creek, the freshwater stream inlet to Moran Lagoon. This community most closely resembles the Himalayan blackberry – rattlebox – edible fig (*Rubus armeniacus – Sesbania punicea – Ficus carica*) Shrubland Semi-Natural Alliance and *Rubus armeniacus* association described by Sawyer et al. 2009. This alliance is dominated by non-native plants and can occur in a variety of disturbed landcover types, including pastures, mesic disturbed sites, and stream sides. Within the Project Area, this community covers approximately 0.05 acre and is dominated by invasive Himalayan blackberry (*Rubus armeniacus*), with invasive elmleaf blackberry (*Rubus ulmifolius*), cape ivy (*Delairea odorata*), and French broom (*Genista monspessulana*) present as codominant species. Several native coast live oak (*Quercus agrifolia*) and California bay laurel (*Umbellularia californica*) trees are also present in this community, near the Thirtieth Avenue culvert outlet.

Iceplant Mats

This vegetation type most closely resembles the Ice Plant Mats (*Mesembryanthemum* spp. – *Carpobrotus* spp.) Herbaceous Semi-Natural Alliance described by Sawyer et al. (2009). Ice plant mats can occur in bluffs, disturbed land, and coastal sand dunes and consist of non-native, perennial, ground-hugging succulents that form large monospecific mats.

Within the Project Area, this vegetation type is dominated by iceplant (*Carpobrotus edulis*), and occurs along the sandy banks of the lagoon, upslope of the OHWM, covering approximately 0.33 acre. *Carpobrotus edulis* has a California Invasive Plant Council (Cal-IPC) rating of 'High' and spreads readily from landscaped areas into adjacent habitats, outcompeting native species for space, nutrients, and moisture. Restoration efforts associated with the Project will involve removal of iceplant from the banks surrounding Moran Lagoon.

Sandy Beach

This land cover type covers approximately 0.24 acre within the Project Area and consists of unvegetated sand between East Cliff Drive and the Pacific Ocean. This area is part of Moran Lake Beach, which is owned by the County and managed for recreational use.

Eucalyptus Groves

The eucalyptus groves within the Project Area most closely resemble the *Eucalyptus* spp. Woodland Semi-Natural Alliance (*Eucalyptus globulus* Association) described by Sawyer et al. (2009). Eucalyptus trees are dominant in this alliance and preclude most other plant species from growing in the understory. Eucalyptus groves were planted as windbreaks throughout California and have also been naturalized in many areas adjacent to streams and lakes.

[6] Moran Lagoon does experience tidal influence during extreme high tide and storm events. However, due to the installation of the box culvert beneath East Cliff Drive, the lagoon is generally isolated from tidal influence. Therefore, ordinary high-water mark will be used in reference to the lagoon instead of high tide line throughout this report.

Eucalyptus groves cover approximately 8.18 acres within the Project Area, with dense stands growing in the northern portion of the park surrounding the D.A. Porath Sanitation Facility, along the western edge of the lagoon near the center of the Project Area, along the southeastern corner of the lagoon, and within the 40 Moran Way Parcel in the easternmost portion of the Project Area. The understory of the eucalyptus groves is generally scarce due to the allelopathic nature of eucalyptus trees. Poison oak (*Toxicodendron diversilobum*) dominates the shrubby understory, forming low density and coverage thickets and the herbaceous understory is generally absent. Although eucalyptus groves are non-native, they do provide habitat for a variety of native wildlife species, including monarch butterflies, which are known to overwinter in the groves on site (Xerces 2022).

Annual Grassland

This community most closely resembles the *Avena* spp. – *Bromus* spp. Herbaceous Semi-Natural Alliance described by Sawyer et al. (2009). Non-native introduced grass species are dominant in this alliance, though species composition in this community is highly variable and may contain occasional native or ornamental trees and shrubs.

Within the Project Area, this vegetation type occurs in open spaces surrounding the lagoon and eucalyptus groves and covers approximately 2.30 acres. Annual grassland within Project Area is codominated by non-native grasses, including wild oats (*Avena fatua* and *Avena barbata*), ripgut brome (*Bromus diandrus*), kikuyu grass (*Pennisetum clandestinum*), foxtail barley (*Hordeum murinum*), and Italian rye (*Festuca perennis*).

Ruderal

Ruderal areas consist of vegetation that has been heavily disturbed or altered such that native plant communities have largely been removed and non-native plants species are dominant. Ruderal areas are not described in the Holland (1986) or Sawyer et al. (2009) classification systems. Ruderal portions of the Project Area cover approximately 0.41 acre and occur along the periphery of the paved parking area and existing trails. This vegetation type within the Project Area is associated generally with non-native and invasive herbaceous plants such as storks bill (*Erodium* spp.), foxtail barley, English plantain (*Plantago lanceolata*), charlock (*Raphanus* sp.), and burclover (*Medicago* sp.).

Developed

Developed areas are not naturally occurring and are not described in the Holland (1986) or Sawyer et al. 2009 classification systems. Developed portions of the Project Area cover approximately 3.76 acres and include the paved parking lot, existing bathrooms, a portion of East Cliff Drive, paved and unpaved pedestrian trails, and buildings and infrastructure associated with the D.A. Porath Sanitation Facility.

3.3 Reconnaissance-level Field Survey Results

The reconnaissance-level field survey was conducted between 0930 and 1500 on November 11, 2021. Weather conditions were clear and sunny, with temperatures ranging from 65°F to 71°F, and 3 to 10 mile per hour winds. No special-status plant species were observed, though this survey was not a protocol-level botanical survey and was not conducted during the bloom periods of most special status plant species. Special-status wildlife species observed during the survey included monarch butterfly (*Danaus plexippus*), American white pelican (*Pelecanus erythrorhynchos*), double-crested cormorant (*Phalacrocorax auritus*), and tidewater goby (*Eucycloglobius newberryi*) (as described further in Sections 3.4.1 and 4.1.2). A variety of native bird species were observed within the Project Area, including snowy egret (*Egretta thula*), mallard (*Anas platyrhynchos*), black phoebe (*Sayornis nigricans*), chestnut-backed chickadee (*Poecile rufescens*), and red-tailed hawk (*Buteo jamaicensis*). Potentially suitable nesting habitat for these and many other bird species occurs within the Project Area. Habitats within the Project Area have been largely disturbed by human development and introduction of non-native plant species; however, populations of monarch butterfly and tidewater goby are present, and potentially suitable habitat also exists for other special-status wildlife species, including southwestern pond turtle (*Actinemys pallida*) and Cooper's hawk (*Accipiter cooperii*). Section 4.1 describes all special-status plant and wildlife species with potential to occur on-site. Appendix D includes an analysis of the potential for regionally occurring special-status species to be present within the Project Area.

3.4 Focused Survey Results

Focused biological surveys were conducted by Rincon biologists for special-status aquatic and plant species within appropriate habitat throughout the Project Area. The results of each of these surveys are described in detail below.

3.4.1 Aquatic Survey Results

The aquatic survey was conducted within Moran Lagoon between 0900 and 1600 on November 11, 2021. Weather conditions at the time of the survey were clear and sunny, with temperatures ranging from 63 °F and 71 °F and winds from 3 to 10 miles per hour. A total of 636 federally endangered tidewater goby (*Eucyclogobius newberryi*) and 421 partially armored threespine stickleback (*Gasterosteus aculeatus*) were collected, observed, and released during the fifteen seine hauls conducted during the survey (Figure 3). No other fish species were observed, and no fish mortality occurred. The shells of multiple marine invertebrates were also observed within and around the lagoon during the survey, including black-clawed crab (*Lophopanopeus bellus*), purple shore crab (*Hemigrapsus nudus*), and California mussel (*Mytilus californicus*). Table 1 presents the water quality data collected at three locations within the lagoon during the survey (Figure 3). Aquatic survey datasheets are included as Appendix E.

Table 1 Water Quality Data

Date	Time	Haul	Location	DO (mg/L)	Conductivity (µS/cm)	pH	Salinity (ppt)	Turbidity (ntu)	Temperature (°C)
11/11/21	0940	1	36.95657°N, -121.97772° W	6.78	11080	7.23	7.14	5.72	14.2
11/11/21	1125	8	36.95703°N, -121.97671° W	8.70	8200	7.41	7.00	8.71	13.8
11/11/21	1145	9	36.95735°N, -121.97586° W	8.61	8188	7.74	5.88	11.40	14.0

3.4.2 Botanical Survey Results

Eighty-eight plant species were observed during the botanical survey. Of the eighty-eight species observed, 50 are herbs, 10 are grasses, 15 are shrubs or vines, and 13 are trees. Approximately 69 of the 88 species are introduced with approximately 35 of those species being considered invasive by the Cal-IPC. No special-status plant species were observed during the botanical surveys. A complete inventory of all plant species observed during the botanical surveys is provided in Appendix C.

4 Sensitive Biological Resources

This section discusses special-status species and sensitive biological resources observed within the Project Area and evaluates the potential for the Project Area to support additional sensitive biological resources. Assessments for the potential occurrence of special-status species are based upon known ranges, habitat preferences for the species, species occurrence records from the CNDDB and other sources, species occurrence records from other sites in the vicinity of the survey area, previous reports for the Project site, and the results of surveys of the Project Area. The potential for each special status species to occur in the Project Area was evaluated according to the following criteria:

- **No Potential.** Habitat on and adjacent to the site is clearly unsuitable for the species requirements (foraging, breeding, cover, substrate, elevation, hydrology, plant community, site history, disturbance regime), and species would have been identifiable on the site if present (e.g., oak trees). Protocol surveys (if conducted) did not detect species.
- **Low Potential.** Few of the habitat components (foraging, breeding, cover, substrate, elevation, hydrology, plant community, site history, disturbance regime) meeting the species requirements are present, and/or the majority of habitat on and adjacent to the site is unsuitable or of very poor quality. The species is not likely to be found on the site. Protocol surveys (if conducted) did not detect species.
- **Moderate Potential**. Some of the habitat components (foraging, breeding, cover, substrate, elevation, hydrology, plant community, site history, disturbance regime) meeting the species requirements are present, and/or only some of the habitat on or adjacent to the site is unsuitable. The species has a moderate probability of being found on the site.
- **High Potential.** All the habitat components (foraging, breeding, cover, substrate, elevation, hydrology, plant community, site history, disturbance regime) meeting the species requirements are present and/or most of the habitat on or adjacent to the site is highly suitable. The species has a high probability of being found on the site.
- **Present.** Species is observed on the site or has been recorded (e.g., CNDDB, other reports) on the site recently (within the last 5 years).

4.1 Special-status Species

Rincon evaluated forty-nine special-status plant species and forty-six special-status wildlife species for their potential to occur within the Project Area (Appendix D). A list of all wildlife and plant species observed during the biological surveys can be found in Appendix C.

4.1.1 Special-status Plant Species

Forty-nine special-status plant species were evaluated for their potential to occur within the Project Area (Appendix D). Based on the absence of suitable habitat and/or soils; the generally developed and disturbed nature of the site; and the results of the two botanical surveys conducted on site (in April and June 2022), no special-status plant species are expected to occur within the Project Area.

4.1.2 Special-status Wildlife Species

Rincon evaluated forty-six special-status wildlife species for their potential to occur within the Project Area (Appendix D), twenty-one of which have some potential to occur on site based upon direct observation of the species or the presence of suitable habitat. Table 2 lists each of these species, their status, and their potential to occur within the Project Area. The remaining twenty-five special-status wildlife species are not expected to occur in the Project Area or immediate vicinity based on the absence of intact riparian, grassland, woodland, chaparral, coastal scrub, vernal pool, or other suitable natural habitats or vegetation communities, and/or because the known range of the species does not overlap with the Project Area.

Table 2 Special-status Wildlife Species with Potential to Occur within the Project Area

Scientific Name	Common Name	Status	Potential to Occur
Invertebrates			
Danaus plexippus pop. 1	monarch butterfly	FC	Present
Fish			
Eucycloglobius newberryi	tidewater goby	FE	Present
Lavinia exilicauda harengus	Monterey hitch	SSC	Low Potential
Amphibians			
Rana draytonii	California red-legged frog	FT	Low Potential
Reptiles			
Actinemys pallida	southwestern pond turtle	SSC	Low Potential
Anniella pulchra	northern California legless lizard	SSC	Low Potential
Birds			
Accipiter cooperii	Cooper's hawk	WL	High Potential
Agelaius tricolor	tricolored blackbird	ST	Low Potential (non-nesting)
Charadrius nivosus	western snowy plover	FT/SSC	Low Potential (non-nesting)
Cypseloides niger	black swift	SSC	Low Potential (non-nesting)
Elanus leucurus	white-tailed kite	FP	Moderate Potential (non-nesting)
Falco peregrinus anatum	American peregrine falcon	FD/SD/FP	Moderate Potential (non-nesting)
Pandion haliaetus	osprey	WL	Moderate Potential
Pelecanus erythrorhynchos	American white pelican	SSC (nesting colony)	Present (non-nesting)
Pelecanus occidentalis californicus	California brown pelican	FD/SD/FP	High Potential (non-nesting)
Phalacrocorax auritus	double-crested cormorant	WL (nesting colony)	Present (non-nesting)
Riparia riparia	bank swallow	ST	Low Potential (non-nesting)
Setophaga petechia	yellow warbler	SSC	High Potential
Sterna antillarum browni	California least tern	FE/SE/FP	Low Potential (non-nesting)
Mammals			
Antrozous pallidus	pallid bat	SSC	Low Potential
Corynorhinus townsendii	Townsend's big-eared bat	SSC	Low Potential

FE = Federally Endangered FC = Federal Candidate SE = State Endangered ST = State Threatened
SSC = CDFW Species of Special Concern FP = State Fully Protected WL = CDFW Watch List FD = Federally Delisted
SD = State Delisted

Special-status wildlife species that have a moderate or high potential to occur, or are present on site, are discussed in further detail below. State and/or federally listed species with a low potential to occur on-site will also be discussed in further detail. For the purposes of CEQA analysis, special-status species that are not state or federally listed and have a low potential to occur will not be addressed further in this section.

Monarch Butterfly

The monarch butterfly is a candidate species for federal listing. Monarchs overwinter in roost sites that extend along the Pacific coast from northern Mendocino County to Baja California, Mexico. Roosts are located in wind-protected tree groves (typically eucalyptus, Monterey pine, or Monterey cypress), with nectar and water sources nearby.

Wintering monarch habitat occurs around Moran Lagoon (Santa Cruz County Parks 2010, Xerces Society 2022), primarily within stands of blue gum eucalyptus, and the species typically roosts in the area from October through February. The monarch wintering habitat at Moran Lagoon supports the second largest population of wintering monarchs in Santa Cruz County (approximately 20%) and a considerable portion (approximately 5%) of the state-wide population (Santa Cruz County Parks 2010). There are twenty occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022a). Individuals were observed on site during the biological surveys in November and December 2021. Overwintering monarch butterflies are present within the Project Area. The forthcoming Monarch Management Plan Update for Moran Lake County Park will include recommendations for maintaining and improving the health of the eucalyptus groves on site to enhance monarch overwintering habitat.

Tidewater Goby

The tidewater goby is a federally endangered species known to occur along the California coast from the mouth of the Smith River in Del Norte County, south to Agua Hedionda Lagoon in San Diego County. In 2016, a study was published describing tidewater goby populations south of Aliso Creek in Orange County as a distinct species (*Eucyclogobius kristinae*) now referred to as the southern tidewater goby due to molecular distinctions as well as lineage separation and mitochondrial sequence divergence. The tidewater goby species from Santa Monica Artesian Springs (Los Angeles County) northward belong to *E. newberryi* (Swift et al. 2016) now referred to as the northern tidewater goby. Both species are federally listed as endangered. Tidewater gobies generally inhabit lagoons, estuaries, marshes, and coastal streams that are protected from the Pacific Ocean by sandbars creating cool, brackish water conditions, preferably with nearby emergent vegetation. Salinities under 10 parts per thousand (ppt) are favorable although this species has been found in the upper reaches of streams which are tributaries to brackish water. The species may occur in groups under a dozen or in large aggregations of several hundred. Habitat with sandy bottom substrate is preferred to allow subsurface burrowing by males prior to mate selection. Tidewater gobies complete life cycles annually with adults rarely exceeding two inches in length. Threats to the goby include sandbar breaching for tidal flushing, wetland draining, and pollutant accumulation in lagoons. Federally designated critical habitat for the tidewater goby exists approximately 0.35 mile northwest of Moran Lagoon, within Corcoran Lagoon (USFWS 2011). Moran Lagoon is not designated as critical habitat for this species.

Tidewater gobies were observed within Moran Lagoon during surveys in 1997 and 2001, as described in the Tidewater Goby Final Recovery Plan (USFWS 2005). The species was also observed within the lagoon during surveys conducted in 2014 and 2015 (Wasserman and Palkovacs,

unpublished data) and detected in the lagoon in an eDNA study conducted in 2016 (Sutter 2018). There are eight occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022a). As described in Section 3.4.1, 636 tidewater gobies were observed within Moran Lagoon during the aquatic survey conducted by Rincon biologists on November 11, 2021. The species is therefore present within the Project Area and is assumed to be breeding within Moran Lagoon. Salinity measurements within the lagoon taken during the aquatic survey ranged from 5.88 to 7.14 ppt, with water temperature ranging from 13.8 to 14.2 degrees Celsius (°C). These ranges represent preferable habitat conditions for the tidewater goby, though salinity and temperature within the lagoon fluctuate depending on precipitation, tidal conditions, and air temperature. Sandy substrates within Moran Lagoon provide favorable breeding habitat for the tidewater goby, though emergent wetland vegetation for use as cover is scarce and especially limited during low water conditions when the surface water level of the lagoon dips beneath the fringe of pickleweed mats.

California Red-legged Frog

The California red-legged frog (CRLF) is a federally threatened species and a State Species of Special Concern (SSC) that occurs in lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. It typically inhabits quiet pools of streams, marshes, and ponds. All life history stages are most likely to be encountered in and around breeding sites, which include coastal lagoons, marshes, springs, permanent and semi-permanent natural ponds, and ponded and backwater portions of streams, as well as artificial impoundments such as stock ponds, irrigation ponds, and siltation ponds. The CRLF can disperse up to two miles from breeding ponds. Eggs are typically deposited in permanent pools, attached to emergent vegetation. This species typically requires 11 to 20 weeks of permanent water for larval development and must have access to estivation habitat. Suitable upland habitat must provide sufficient moisture to prevent desiccation and sufficient cover to provide protection from predators. Typical upland habitat consists of densely vegetated areas, downed woody vegetation, leaf litter, small mammal burrows, and human-made structures (i.e., culverts, livestock troughs, spring-boxes, abandoned sheds) (USFWS 2002).

A limited amount of marginally suitable freshwater and riparian habitat for the species occurs in the northeastern portion of the Project Area, within Moran Creek and its associated riparian scrub. There are four occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022a), though all of these occurrences are in freshwater ponds near the UC Santa Cruz campus and are at least 4.5 miles west of Moran Lagoon. Due to the disturbed nature of the riparian and instream habitat and the isolation of the site due to urban development, there is only a low potential for the CRLF to occur on site.

Cooper'srHawk

The Cooper's hawk is a CDFW watchlist (WL) species that typically inhabits woodlands and forest edges but can also be found in urban parks and neighborhoods where trees are present. Nests are constructed 25-50 feet high in a variety of tree species, including pines, oaks, beeches, and spruces. Nests are made of sticks and are often lined with bark flakes and green twigs. Cooper's hawks are aerial predators that feed primarily on medium-sized birds, such as mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), California quail (*Callipepla californica*), and European starling (*Sturnus vulgaris*). In addition to preying on adult birds, Cooper's hawks will also occasionally rob nests and hunt rabbits, rodents, and bats (Cornell Lab of Ornithology 2022a).

Suitable foraging habitat for the species is present throughout the Project Area, and suitable nesting habitat for the species exists within eucalyptus, coast redwood, Monterey cypress, and other trees present within the Project Area. There are no occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022a). Multiple occurrences of the species are documented within one mile of the Project Area in eBird (Cornell Lab of Ornithology 2022b). The Cooper's hawk has a high potential to forage and nest within the Project Area.

Tricolored Blackbird

The tricolored blackbird is a State threatened species that is largely endemic to California and is most common in the Central Valley, though it also occurs in coastal areas. The species is highly colonial and historically nested in wetlands with cattails, bulrushes, and willows. Today, much of the wetland habitat in California has been converted to agriculture and the species nests primarily in triticale fields (Cornell Lab of Ornithology 2022a). Nesting colonies require open water, protected nesting substrate, and foraging areas with adequate insect prey within a few kilometers of the colony.

Suitable foraging habitat for the species occurs around Moran Lagoon, though no suitable cattail, agricultural field, or other dense vegetative nesting habitat is present. Two historic occurrences (in 1973 and 1987) of the species are documented in the CNDDB approximately three miles west of the Project Area (CDFW 2022a). One occurrence of the species is documented within one mile of the lagoon in eBird (Cornell Lab of Ornithology 2022b). The tricolored blackbird has a low potential to fly over or forage within the Project Area but is not expected to nest on site.

Western Snowy Plover

The western snowy plover is federally threatened and a CDFW SSC. This small shorebird is about six inches long, with a thin dark bill, pale brown to gray upper parts, white or buff colored belly, and darker patches on its shoulders and head, and white forehead and eyebrow. The Pacific Coast population of the western snowy plover breeds primarily on coastal beaches from southern Washington to southern Baja California, Mexico. The population breeds above the high tide line on coastal beaches, sand spits, dune-backed beaches, sparsely vegetated dunes, beaches at creek and river mouths, and salt pans at lagoons and estuaries (USFWS 2022d).

Some suitable nesting habitat for the species occurs within the Project Area, including a small stretch of sandy beach in the southernmost portion of the site. However, Moran Lagoon and Moran Lake Beach are heavily impacted by recreational use and development and no longer provide suitable breeding habitat for the species. There are two historic occurrences (from 1878 and 1887) of the western snowy plover documented in the CNDDB (CDFW 2022a) approximately two and four miles west of the Project Area. There are multiple occurrences documented in eBird within five miles of the Project Area (Cornell Lab of Ornithology 2022b), though none are documented within the Project Area. The western snowy plover has a low potential to occur within the Project Area, though the species is not expected to nest on site.

White-tailed Kite

The white-tailed kite is a State fully protected species that occurs in open grasslands, meadows, open woodlands, marshes, and cultivated areas. Nests are built near the top of dense-topped trees. Diet consists primarily of small mammals, and the species hunts by facing into the wind and hovering (or "kiting") above the ground while scanning the ground for movement (Cornell Lab of Ornithology 2022a).

The white-tailed kite has a moderate potential to fly over or forage within the Project Area, though it is not expected to nest within the Project Area due to the high level of human activity and surrounding urban development. Multiple occurrences of the species are documented within one mile of the Project Area in eBird (Cornell Lab of Ornithology 2022b).

American Peregrine Falcon

The American peregrine falcon is a federally and State delisted species and a State fully protected species that occurs in urban areas and open habitats, including coastlines, mudflats, lake edges, and mountain sides. American peregrine falcon populations were nearly exterminated from 1940-1970 due to wide-spread use of organochlorine pesticides. In 1970, the species was listed as federally endangered and conservation efforts began. Following the ban of the pesticide DDT and the implementation of captive breeding programs, American peregrine falcon populations have rebounded, and the species was delisted in 1999 (Center for Biological Diversity 2021). Prey includes a wide variety of bird species and nest sites are typically in rocky cliffs faces, but can also be located on transmission towers, skyscrapers, bridges, or other human-made structures (Cornell Lab of Ornithology 2022a).

Suitable cliffs or tall structures preferred by the species for nesting habitat are not present within the Project Area. Multiple occurrences of the species are documented within five miles of Moran Lake County Park in eBird (Cornell Lab of Ornithology 2022b) and there is a moderate potential for the species to fly over or forage in the Project Area.

Osprey

The osprey is a CDFW WL species that feeds on live fish and inhabits areas near large water bodies with adequate shallow fishing grounds, including oceans, rivers, lagoons, lakes, and marshes. Osprey nest in elevated, open sites (typically in trees) that are within twelve miles of water bodies with adequate fish supplies (Cornell Lab of Ornithology 2021a).

Trees within the Project Area provide suitable nesting habitat for ospreys that is within close proximity to suitable fishing grounds in the ocean. Multiple occurrences of the species are documented within one mile of the Project Area in eBird (Cornell Lab of Ornithology 2022b). There is a moderate potential for the species to forage and nest within the Project Area.

American White Pelican

The American white pelican is a CDFW SSC that nests primarily on isolated islands in freshwater lakes and feeds primarily on small fish. In the winter, the species favors coastal bays, estuaries, lagoons that provide shallow foraging habitat and exposed sandbars for resting (Cornell Lab of Ornithology 2022a).

American white pelicans were observed during the field reconnaissance survey on November 11, 2021. Multiple occurrences of the species are documented within five miles of the Project Area in eBird (Cornell Lab of Ornithology 2022b). Moran Lagoon and Moran Lake Beach provide suitable foraging habitat for the species, though no isolated islands within freshwater are present and the species is not expected to nest within the Project Area.

California Brown Pelican

The California brown pelican is a State fully protected species that was both federally and State delisted. The species lives year-round in estuaries and coastal marine habitats along the California

coast, and forage, rest, and roost on islands, offshore rocks, breakwaters and other humanmade structures, rocky intertidal areas, mudflats, and beaches. The species generally nests and breeds at offshore Islands in southern California. Diet includes mostly small fish that school near the surface of the water. Brown pelicans spot fish from the air and dive head-first from as high as 65 feet over the ocean before plunging into the water and expanding their throat patch to trap fish (Cornell Lab of Ornithology 2022a).

The Project Area is outside of the typical breeding range of the California brown pelican and the species is not expected to nest on site. However, multiple occurrences of the species are documented within and around Moran Lake County Park in eBird (Cornell Lab of Ornithology 2022) and the species has a high potential to fly through or forage within the Project Area.

Double-crested Cormorant

The double-crested cormorant is a CDFW WL species that forms breeding colonies in clusters of trees near large bodies of water. Diet consists primarily of fish, which they catch by diving and chasing their prey underwater with powerful propulsion from webbed feet. After fishing, the birds rest on high, airy perches to dry off and digest (Cornell Lab of Ornithology 2022a).

Double-crested cormorants were observed within the Project Area during the field reconnaissance survey on November 11, 2021 and have been frequently documented within Moran Lake County Park and the surrounding area in eBird (Cornell Lab of Ornithology 2022b). Suitable nesting habitat for the species is present in eucalyptus groves within the Project Area, no known cormorant rookeries occur on site.

Bank Swallow

The bank swallow is a State threatened species that inhabits low areas along rivers, streams, ocean coasts, and reservoirs. The species nests colonially on vertical banks or cliffs with fine-textured or sandy soils and forages in open areas. Diet includes insects, such as bees, wasps, ants, butterflies, and moths (Cornell Lab of Ornithology 2022a).

No suitable banks or cliffs for nesting occur within the Project Area. However, multiple occurrences of the species are documented within five miles of Moran Lake County Park in eBird (Cornell Lab of Ornithology 2022b) and there is a low potential for the species to fly through or forage within open portions of the Project Area.

Yellow Warbler

The yellow warbler is a CDFW SSC that inhabits riparian plant communities and is typically found in close proximity to water. The species frequently nests and forages in willow shrubs and thickets, and can also be found in other riparian trees, including cottonwoods, sycamores, ash, and alders. The yellow warbler also nests in montane shrubbery in open conifer forests in the Cascades and Sierra Nevada range. Diet consists primarily of insects picked from foliage or captured mid-air and can include midges, caterpillars, beetles, and wasps. Nests are built from grasses, bark, and broad leaves and are usually found in vertical forks of bushes and small trees about ten feet above ground. Clutch size is typically one to seven eggs, which are incubated for 10-13 days prior to a 9-12 day nestling period. Yellow warblers are still numerous, but their populations decreased by approximately 25% between 1966 and 2014, likely due to habitat loss (Cornell Lab of Ornithology 2022a).

Some marginally suitable nesting habitat for the species occurs within the disturbed riparian scrub in the northeast portion of the Project Area, though willows and other riparian trees are scarce.

There are multiple occurrences of the species documented within one mile of the Project Area in eBird (Cornell Lab of Ornithology 2021b). The yellow warbler has a high potential to fly through or forage within the Project Area and a low potential to nest on site.

California Least Tern

The California least tern is a federally endangered, State endangered, and State fully protected species that nests along the California coast from San Francisco Bay south to northern Baja California. The species is a colonial breeder on bare or sparsely vegetated, flat substrates, including sandy beaches, alkali flats, and occasionally landfills, agricultural fields, or paved areas. Diet consists almost entirely of small fish, which are caught by diving in shallow water after hovering briefly. Least terns will feed in almost any aquatic habitat with fish, including oceans, bays, rivers, marshes, ponds, and reservoirs (Cornell Lab of Ornithology 2022a).

While some suitable nesting habitat for the species is present, the California least tern is not known to nest within Moran Lake County Park, and due to the high level of human traffic, it is unlikely that the species would establish a nesting colony within the Project Area. Multiple occurrences of the species are documented in eBird within five miles of Moran Lake County Park (Cornell Lab of Ornithology 2022b). There is a low potential for the species to fly through and forage within the Project Area.

Nesting Birds

Migratory birds protected under the MBTA and nesting birds and raptors protected under CFGC Section 3503 have the potential to breed and forage throughout the Project Area. Nesting habitat could include eucalyptus trees, native trees such as coast redwood and Monterey cypress, shrubs, sedges, and other vegetation, human-made structures, and the ground surface.

4.2 Sensitive Plant Communities, Environmentally Sensitive Habitat Areas, and Critical Habitats

Plant communities are considered sensitive biological resources if they have limited distributions, have high wildlife value, include sensitive species, or are particularly susceptible to disturbance. Vegetation rarity ranking is based on a rank calculator developed by NatureServe. According to the CDFW Vegetation Program, alliances with state ranks of S1-S3, as well as certain additional associations specifically noted as sensitive in the list, are considered to be imperiled, and thus, potentially of special concern. One sensitive plant community occurs within the Project Area: pickleweed mats (*Sarcoconia pacifica – Jaumea carnosa – Distichlis spicata* Association). This community is designated as G3/S3 and occurs in a narrow band along the lagoon OHWM, covering approximately 0.18 acre within the Project Area.

The California Coastal Act defines Environmentally Sensitive Habitat Areas (ESHAs) as “any area in which plant or animal life or their habitats are either rare or especially valuable because of their nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments.” Unique plant habitats, rare and endangered plant and animal habitats, wetlands, coastal streams, rocky points, sea cliffs, intertidal areas, and kelp beds are typically considered ESHA. According to the County General Plan and Local Coastal Plan (County of Santa Cruz 1994), “all lakes, wetlands, estuaries, lagoons, streams, and rivers” are considered sensitive habitat. Therefore, Moran Lagoon and its associated wetlands, as well as Moran Creek, are

designated as ESHAs. Riparian corridors within the Coastal Zone are also considered ESHAs and the riparian vegetation associated with Moran Creek is an ESHA. Additionally, the marine and estuarine habitat that occurs in the southwestern portion of the Project Area, below the HTL of the Pacific Ocean is also considered an ESHA. Areas which provide habitat for rare, endangered, or threatened species are also considered ESHA. The eucalyptus groves within Moran Lake County Park which provide overwintering habitat for the monarch butterfly are therefore also ESHAs.

Federally designated critical habitat for the black abalone (*Haliotis cracherodii,* FE) occurs along many portions of the California coastline from the Mean Higher High Water (MHHW) line to a depth of six meters (NOAA 2022). The southern portion of the Project Area overlaps with black abalone critical habitat. However, this narrow overlap occurs only between the MHHW line and the southern Project Area boundary, which includes only sandy portions of Moran Lake Beach and contains no rocky intertidal or subtidal habitat for the species. Critical habitat for the federally endangered tidewater goby occurs within Corcoran Lagoon, approximately 0.35 mile northwest of Moran Lagoon (USFWS 2021a).

4.3 Jurisdictional Waters and Wetlands

The United States Army Corp of Engineers (USACE) asserts jurisdiction under Section 404 of the Clean Water Act (CWA) over non-wetland (e.g., streams, lakes, oceans) and wetland (e.g., marshes, estuaries) waters of the U.S. that typically exhibit a hydrologic surface connection to traditionally navigable waters. The limits of jurisdiction extend to the OHWM for non-tidal waters or HTL for tidal waters, and to the edge of those wetlands abutting or, in some cases, adjacent to non-wetland waters of the U.S. that exhibit all three criteria defining federal wetlands: hydric soils, hydrophytic vegetation, and wetland hydrology. Navigable waters of the U.S. are also regulated under Section 10 of the Rivers and Harbors Act of 1899 (USACE) and most proposed activities within the limits defined for navigable waters of the U.S. require a Department of the Army permit, especially if the placement of a new structure or work affects the course, location, or condition of the water body. The CDFW has regulatory authority over activities that divert, obstruct, or alter the channel, bed, or bank of any river, stream, or lake under Section 1600 et seq. of the CFGC. Therefore, perennial, intermittent, and ephemeral streams and associated riparian vegetation also fall under the jurisdiction of the CDFW. The Regional Water Quality Control Board (RWQCB) also has jurisdiction over waters of the State under Section 401 of the CWA and the Porter-Cologne Water Quality Control Act. The CCC has a one-parameter definition of wetlands, which states that wetlands must have only one or more of the following three attributes: (1) at least periodically the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and/or (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. The CCC also regulates activities occurring below the HTL, as does the State Lands Commission.

Moran Lagoon is a coastal lagoon and a Relatively Permanent Water (RPW) with tidal influence from the Pacific Ocean, a Traditional Navigable Water (TNW). Moran Lagoon has intermittent connectivity with the Pacific Ocean during storm and king tide events. Moran Lagoon receives flow Moran Creek and directly from stormwater and residential runoff from the culverts located around the lagoon and creek. Moran Lagoon is heavily used by the public; trash, pet fecal matter, and pollutants from stormwater runoff impact this feature. In spite of these anthropogenic impacts, this feature supports native fish species including tidewater goby and threespine stickleback. The OHWM of Moran Lagoon is defined by a change of vegetation, drift deposits, and break in bank slope. Substrates within the lagoon consist of sandy silt with occasional boulders. Saline emergent

wetland vegetation was observed within the OHWM of the lagoon consisting primarily of pickleweed, salt grass, and marsh jaumea. Moran Lagoon contains intermittent fringes of coastal wetlands within the OHWM.

Moran Creek is an intermittent stream and a RPW with confluence to Moran Lagoon. Moran Creek receives flow from stormwater and residential runoff from the culverts located around the creek. The OHWM of Moran Creek is defined by a change in vegetation and break in bank slope. Substrates within the creek are similar to Moran Lagoon, consisting of sandy silt with cobble. No vegetation was observed within the OHWM of the creek. Riparian vegetation along the banks of Moran Creek consists primarily of invasive species, including Himalayan blackberry and cape ivy, with several coast live oak and California bay laurel trees growing near the Thirtieth Avenue culvert outlet.

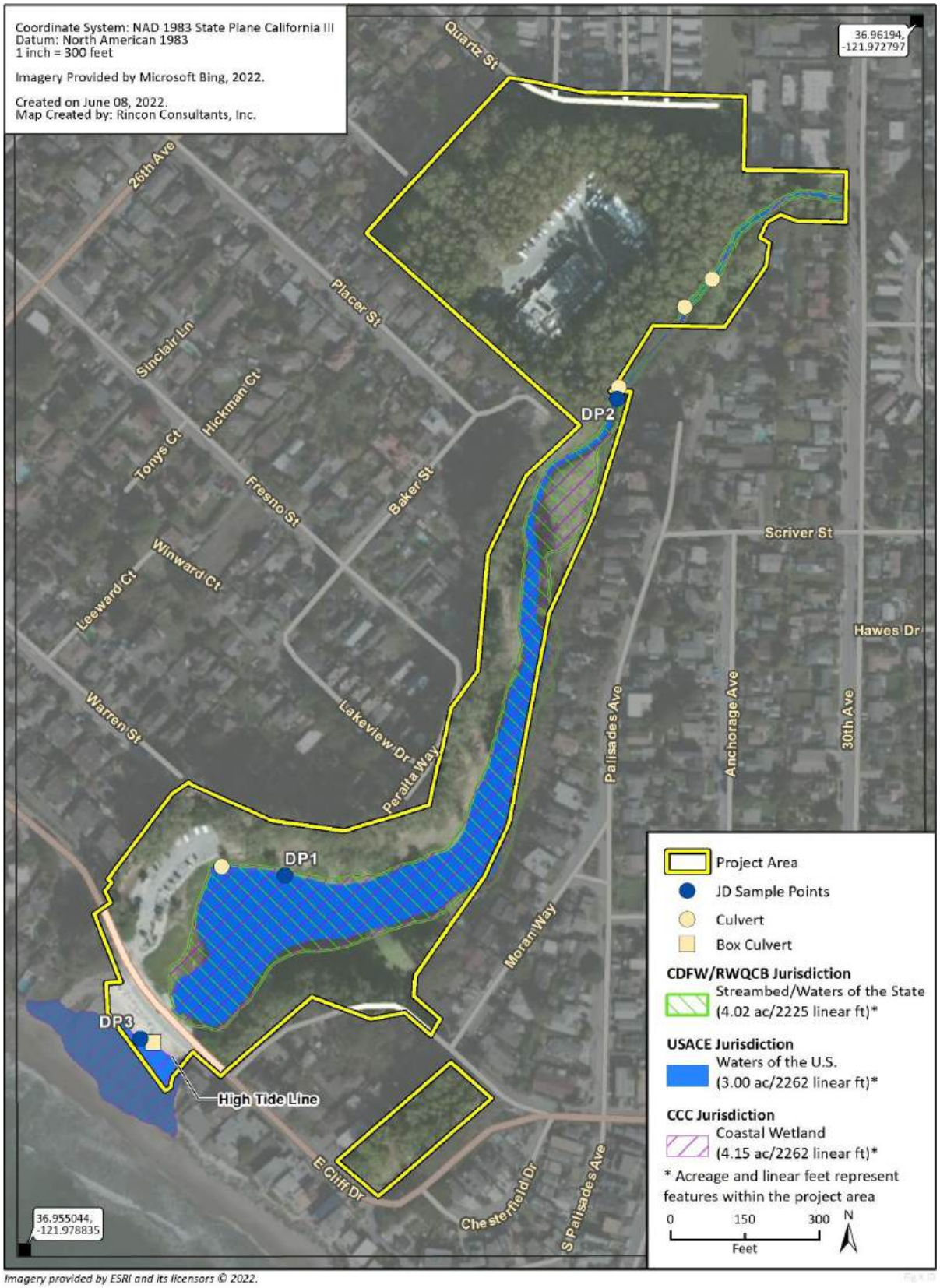
Moran Lagoon and Moran Creek qualify as waters of the U.S. and State and are considered potentially subject to the jurisdiction of the USACE and RWQCB pursuant to Sections 404 and 401, respectively, of the CWA based on their status as RPWs and direct surface connection to a TNW (i.e., the Pacific Ocean). The riparian vegetation associated with Moran Creek is likely subject to the jurisdiction of the RWQCB under the Porter-Cologne Water Quality Control Act. Considering that these features contain defined bed and banks as well as wetland and riparian vegetation, they are also considered potentially subject to the jurisdiction of CDFW pursuant to CFGC Section 1600 et seq. The wetland and riparian vegetation associated with Moran Lagoon and Moran Creek, respectively, and the lake and creek themselves are considered potentially subject to the jurisdiction of CCC (Figure 5).

Marine portions of the Project Area extend from the HTL of the Pacific Ocean to the southwestern most boundary of the Project Area. This area consists of sandy beach habitat within Moran Lake Beach and is potentially subject to USACE and CCC jurisdictions. This area is also potentially under the jurisdiction of the State Lands Commission. Table 4 provides a summary of jurisdictional areas within the Project Area.

Table 3 USACE, CDFW, RWQCB and CCC Jurisdictional Areas within the Project Area

	USACE Waters of the U.S.		CDFW Streambed/RWQCB Waters of the State		CCC Jurisdiction
Feature	Waters of the U.S. (acres/linear feet)	Wetland Waters of the U.S. (acres/linear feet)	Waters of the State (acres/linear feet)	Wetland Waters of the State (acres/linear feet)	Coastal Wetlands (acres/linear feet)
Moran Lagoon and Moran Creek	2.87/2,225	–	4.02/2,225	–	4.02/2,225
Pacific Ocean (Moran Lake Beach)	0.13/37	–	–	–	0.13/37
Total	**3.00/2,262**	**–**	**4.02/2,225**	**–**	**4.15/2,262**

Figure 5 Jurisdictional Waters and Wetlands



4.4 Wildlife Movement

Wildlife movement corridors, or habitat linkages, are generally defined as connections between areas of suitable habitat that allow for physical and genetic exchange between otherwise isolated wildlife populations. Such linkages may serve a local purpose, such as providing a linkage between foraging and denning areas, or they may be regional in nature. Some habitat linkages may serve as migration corridors, wherein wildlife periodically move away from an area and then subsequently return. Others may be important as dispersal corridors for young wildlife. A group of habitat linkages in an area can form a wildlife corridor network. The California Essential Habitat Connectivity Project, commissioned by the California Department of Transportation (Caltrans) and CDFW, identifies "Natural Landscape Blocks" which support native biodiversity and the "Essential Connectivity Areas" which link them (Spencer et al. 2010).

Trails and open spaces surrounding the lagoon, as well as the disturbed riparian corridor, could serve as local wildlife movement corridors, particularly for disturbance-tolerant species, such as racoons and coyotes. The lagoon can provide small-scale movement opportunities for aquatic species, including the federally endangered tidewater goby. No Essential Connectivity Areas or Natural Landscape Blocks are mapped within the Project Area (Spencer et al. 2010).

4.5 Local Policies and Ordinances

The Project is located in the County of Santa Cruz and is subject to all policies and ordinances within the County of Santa Cruz General Plan and the Local Coastal Plan. Biological and water resources are protected by policies outlined in *Chapter 5: Conservation and Open Space* of the General Plan. Relevant policies for the Moran Lake County Park Improvement Project include those outlined under the following General Plan and Local Coastal Plan objectives: *5.1 Biological Diversity, 5.2 Riparian Corridors and Wetlands, 5.3 Aquatic and Marine Habitats, 5.4 Monterey Bay and Coastal Water Quality,* and *5.7 Maintaining Surface Water Quality*. Each of the pertinent policies is outlined in Appendix A. The goals of the Project will directly align with the goals and policies of the General Plan and Local Coastal Plan and the Project will not conflict with any local policies or ordinances.

4.6 Habitat Conservation Plans

The Project Area falls within the Plan Area of the City of Santa Cruz Operations and Maintenance Habitat Conservation Plan (HCP). However, the County is not included as a responsible entity in the HCP and Project activities are not part of any Covered Activity described in the HCP. Therefore, the HCP is not applicable for this Project.

Avoidance and minimization measures developed for the Project will align with the general conservation measures and species-specific measures outlined in the HCP. The Project will not conflict with any of the HCP measures or objectives.

5 Impact Analysis and Avoidance and Minimization Measures

This section discusses the potential impacts and effects to special-status species and sensitive biological resources that may occur from implementation of the Project and provides recommended avoidance and minimization measures (AMMs) that would reduce those impacts where applicable. The analysis and recommendations are based on the CEQA Guidelines Appendix G Initial Study Checklist; therefore, Section 5 is organized according to the threshold criteria therein.

5.1 Special-status Species

The Project would have a significant effect on biological resources if it would:

a) *Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.*

5.1.1 Special-status Plant Species

Based on the level of disturbance within the Project Area and the results of two botanical surveys, no special-status plant species are expected to occur on site. Therefore, no impacts to special-status plant species are anticipated and no additional measures are recommended.

5.1.2 Special-status Wildlife Species

Twenty-one special-status wildlife species have potential to occur within the Project Area. The Monterey hitch (SSC), CRLF (FT), southwestern pond turtle (SSC), northern California legless lizard (SSC), tricolored blackbird (ST), western snowy plover (FT, SSC), black swift (SSC), bank swallow (ST), California least tern (FE, SE, FP), pallid bat (SSC), and Townsend's big-eared bat (SSC) all have a low potential to occur. The white-tailed kite (FP), American peregrine falcon (FD, SD, FP), and osprey (WL) have a moderate potential to occur. The Cooper's hawk (WL), California brown pelican (FD, SD, FP), and yellow warbler (SSC) have a high potential to occur. The monarch butterfly (FC), tidewater goby (FE), American white pelican (SSC), and double-crested cormorant (WL) are present within the Project Area. Nesting birds protected under the MBTA and CFGC also have potential to occur throughout the Project Area during the nesting season (February 1 to September 15).

Potential impacts from Project activities to each of these special-status wildlife species are described below. Recommended measures for avoiding and minimizing potential impacts to less than significant, as necessary, are also provided. Adherence to agency permits and/or agreements that will be required for Project implementation will also ensure that any potential impacts to special-status species are reduced to less than significant.

Monarch Butterfly

Eucalyptus groves within the Project Area provide important overwintering habitat for monarch butterflies and the species is present on site. Should monarchs be present within the Project Area

during construction, direct impacts could include injury or mortality of individuals. Implementation of AMMs BIO-1, BIO-2, BIO-4, BIO-5, and BIO-9 will reduce any potential impacts to less than significant. The Project will result in overall improvements to monarch habitat within Moran Lake County Park, including installation of late-flowering native plant species and planting of new trees within overwintering groves to provide additional habitat and fill in wind gaps. The forthcoming Monarch Management Plan for Moran Lake County Park will include more specific recommendations for maintaining and enhancing monarch habitat on site. These recommendations will also be incorporated into Project plans prior to construction.

Tidewater Goby

The tidewater goby is present within Moran Lagoon and is likely breeding within the lagoon. Potential impacts to the species could include injury or mortality of individuals, habitat disturbance, and/or disruption of breeding or foraging behavior. Should sediment or pollutants be allowed to enter Moran Lagoon as a result of construction activities, water quality changes could also impact tidewater gobies. Implementation of AMMs BIO-1 through BIO-4, BIO-5, BIO-6, and BIO-9 will reduce any potential impacts to less than significant. The Project may require a Biological Opinion and Incidental Take Statement from the USFWS, which will likely include further AMMs. Wetland restoration efforts included in the Project plans will likely result in improved water quality and tidewater goby habitat within Moran Lagoon.

Monterey Hitch

The Monterey hitch has a low potential to occur within Moran Lagoon. Impacts to non-listed species such as the Monterey hitch (SSC) would be considered significant under CEQA if they would threaten the continued existence of the population. Project activities are not expected to threaten the continued existence of the population, nor result in a downward trend leading to the listing of the species. Therefore, no significant impacts are anticipated and no further AMMs are recommended. Implementation of AMMs BIO-1 through BIO-4 and BIO-5 would further reduce the risk of potential impacts to these species.

California Red-legged Frog

The CRLF has a low potential to occur within and around the freshwater inlet to Moran Lagoon, in the northeastern portion of the Project Area. Should any CRLF be present within the Project Area during construction, direct impacts could include injury or mortality of individuals. Other potential impacts could include disruption of foraging, migration, or breeding habitat. Implementation of AMMs BIO-1 through BIO-4, BIO-5, BIO-7, and BIO-9 will reduce any potential impacts to less than significant.

Special-status Reptiles

The southwestern pond turtle and northern California legless lizard both have a low potential to occur within the Project Area. Impacts to non-listed species such as the southwestern pond turtle (SSC) and northern California legless lizard (SSC) would be considered significant under CEQA if they would threaten the continued existence of the population. Project activities are not expected to threaten the continued existence of these populations, nor result in a downward trend leading to the listing of these species. Therefore, no significant impacts are anticipated. Implementation of AMMs BIO-1, BIO-2, and BIO-5 would further reduce the risk of potential impacts to these species.

Special-status Bird Species

The American white pelican is present within the Project Area, but no suitable nesting habitat for the species occurs on site. The double-crested cormorant is present within the Project Area and has a high potential to nest within eucalyptus groves on site. No pelican or cormorant nesting colonies were observed on site during the biological surveys. The Cooper's hawk has a high potential to fly through, forage, and nest within the Project Area. The California brown pelican has a high potential to fly through, forage, or rest within the Project Area, but is not expected to nest on site. The osprey has a moderate potential to fly through, forage, and nest within the Project Area. The white-tailed kite and American peregrine falcon both have a moderate potential to fly through or forage within the Project Area, but neither is expected to nest on site. The tricolored blackbird, black swift, western snowy plover, bank swallow, and California least tern all have a low potential to fly through or forage within the Project Area, but are not expected to nest on site. Should any of these species occur within the Project Area during construction, potential Project impacts could include injury or mortality to individuals. Should these species nest within the vicinity of the Project Area, Project activities could result in altered nesting behavior or nest abandonment. The loss of a nest due to construction activities would be a violation of the MBTA and CFGC Section 3503. Implementation of AMMs BIO-1 through BIO-4, BIO-8, and BIO-9 would reduce potential impacts to special-status bird species to less than significant.

Special-status Bat Species

The pallid bat and Townsend's big-eared bat both have a low potential to occur and roost within the Project Area. Impacts to non-listed species such as the pallid bat (SSC) and Townsend's big-eared bat (SSC) would be considered significant under CEQA if they would threaten the continued existence of the population. Project activities are not expected to threaten the continued existence of these populations, nor result in a downward trend leading to the listing of these species. Therefore, no significant impacts are anticipated. Implementation of AMMs BIO-1 through BIO-4, and BIO-5 would further reduce any potential impacts to special-status bat species to less than significant.

Migratory and Nesting Birds

Migratory birds protected under the MBTA and nesting birds and raptors protected under CFGC Section 3503 have the potential to breed throughout the Project Area during the nesting season (February 1 to September 15). Potential nesting habitat includes eucalyptus and other trees, shrubs, other vegetation, human-made structures, and the ground surface.

Should any birds nest on or near the Project Area, Project activities could directly impact breeding by destroying the nest, or through disruption of normal biological behaviors during construction of the Project resulting in nest failure. Indirect impacts could include disturbance of breeding habitat. The loss of a nest or disturbance of nesting habitat due to construction activities would be a violation of the MBTA and CFGC Section 3503. Implementation of AMMs BIO-1 through BIO-4, BIO-8, and BIO-9 would reduce potential impacts to special-status bird species to less than significant.

5.2 Sensitive Plant Communities, Environmentally Sensitive Habitat Areas, and Critical Habitat

The proposed Project would have a significant effect on biological resources if it would:

b) Have a substantial adverse impact on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or US Fish and Wildlife Service.

One sensitive plant community occurs within the Project Area: pickleweed mats (*Salicornia pacifica – Jaumea carnosa - Distichlis spicata* Association). This community occurs in a narrow band near the lagoon OHWM and covers approximately 0.18 acre within the Project Area. This community is designated as G3/S3 and is listed on the CDFW Sensitive Natural Communities List (CDFW 2021). This plant community exists within the saline emergent wetland habitat surrounding Moran Lagoon and is potentially under the jurisdiction of the USACE, RWQCB, CDFW, and CCC. Impacts to this community could result if any sediment or pollutants were allowed to enter the community as a result of Project activities. Implementation of AMMs BIO-1 through BIO-4 and BIO-9 will reduce these potential impacts to less than significant. Other impacts to this community could include grading along the banks of Moran Lagoon as part of wetland restoration efforts. Any impacts to pickleweed mats will be mitigated for at a minimum ratio of 1:1 for temporary impacts and 2:1 for permanent impacts. The Project includes restoration of the wetland habitat surrounding Moran Lagoon and will likely result in long-term benefits to, and expansion of, the pickleweed mats within the Project Area. The Project will therefore be self-mitigating and a separate Habitat Mitigation and Monitoring Plan will not be required.

ESHAs within the Project Area include Moran Lagoon and its adjacent wetlands, Moran Creek and its associated riparian corridor, marine habitat on the southwest side of East Cliff Drive, and the eucalyptus groves that provide overwintering habitat for monarch butterflies. Potential impacts to these areas could include grading along the banks of the lagoon, temporary water quality impacts, and vegetation trimming. Implementation of AMMs BIO 1 through BIO-4 and BIO-9 will reduce any potential impacts to ESHAs to less than significant during Project construction. The Project is focused on restoration and enhancement of these important habitat areas and will include invasive species removal surrounding Moran Lagoon, installation of native wetland and riparian plant species, maintenance and enhancement of monarch habitat within the existing eucalyptus groves, and stormwater and drainage improvements that will enhance water quality.

The southern portion of the Project Area overlaps with federally designated critical habitat for the black abalone. However, this overlap only occurs between the MHHW line and the southern Project Area boundary, which includes only sandy portions of Moran Lake Beach and contains no suitable habitat for the species. Therefore, no significant impacts are anticipated and no further AMMs are recommended.

5.3 Jurisdictional Waters and Wetlands

The proposed Project would have a significant effect on biological resources if it would:

c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.

Moran Lagoon and its surrounding wetlands, as well as Moran Creek and its associated riparian corridor, occur within the Project Area and are potentially under the jurisdiction of the USACE, RWQCB, CDFW, and CCC. A portion of marine habitat below the HTL of the Pacific Ocean also occurs within the Project Area and is potentially subject to USACE and CCC jurisdictions. Temporary impacts to water quality in these jurisdictional areas could occur due to the run-off of sediment or pollutants from construction activities. Implementation of AMMs BIO-1 through BIO-4 and BIO-9 will reduce potential impacts to water quality to less than significant. Other Project impacts to jurisdictional areas could include grading along the banks of Moran Lagoon as part of wetland restoration efforts. Project goals include restoration of wetland habitat and improvement of water quality within Moran Lake County Park. The Project will therefore be self-mitigating and a separate Habitat Mitigation and Monitoring Plan will not be required. Any impacts to jurisdictional features will be mitigated for at a minimum ratio of 1:1 for temporary impacts and 2:1 for permanent impacts.

5.4 Wildlife Movement

The proposed Project would have a significant effect on biological resources if it would:

d) Interfere substantially with the movement of any resident or migratory fish or wildlife species or with established resident or migratory wildlife corridors or impede the use of wildlife nursery sites.

There are no Natural Landscape Blocks or Essential Connectivity Areas mapped within the Project Area (Spencer et al. 2010). The Project is not expected to substantially alter existing wildlife movement or interfere with established resident or migratory wildlife corridors. Therefore, impacts to wildlife movement would be less than significant.

5.5 Local Policies and Ordinances

The proposed Project would have a significant effect on biological resources if it would:

e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.

The County General Plan and Local Coastal Program includes policies related to land use, conservation, and open space, as well as additional protections for ESHAs. Proposed Project activities are not in conflict with any elements of the General Plan or Local Coastal Program. The restoration goals of the Project are directly aligned with the goals and policies of the County General Plan and Local Coastal Program. Therefore, no additional AMMs are recommended.

5.6 Adopted or Approved Plans

The proposed Project would have a significant effect on biological resources if it would:

f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Conservation Community Plan, or other approved local, regional, or state habitat conservation plan.

The Project Area falls within the Plan Area of the City of Santa Cruz Operations and Maintenance Habitat Conservation Plan (HCP). However, the County is not included as a responsible entity in the HCP and Project activities are not part of any Covered Activity described in the HCP.

Therefore, the Project will not conflict with any of the HCP measures or objectives and no additional AMMs are recommended.

5.7 Recommended Avoidance and Minimization Measures

BIO-1 Worker Environmental Awareness Program

Prior to initiation of construction activities (including staging and mobilization), all personnel associated with Project construction should attend Worker Environmental Awareness Program (WEAP) training, conducted by a qualified biologist, to aid workers in recognizing special-status species (e.g., tidewater goby, monarch and CRLF), nesting birds, pickleweed mats, and other biological resources that may occur in the Project Area. The specifics of this program will include identification of special-status species with potential to occur, a description of their regulatory status and habitat requirements, general ecological characteristics of any other sensitive resources, and a review of the limits of construction and mitigation measures required to reduce impacts to biological resources within the Project Area. A fact sheet conveying this information will also be prepared for distribution to all contractors, their employers, and other personnel involved with construction. All employees should sign a form provided by the trainer indicating they have attended the WEAP and understand the information presented to them. A WEAP training recorded by a qualified biologist specifically for the Project may be utilized if in-person trainings are restricted due to COVID-19 or if the construction schedule makes it infeasible for a biologist to train each new crew member in person. The crew foreman will be responsible to ensure crew members are aware of project boundaries and adhere to the guidelines and restrictions designed to avoid or minimize effects to CRLF, steelhead, nesting birds, and other sensitive species and biological resources.

BIO-2 Project Delineation, Staging Areas, Materials Storage, and Waste Management

Prior to the start of any Project activities (including any vegetation clearing), sturdy, high-visibility fencing should be installed to protect jurisdictional areas and sensitive resource areas adjacent to and within the Project Area. This fencing shall be placed so that unnecessary impacts to adjacent habitat are avoided. No Project activities (including storage of materials) should occur outside of the "Project Limits". The required fencing shall remain in place during the entire construction period and be maintained as needed by the contractor.

Areas of temporary disturbance shall be minimized to the extent practicable. Staging and laydown areas should be limited to sites that are unvegetated and previously disturbed (e.g., existing paved parking areas). Materials should be stored on impervious surfaces or plastic ground covers to prevent any spills or leakage. Material storage should be at least 50 feet from Moran Lagoon and the Pacific Ocean. Construction materials and spoils should be protected from stormwater runoff using temporary perimeter sediment barriers such as fiber rolls, sand/gravel bags, and straw bale barriers, as appropriate.

All trash should be properly contained and regularly disposed of such that it does not leave the Project site, enter any water body, or attract wildlife. Following Project completion, all trash and construction debris will be removed from the work and laydown areas.

BIO-3 Best Management Practices to Protect Water Quality

No construction activities should occur within wetted portions of any jurisdictional water body to the greatest extent practicable. Grading along the banks of Moran Lagoon may occur below the OHWM, as necessary for wetland restoration efforts, but will be conducted during times when the water level is below the OHWM (e.g., during the dry season and/or at low tide).

All vehicles and equipment should be in good working condition and checked daily for leaks. The contractor shall prevent petroleum products, or any other pollutant, from contaminating the soil or entering any water body. When vehicles or equipment are not in use, mats or drip pans should be placed below vehicles to contain fluid leaks.

Work during times of precipitation should be avoided to the maximum extent possible. The County or their contractor(s) or representative(s) shall utilize Best Management Practices (BMPs), including (but not limited to): berms, burlap-wrapped fiber rolls, jute netting, sand/gravel bags, and straw bale barriers to stabilize work areas and prevent any sediment or pollutants from entering the creek.

To further protect water quality and sensitive habitat areas, no refueling, cleaning, or maintenance of equipment or vehicles shall occur within 50 feet of Moran Lagoon or any other water body. Spill kits must be kept on the project site and readily available at all times. Should a spill occur in the work area, clean-up shall be conducted immediately, the contaminant(s) removed to the greatest extent feasible, and any contaminated materials disposed of properly. The project foreman or other designated liaison shall immediately notify the biological monitor and the County following any project spills. Additionally, the off-site tracking of loose construction and landscape materials shall be prevented and/or cleaned up daily, with street sweeping, vacuuming, and/or rumble plates, as appropriate.

These measures may be superseded or added to by resource agency permits. A Stormwater Pollution Prevention Plan may be prepared for the Project, if required by resource agencies.

BIO-4 Invasive Species Management

Prior to construction, Project plans will clearly identify methodology for removal and disposal of invasive exotic species found within the Project Area, including iceplant. Invasive vegetation removed within the Project Area shall be properly disposed of at an offsite location[7]. All construction materials (including jute netting, fiber rolls, and straw bales) brought into the Project Area should be free from invasive plant material. All revegetation efforts (e.g., hydroseeding, planting container stock or cuttings) surrounding the lagoon and lagoon inlet shall include only native plant species appropriate for the Project site and existing habitat. Eucalyptus trees may be planted in limited areas within existing groves, as necessary, to enhance or maintain monarch overwintering habitat. Invasive aquatic wildlife species, including bullfrog (*Rana catesbeiana*), and signal and red swamp crayfish (*Pacifasticus leniusculus*; *Procambarus clarkii),* should be removed from the Project Area by a qualified biologist using methodologies approved by the USFWS, NMFS, and/or CDFW.

[7] Eucalyptus trees or limbs removed from onsite groves may be utilized within the Project Area for informal seating, delineation of restoration areas, etc.

BIO-5 General Avoidance and Minimization Measures for Special-status Wildlife Species

A preconstruction survey for special-status wildlife species (including southwestern pond turtle, northern California legless lizard, pallid bat, and Townsend's big-eared bat) shall be conducted within the Project Area by a qualified biologist no more than 48 hours before the onset of work activities. This survey can be conducted concurrently with the preconstruction survey for CRLF. If any special-status wildlife species are found in areas where they are likely to be killed or injured by work activities, then a qualified biologist will be allowed sufficient time to relocate them from the Project Area before work begins. A qualified biologist will also be on site during any vegetation removal or initial ground disturbing activities. Should any special-status species be encountered within the Project Area prior to or during these activities, work shall be halted until the biologist has sufficient time to move any non-listed individuals from the site.

BIO-6 Avoidance and Minimization Measures for the Tidewater Goby

BMPs should be implemented (as described in AMM BIO-3) to prevent any changes to water quality within Moran Lagoon that could impact tidewater gobies.

Any grading or ground disturbance that occurs near the OHWM of Moran Lagoon should be conducted such that soil, sediment, and/or vegetation is pulled back away from the water's edge and is not pushed toward the lagoon or allowed to enter the water. Construction activities should not occur within 50 feet of the lagoon OHWM during rain events when greater than 0.25 inches of precipitation is predicted, or at times when the ocean has breached the lagoon (e.g., during king tides and/or large swell events). Wetland restoration may require some construction activity below the OHWM, but no Project activities should occur within any wetted portions of the lagoon. Therefore, work beneath the OHWM should only occur during times when the surface water level of the lagoon is substantially lower than the OHWM (likely during the dry season and on days when the high tides are not above 5 feet MLLW).

The Project may require a Biological Opinion and Incidental Take Statement from the USFWS, which would likely include further AMMs. The measures detailed above may be superseded or added to by resource agency permits and incidental take authorizations. Wetland restoration efforts are included in Project plans and will likely result in improved water quality and tidewater goby habitat within Moran Lagoon.

BIO-7 Avoidance and Minimization Measures for the California Red-legged Frog

A qualified biologist should survey potential CRLF habitat within the Project Area no more than 48 hours before the onset of work activities. If the biologist finds any life stage of the CRLF and these individuals are likely to be killed or injured by work activities, the biologist will contact the County immediately to discuss next steps (e.g., contacting the USFWS) before work can begin. Project activities will occur between June 1 and October 15, to the maximum extent possible, in order to avoid the CRLF breeding season. In the unlikely event that CRLFs are detected, the Project may require a Biological Opinion and Incidental Take Statement from the USFWS, which would likely include further AMMs. The measures detailed above may be superseded or added to by resource agency permits and incidental take authorizations, as applicable.

BIO-8 Avoidance and Minimization Measures for Special-status Birds and Other Nesting Birds

Project activities will likely occur during the nesting bird season (February 1 to September 15). As such, the following mitigation measures are recommended to reduce impacts to protected species (including the double-crested cormorant, osprey, and Cooper's hawk) and other nesting birds protected by CFGC and the MBTA.

- A preconstruction nesting bird survey shall be conducted by a qualified biologist no more than 14 days prior to initiation of Project activities. The survey shall be conducted within the Project Area and include a 50-foot buffer for passerines and a 500-foot buffer for raptors. The survey shall be conducted by a biologist familiar with the identification of avian species known to occur in the region and should focus on trees, vegetated areas, and other potential nesting within the vicinity of the Project Area. If nests are found, an appropriate avoidance buffer (typically 50 feet for passerine species and 500 feet for raptors) will be determined and demarcated by the biologist with high visibility material located within the Project Area.
- All Project personnel shall be notified as to the existence of the buffer zones and to avoid entering buffer zones during the nesting season. No Project activities shall occur within the buffer until the avian biologist has confirmed that breeding/nesting is complete, and the young have fledged the nest. Encroachment into the buffer shall occur only at the discretion of the qualified biologist.

BIO-9 Avoidance and Minimization Measures for Sensitive Plant Communities and Environmentally Sensitive Habitat Areas

In order to reduce potential impacts to sensitive pickleweeds mats, wetland habitat, riparian habitat, monarch overwintering habitat, and lagoon habitat, the following measures shall be implemented:

- Pickleweed mats within the Project Area will be identified and clearly marked by a qualified biologist prior to the start of construction activities. Impacts to this sensitive plant community will be avoided to the greatest extent feasible during all project activities, including the implementation of wetland restoration surrounding Moran Lagoon.
- Wetlands within 50 feet of any ground disturbance and/or construction-related activities (including staging and access roads) shall be identified and clearly marked by a qualified biologist. Impacts to existing wetland habitat will be limited to the grading, invasive plant removal, and planting activities necessary for implementation of wetland restoration areas. All other impacts from construction equipment and vehicles will be avoided.
- Work within wetlands will have the immediate work area fenced off to prevent equipment and personnel from further impacting portions of the wetland where no work is needed.
- All heavy construction equipment and vehicles shall be restricted to established roadways and access roads to the maximum extent practicable to minimize habitat disturbance. Wetland (i.e., rubber) mats shall be used when heavy equipment must be used outside of established roadways or access roads.
- All construction work within wetland areas will follow the methods and specifications of Project restoration plans and will maintain or improve existing wetland soils, hydrology, and vegetation within work areas.

6 Limitations, Assumptions, and Use Reliance

This Biological Resources Assessment has been performed in accordance with professionally accepted biological investigation practices conducted at this time and in this geographic area. The biological investigation is limited by the scope of work performed. Reconnaissance-level biological surveys for certain taxa were conducted as part of this assessment but were not performed during a particular nesting period, or particular portion of the season when positive identification would be expected if present, and therefore, cannot be considered definitive. The biological surveys are limited also by the environmental conditions present at the time of the surveys. In addition, general biological (or protocol) surveys do not guarantee that the organisms are not present and will not be discovered in the future within the site. In particular, mobile wildlife species could occupy the site on a transient basis or re-establish populations in the future. Our field studies were based on current industry practices, which change over time and may not be applicable in the future. No other guarantees or warranties, expressed or implied, are provided. The findings and opinions conveyed in this report are based on findings derived from the specified historical and literature sources (Section 2.1) and the biological surveys. Standard data sources relied upon during the completion of this report, such as the CNDDB, may vary with regard to accuracy and completeness. In particular, the CNDDB is compiled from research and observations reported to CDFW that may or may not have been the result of comprehensive or site-specific field surveys. Although Rincon believes the data sources are reasonably reliable, Rincon cannot and does not guarantee the authenticity or reliability of the data sources it has used. Additionally, pursuant to our contract, the data sources reviewed included only those that are practically reviewable without the need for extraordinary research and analysis.

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Appendix A

Regulatory Setting

Regulatory Setting

The following is a brief summary of the regulatory context under which biological resources are managed at the federal, State, and local levels. A number of federal and State statutes provide a regulatory structure that guides the protection of biological resources. Agencies with the responsibility for protection of biological resources within the Project site include the following:

- U.S. Army Corps of Engineers (wetlands and other waters of the United States)
- U.S. Fish and Wildlife Service (federally listed species and migratory birds)
- National Marine Fisheries Service (marine animals and anadromous fishes)
- Central Coast Regional Water Quality Control Board (waters of the State)
- California Department Fish and Wildlife (riparian areas, streambeds, and lakes; State-listed species; nesting birds, marine resources)
- County of Santa Cruz General Plan
- City of Santa Cruz General Plan

United States Army Corps of Engineers

The United States Army Corps of Engineers (USACE), is responsible for administering several federal programs related to ensuring the quality and navigability of the nation's waters.

Clean Water Act Section 404

Congress enacted the CWA "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Section 404 of the Clean Water Act (CWA) authorizes the Secretary of the Army, acting through the USACE, to issue permits regulating the discharge of dredged or fill materials into the "navigable waters at specified disposal sites."

Section 502 of the CWA further defines "navigable waters" as "waters of the United States, including the territorial seas." "Waters of the United States" are broadly defined at 33 CFR Part 328.3 to include navigable waters, perennial and intermittent streams, lakes, rivers, ponds, as well as wetlands, marshes, and wet meadows. In recent years the USACE and US Environmental Protection Agency (USEPA) have undertaken several efforts to modernize their regulations defining "waters of the United States" (e.g., the 2015 Clean Water Rule and 2020 Navigable Waters Protection Rule), but these efforts have been frustrated by legal challenges which have invalidated the updated regulations. Thus, the agencies' longstanding definition of "waters of the United States," which dates from 1986, remains in effect albeit with supplemental guidance interpreting applicable court decisions as described below.

Waters of the U.S.

In summary, USACE and USEPA regulations define "waters of the United States" as follows:

1. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

2. All interstate waters including interstate wetlands;
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
    i. Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
    ii. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    iii. Which are used or could be used for industrial purpose by industries in interstate commerce;
4. All impoundments of waters otherwise defined as waters of the United States;
5. Tributaries of waters identified in paragraphs (a)(1)-(4) of this section;
6. The territorial sea;
7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in items 1-6 above.

Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with the USEPA.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA are not waters of the United States.

The lateral limits of USACE jurisdiction in non-tidal waters is defined by the "ordinary high-water mark" (OHWM) unless adjacent wetlands are present. The OHWM is a line on the shore or edge of a channel established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed upon the bank, shelving, changes in the character of soil, destruction of vegetation, or the presence of debris (33 CFR 328.3(e)). As such, waters are recognized in the field by the presence of a defined watercourse with appropriate physical and topographic features. If wetlands occur within, or adjacent to, waters of the United States, the lateral limits of USACE jurisdiction extend beyond the OHWM to the outer edge of the wetlands (33 CFR 328.4 (c)). The upstream limit of jurisdiction in the absence of adjacent wetlands is the point beyond which the OHWM is no longer perceptible (33 CFR 328.4; see also 51 FR 41217.)

Wetlands

The USACE defines wetlands as “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (33 CFR 328.3). The USACE’s delineation procedures identify wetlands in the field based on indicators of three wetland parameters: hydrophytic vegetation, hydric soils, and wetland hydrology. The following is a discussion of each of these parameters.

Hydrophytic Vegetation

Hydrophytic vegetation dominates areas where frequency and duration of inundation or soil saturation exerts a controlling influence on the plant species present. Plant species are assigned wetland indicator status according to the probability of their occurring in wetlands. More than fifty percent of the dominant plant species must have a wetland indicator status to meet the hydrophytic vegetation criterion. The USACE published the National Wetland Plant List (USACE 2018), which separates vascular plants into the following four basic categories based on plant species frequency of occurrence in wetlands:

- **Obligate Wetland (OBL).** Almost always occur in wetlands
- **Facultative Wetland (FACW).** Usually occur in wetlands, but occasionally found in non-wetlands
- **Facultative (FAC).** Occur in wetlands or non-wetlands
- **Facultative Upland (FACU).** Usually occur in non-wetlands, but may occur in wetlands
- **Obligate Upland (UPL).** Almost never occur in wetlands

The USACE considers OBL, FACW and FAC species to be indicators of wetlands. An area is considered to have hydrophytic vegetation when greater than 50 percent of the dominant species in each vegetative stratum (tree, shrub, and herb) fall within these categories. Any species not appearing on the United States Fish and Wildlife Service's list is assumed to be an upland species, almost never occurring in wetlands. In addition, an area needs to contain at least 5% vegetative cover to be considered as a vegetated wetland.

Hydric Soils

Hydric soils are saturated or inundated for a sufficient duration during the growing season to develop anaerobic or reducing conditions that favor the growth and regeneration of hydrophytic vegetation. Field indicators of wetland soils include observations of ponding, inundation, saturation, dark (low chroma) soil colors, bright mottles (concentrations of oxidized minerals such as iron), gleying (indicates reducing conditions by a blue-grey color), or accumulation of organic material. Additional supporting information includes documentation of soil as hydric or reference to wet conditions in the local soils survey, both of which must be verified in the field.

Wetland Hydrology

Wetland hydrology is inundation or soil saturation with a frequency and duration long enough to cause the development of hydric soils and plant communities dominated by hydrophytic vegetation. If direct observation of wetland hydrology is not possible (as in seasonal wetlands), or records of wetland hydrology are not available (such as stream gauges), assessment of wetland hydrology is frequently supported by field indicators, such as water marks, drift lines, sediment deposits, or drainage patterns in wetlands.

Applicable Case Law and Agency Guidance

The USACE's regulations defining "waters of the United States" have been subject to legal interpretation, and two influential Supreme Court decisions have narrowed the definition to exclude certain classes of waters that bear an insufficient connection to navigable waters. In *Solid Waste Agency of Northern Cook County v. Army Corps of Engineers* (2001), the United States Supreme Court stated that the USACE's CWA jurisdiction does not extend to ponds that "are not adjacent to

open water." In reaching its decision, the Court concluded that the "Migratory Bird Rule," which served as the basis for the USACE's asserted jurisdiction, was not supported by the CWA. The Migratory Bird Rule extended CWA jurisdiction to intrastate waters "which are or would be used as habitat by birds protected by Migratory Bird Treaties or which are or would be used as habitat by other migratory birds which cross state lines…" The Court was concerned that application of the Migratory Bird Rule resulted in "reading the term 'navigable waters' out of the statute. Highlighting the language of the CWA to determine the statute's jurisdictional reach, the Court stated, "the term 'navigable' has at least the import of showing us what Congress had in mind as its authority for enacting the CWA: its traditional jurisdiction over waters that were or had been navigable in fact or which could reasonably be so made." This decision stands for the proposition that non-navigable isolated, intrastate waters are not waters of the United States and thus are not jurisdictional under the CWA.

In 2006 the United States Supreme Court decided *Rapanos v. United States* and *Carabell v. United States* (collectively "Rapanos"), which were consolidated cases determining the extent of CWA jurisdiction over waters that carry only an infrequent surface flow. The court issued no majority opinion in Rapanos. Instead, the justices authored five separate opinions including the "plurality" opinion, authored by Justice Scalia (joined by three other justices), and a concurring opinion by Justice Kennedy. To guide implementation of the decision, the USACE and USEPA issued a joint guidance memorandum ("Rapanos Guidance Memorandum") in 2008 stating that "regulatory jurisdiction under the CWA exists over a water body if either the plurality's or Justice Kennedy's standard is satisfied."

According to the plurality opinion in Rapanos, "the waters of the United States include only relatively permanent, standing or flowing bodies of water" and do not include "ordinarily dry channels through which water occasionally or intermittently flows." In addition, while all wetlands that meet the USACE definition are considered adjacent wetlands, only those adjacent wetlands that have a continuous surface connection because they directly abut the tributary (e.g., they are not separated by uplands, a berm, dike, or similar feature) are considered jurisdictional under the plurality standard.

Under Justice Kennedy's opinion, "the USACE's jurisdiction over wetlands depends upon the existence of a significant nexus between the wetlands in question and navigable waters in the traditional sense. Wetlands possess the requisite nexus, and thus come within the statutory phrase 'navigable waters,' if the wetlands, either alone or in combination with similarly situated lands in the region, significantly affect the chemical, physical, and biological integrity of other covered waters more readily understood as 'navigable.' When, in contrast, wetlands' effects on water quality are speculative or insubstantial, they fall outside the zone fairly encompassed by the statutory term 'navigable waters.'" Justice Kennedy identified "pollutant trapping, flood control, and runoff storage" as some of the critical functions wetlands can perform relative to other waters. He concluded that, given wetlands' ecological role, "mere adjacency" to a non-navigable tributary was insufficient to establish CWA jurisdiction, and that "a more specific inquiry, based on the significant nexus standard, is therefore necessary."

Interpreting these decisions, and according to the Rapanos Guidance Memorandum, the USACE and USEPA will assert jurisdiction over the following waters:

- Traditional navigable waters;
- Wetlands adjacent to traditional navigable waters;

- Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months); and,
- Wetlands that directly abut such tributaries.

The USACE and USEPA will decide jurisdiction over the following waters based on a fact-specific analysis to determine whether they have a significant nexus with a traditional navigable water:

- Non-navigable tributaries that are not relatively permanent;
- Wetlands adjacent to non-navigable tributaries that are not relatively permanent; and,
- Wetlands adjacent to but that do not directly abut a relatively permanent non-navigable tributary.

Where a significant nexus analysis is required, the USACE and USEPA will apply the significant nexus standard as follows:

- A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by all wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical and biological integrity of downstream traditional navigable waters; and,
- Significant nexus includes consideration of hydrologic and ecologic factors.

The USACE and USEPA generally will not assert jurisdiction over the following features:

- Swales or erosional features (e.g., gullies, small washes characterized by low volume, infrequent, or short duration flow); and,
- Ditches (including roadside ditches) excavated wholly in and draining only uplands and that do not carry a relatively permanent flow of water.

Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the USACE for the construction of any structure in or over any navigable water of the United States. Structures or work outside the limits defined for navigable waters of the United States require a Section 10 permit if the structure or work affects the course, location, or condition of the water body. The law applies to any dredging or disposal of dredged materials, excavation, filling, re-channelization, or any other modification of a navigable water of the United States, and applies to all structures and work. It further includes, without limitation, any wharf, dolphin, weir, boom breakwater, jetty, groin, bank protection (e.g. riprap, revetment, bulkhead), mooring structures such as pilings, aerial or subaqueous power transmission lines, intake or outfall pipes, permanently moored floating vessel, tunnel, artificial canal, boat ramp, aids to navigation, and any other permanent, or semi-permanent obstacle or obstruction. It is important to note that Section 10 applies only to navigable waters, and thus does not apply to work in non-navigable wetlands or tributaries. In some cases, Section 10 authorization is issued by the USACE concurrently with CWA Section 404 authorization, such as when certain Nationwide Permits are used.

Regional Water Quality Control Board

The State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards (RWQCBs) have jurisdiction over "waters of the State," which are defined as any surface water or groundwater, including saline waters, within the boundaries of the State (California Water Code sec. 13050(e)). These agencies also have responsibilities for administering portions of the CWA.

Clean Water Act Section 401

Section 401 of the CWA requires an applicant requesting a federal license or permit for an activity that may result in any discharge into navigable waters (such as a Section 404 Permit) to provide State certification that the proposed activity will not violate State and federal water quality standards. In California, CWA Section 401 Water Quality Certification (Section 401 Certification) is issued by the RWQCBs and by the SWRCB for multi-region Projects. The process begins when an applicant requests a pre-application meeting with the RWQCB, waits no less than 30 days, and then submits an application to the RWQCB and informs the USACE (or the applicable agency from which a license or permit was requested) that an application has been submitted. The USACE will then determine a "reasonable period of time" for the RWQCB to act on the application; this is typically 60 days for routine Projects and longer for complex Projects but may not exceed one year. Under current regulations, once initiated, the reasonable period of time cannot be stopped or paused. When the period has elapsed, if the RWQCB has not either issued or denied the application for Section 401 Certification, the USACE may determine that Certification has been waived and issue the requested permit. If a Section 401 Certification is issued it may include binding conditions, imposed either through the Certification itself or through the requested federal license or permit.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) is the principal law governing water quality regulation in California. It establishes a comprehensive program to protect water quality and the beneficial uses of water. The Porter-Cologne Act applies to surface waters, wetlands, and ground water and to both point and nonpoint sources of pollution. Pursuant to the Porter-Cologne Act (California Water Code section 13000 et seq.), the policy of the State is as follows:

- The quality of all the waters of the State shall be protected
- All activities and factors affecting the quality of water shall be regulated to attain the highest water quality within reason
- The State must be prepared to exercise its full power and jurisdiction to protect the quality of water in the State from degradation

The Porter-Cologne Act established nine RWQCBs (based on watershed boundaries) and the SWRCB, which are charged with implementing its provisions and which have primary responsibility for protecting water quality in California. The SWRCB provides program guidance and oversight, allocates funds, and reviews RWQCB decisions. In addition, the SWRCB allocates rights to the use of surface water. The RWQCBs have primary responsibility for individual permitting, inspection, and enforcement actions within each of nine hydrologic regions. The SWRCB and RWQCBs have numerous nonpoint source related responsibilities, including monitoring and assessment, planning, financial assistance, and management.

Section 13260 of the Porter-Cologne Act requires any person discharging or proposing to discharge waste that could affect the quality of waters of the State to file a Report of Waste Discharge with the appropriate RWQCB. The RWQCB may then authorize the discharge, subject to conditions, by issuing Waste Discharge Requirements (WDRs). While this requirement was historically applied primarily to outfalls and similar point source discharges, the SWRCB's *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State*, effective May 2020, make it clear that the agency will apply the Porter-Cologne Act's requirements to discharges of dredge and fill material as well. The *Procedures* state that they are to be used in issuing CWA Section 401 Certifications and WDRs, and largely mirror the existing review requirements for CWA Section 404 Permits and Section 401 Certifications, incorporating most elements of the USEPA's *Section 404(b)(1) Guidelines*. Following issuance of the *Procedures*, the SWRCB produced a consolidated application form for dredge/fill discharges that can be used to obtain a CWA Section 401 Water Quality Certification, WDRs, or both.

Non-Wetland Waters of the State

The SWRCB and RWQCBs have not established regulations for field determinations of waters of the State except for wetlands currently. In many cases the RWQCBs interpret the limits of waters of the State to be bounded by the OHWM unless isolated conditions or ephemeral waters are present. However, in the absence of statewide guidance each RWQCB may interpret jurisdictional boundaries within their region and the SWRCB has encouraged applicants to confirm jurisdictional limits with their RWQCB before submitting applications. As determined by the RWQCB, waters of the State may include riparian areas or other locations outside the OHWM, leading to a larger jurisdictional area over a given water body compared to the USACE.

Wetland Waters of the State

Procedures for defining wetland waters of the State pursuant to the SWRCB's *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State* went into effect May 28, 2020. The SWRCB defines an area as wetland if, under normal circumstances:

(i) the area has continuous or recurrent saturation of the upper substrate caused by groundwater, or shallow surface water, or both;

(ii) the duration of such saturation is sufficient to cause anaerobic conditions in the upper substrate; and

(iii) the area's vegetation is dominated by hydrophytes or the area lacks vegetation.

The SWRCB's *Implementation Guidance for the Wetland Definition and Procedures for Discharges of Dredge and Fill Material to Waters of the State* (2020), states that waters of the U.S. and waters of the State should be delineated using the standard USACE delineation procedures, taking into consideration that the methods shall be modified only to allow for the fact that a lack of vegetation does not preclude an area from meeting the definition of a wetland.

United States Fish and Wildlife Service

The United States Fish and Wildlife Service (USFWS) implements several laws protecting the Nation's fish and wildlife resources, including the Endangered Species Act (ESA; 16 United States Code [USC] Sections 153 et seq.), the Migratory Bird Treaty Act (MBTA; 16 USC Sections 703-711) and the Bald and Golden Eagle Protection Act (16 USC Section 668).

Endangered Species Act

The USFWS and National Marine Fisheries Service (NMFS) share responsibility for implementing the ESA. Generally, the USFWS implements the FESA for terrestrial and freshwater species, while the NMFS implements the FESA for marine and anadromous species. Projects that would result in "take" of any threatened or endangered animal species, or a threatened or endangered plant species if occurring on federal land, are required to obtain permits from the USFWS or NMFS through either Section 7 (interagency consultation with a federal nexus) or Section 10 (Habitat Conservation Plan) of the ESA, depending on the involvement by the federal government in funding, authorizing, or carrying out the project. The permitting process is used to determine if a project would jeopardize the continued existence of a listed species and what measures would be required to avoid jeopardizing the species. "Take" under federal definition means to harass, harm (which includes habitat modification), pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Proposed or candidate species do not have the full protection of the ESA; however, the USFWS and NMFS advise project applicants that they could be elevated to listed status at any time.

Migratory Bird Treaty Act

The MBTA of 1918 implements four international conservation treaties that the U.S. entered into with Canada in 1916, Mexico in 1936, Japan in 1972, and Russia in 1976. It is intended to ensure the sustainability of populations of all protected migratory bird species. The law has been amended with the signing of each treaty, as well as when any of the treaties were amended, such as with Mexico in 1976 and Canada in 1995. The MBTA prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the USFWS.

The list of migratory bird species protected by the law, in regulations at 50 CFR Part 10.13, is primarily based on bird families and species included in the four international treaties. A migratory bird species is included on the list if it meets one or more of the following criteria:

1. It occurs in the United States or U.S. territories as the result of natural biological or ecological processes and is currently, or was previously listed as, a species or part of a family protected by one of the four international treaties or their amendments.
2. Revised taxonomy results in it being newly split from a species that was previously on the list, and the new species occurs in the United States or U.S. territories as the result of natural biological or ecological processes.
3. New evidence exists for its natural occurrence in the United States or U.S. territories resulting from natural distributional changes and the species occurs in a protected family.

In 2004, the Migratory Bird Treaty Reform Act limited the scope of the MBTA by stating the MBTA applies only to migratory bird species that are native to the United States or U.S. territories, and that a native migratory bird species is one that is present as a result of natural biological or ecological processes. The MBTRA requires the USFWS to publish a list of all nonnative, human-introduced bird species to which the MBTA does not apply, and an updated list was published in 2020. The 2020 update identifies species belonging to biological families referred to in treaties the MBTA implements but are not protected because their presence in the United States or U.S. territories is solely the result of intentional or unintentional human-assisted introductions.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act prohibits anyone, without a permit issued by the USFWS, from "taking" bald or golden eagles, including their parts (including feathers), nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

"Disturb" means “to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death or nest abandonment.

California Department of Fish and Wildlife

The California Department of Fish and Wildlife (CDFW) derives its authority from the Fish and Game Code of California and administers several State laws protecting fish and wildlife resources and the habitats upon which they depend.

California Endangered Species Act

The California Endangered Species Act (CESA) (Fish and Game Code Section 2050 et. seq.) prohibits take of state listed threatened or endangered. Take under CESA is defined as “Hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill” (Fish and Game Code sec. 86). This definition does not prohibit indirect harm by way of habitat modification, except where such harm is the proximate cause of death of a listed species. Where incidental take would occur during construction or other lawful activities, CESA allows the CDFW to issue an Incidental Take Permit upon finding, among other requirements, that impacts to the species have been minimized and fully mitigated. Unlike the federal ESA, CESA’s protections extend to candidate species during the period (typically one year) while the California Fish and Game Commission decides whether the species warrants CESA listing.

Native Plant Protection Act

The CDFW also has authority to administer the Native Plant Protection Act (NPPA) (Fish and Game Code Section 1900 et seq.). The NPPA requires the CDFW to establish criteria for determining if a species, subspecies, or variety of native plant is endangered or rare, and prohibits the take of listed plant species. Effective in 2015, CDFW promulgated regulations (14 CCR 786.9) under the authority of the NPPA, establishing that the CESA’s permitting procedures would be applied to plants listed

under the NPPA as "Rare." With this change, there is little practical difference for the regulated public between plants listed under CESA and those listed under the NPPA.

Fully Protected Species Laws

The CDFW enforces Sections 3511, 4700, 5050, and 5515 of the Fish and Game Code, which prohibit take of species designated as Fully Protected. The CDFW is not allowed to issue an Incidental Take Permit for Fully Protected species; therefore, impacts to these species must be avoided. The exception is situations where a Natural Community Conservation Plan (NCCP) is in place that authorizes take of the fully protected species.

Avian Protection Laws

California Fish and Game Code sections 3503, 3503.5, and 3513 describe unlawful take, possession, or destruction of native birds, nests, and eggs. Section 3503.5 of the Code protects all birds-of-prey and their eggs and nests against take, possession, or destruction of nests or eggs. Section 3513 makes it a state-level offense to take any bird in violation of the federal Migratory Bird Treaty Act.

Protection of Lakes and Streambeds

California Fish and Game Code section 1602 states that it is unlawful for any person to "substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake" without first notifying the California Department of Fish and Wildlife (CDFW) of that activity. Thereafter, if CDFW determines and informs the entity that the activity will not substantially adversely affect any existing fish or wildlife resources, the entity may commence the activity. If, however, CDFG determines that the activity may substantially adversely affect an existing fish or wildlife resource, the entity may be required to obtain from CDFW a Streambed Alteration Agreement (SAA), which will include reasonable measures necessary to protect the affected resource(s), before the entity may conduct the activity described in the notification. Upon receiving a complete Notification of Lake/Streambed Alteration, CDFW has 60 days to present the entity with a Draft SAA. Upon review of the Draft SAA by the applicant, any problematic terms are negotiated with CDFW and a final SAA is executed.

The CDFW has not defined the term “stream” for the purposes of implementing its regulatory program under Section 1602, and the agency has not promulgated regulations directing how jurisdictional streambeds may be identified, or how their limits should be delineated. However, four relevant sources of information offer insight as to the appropriate limits of CDFW jurisdiction as discussed below.

- **The plain language of Section 1602 of CFGC** establishes the following general concepts:
  - References “river,” “stream,” and “lake”
  - References “natural flow”
  - References “bed,” “bank,” and “channel”
- **Applicable court decisions**, in particular *Rutherford v. State of California* (188 Cal App. 3d 1276 (1987), which interpreted Section 1602’s use of “stream” to be as defined in common law. The Court indicated that a “stream” is commonly understood to:
  - Have a source and a terminus

  - Have banks and a channel
  - Convey flow at least periodically, but need not flow continuously and may at times appear outwardly dry
  - Represent the depression between the banks worn by the regular and usual flow of the water
  - Include the area between the opposing banks measured from the foot of the banks from the top of the water at its ordinary stage, including intervening sand bars
  - Include the land that is covered by the water in its ordinary low stage
  - Include lands below the OHWM

- **CDFW regulations** defining "stream" for other purposes, including sport fishing (14 CCR 1.72) and streambed alterations associated with cannabis production (14 CCR 722(c)(21)), which indicate that a stream:
  - Flows at least periodically or intermittently
  - Flows through a bed or channel having banks
  - Supports fish or aquatic life
  - Can be dry for a period of time
  - Includes watercourses where surface or subsurface flow supports or has supported riparian vegetation

- **Guidance documents**, *including A Field Guide to Lake and Streambed Alteration Agreements* (CDFG 1994) and *Methods to Describe and Delineate Episodic Stream Processes on Arid Landscapes for Permitting Utility-Scale Solar Power Plants* (Brady and Vyverberg 2013), which suggest the following:
  - A stream may flow perennially or episodically
  - A stream is defined by the course in which water currently flows, or has flowed during the historic hydrologic course regime (approximately the last 200 years)
  - Width of a stream course can reasonably be identified by physical or biological indicators
  - A stream may have one or more channels (single thread vs. compound form)
  - Features such as braided channels, low-flow channels, active channels, banks associated with secondary channels, floodplains, islands, and stream-associated vegetation, are interconnected parts of the watercourse
  - Canals, aqueducts, irrigation ditches, and other means of water conveyance can be considered streams if they support aquatic life, riparian vegetation, or stream-dependent terrestrial wildlife
  - Biologic components of a stream may include aquatic and riparian vegetation, all aquatic animals including fish, amphibians, reptiles, invertebrates, and terrestrial species which derive benefits from the stream system
  - The lateral extent of a stream can be measured in different ways depending on the particular situation and the type of fish or wildlife resource at risk

The tenets listed above, among others, are applied to establish the boundaries of streambeds in various environments. Importance of each factor may be weighted based on site-specific considerations and the applicability of the indicators to the streambed at hand.

The California Coastal Act

The California Coastal Act (Public Resources Code Division 20, 1976) declares that the California coastal zone is a distinct and valuable natural resource of vital and enduring interest to all the people and exists as a delicately balanced ecosystem. As such, development within the coastal zone requires a Coastal Development Permit from either the California Coastal Commission or a local government. Coastal Development Permits are the regulatory mechanism by which proposed developments in the coastal zone are brought into compliance with the policies of Chapter 3 of the Coastal Act. After the Commission certifies a Local Coastal Program, most coastal development permit authority is delegated, and coastal development permit applications are then reviewed and acted on by cities and counties (in this case, the Santa Cruz County Local Coastal Program).

Section 30107.5 of the Coastal Act defines Environmentally Sensitive Habitat Areas (ESHA) as areas in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem, and which could be easily disturbed, degraded, or enhanced by human activities and developments. The Coastal Act states that resource extraction, development, and sales or transfers should be limited or prohibited in ESHA in order to ensure that these areas remain intact (especially Sections 30240, 30233, 30263, and 30609.5). These areas must be protected against habitat disruption, including land use and development that are adjacent to ESHA and may impact such areas. Under the Coastal Act, only uses that are dependent on ESHA resources shall be allowed in ESHA.

The California Coastal Act mandates that local governments prepare a land use plan and schedule of implementing actions to carry out the policies of the Coastal Act. The County of Santa Cruz Local Coastal Program is incorporated into the County's General Plan and represents the County's commitment to implement the Coastal Act through both General Plan policies and identification of detailed land use recommendations.

County of Santa Cruz General Plan and Local Coastal Program

Chapter 5: Conservation and Open Space

Objective 5.1 Biological Diversity

5.1.1 Sensitive Habitat Designation (Local Coastal Program [LCP]) Designate the following areas as sensitive habitats: (a) areas shown on the County General Plan and LCP Resources and Constraints Maps; (b) any undesignated areas which meet the criteria (policy 5.1.2) and which are identified through the biotic review process or other means; and (c) areas of biotic concern as shown on the Resources and Constraints Maps which contain concentrations of rare, endangered. threatened or unique species.

5.1.2 Definition of Sensitive Habitat (LCP) An area is defined as a sensitive habitat if it meets one or more of the following criteria: (a) Areas of special biological significance as identified by the state Water Resources Control Board. (b) Areas which provide habitat for locally unique biotic species/communities, including coastal scrub, maritime chaparral, native rhododendrons and associated Elkgrass, mapped grasslands in the coastal zone and sand parkland; and Special Forests including San Andreas Live Oak Woodlands, Valley Oak, Santa Cruz Cypress, indigenous Ponderosa Pine, indigenous Monterey Pine and ancient forests. (c) Areas adjacent to essential habitats of rare,

endangered or threatened species as defined in (e) and (f) below. (d) Areas which provide habitat for Species of Special Concern as listed by the California Department of Fish and Game in the Special Animals list, Natural Diversity Database. (e) Areas which provide habitat for rare or endangered species which meet the definition of Section 15380 of the California Environmental Quality Act guidelines. (f) Areas which provide habitat for rare, endangered or threatened species as designated by the State Fish and Game Commission, United States Fish and Wildlife Service or California Native Plant Society. (g) Nearshore reefs, rocky intertidal areas, sea caves, islets, offshore rocks, kelp beds, marine mammal hauling grounds, sandy beaches, shorebird roosting, resting and nesting areas, cliff nesting areas and marine. wildlife or educational research reserves. (h) Dune plant habitats. (i) All lakes, wetlands, estuaries, lagoons, streams and rivers. (j) Riparian corridors. (See Appendix B for a list of specific habitats and/or species.)

5.1.3 Environmentally Sensitive Habitats (LCP) Designate the areas described in 5.1.2 (d) through (j) as Environmentally Sensitive Habitats per the California Coastal Act and allow only uses dependent on such resources in these habitats within the Coastal Zone unless other uses are: (a) consistent with sensitive habitat protection policies and serve a specific purpose beneficial to the public; (b) it is determined through environmental review that any adverse impacts on the resource will be completely mitigated and that there is no feasible less-damaging alternative; and (c) legally necessary to allow a reasonable economic use of the land, and there is no feasible less damaging alternative.

5.1.4 Sensitive Habitat Protection Ordinance (LCP) Implement the protection of sensitive habitats by maintaining the existing Sensitive Habitat Protection ordinance. The ordinance identifies sensitive habitats, determines the uses which are allowed in and adjacent to sensitive habitats, and specifies required performance standards for land in or adjacent to these areas. Any amendments to this ordinance shall require a finding that sensitive habitats shall be afforded equal or greater protection by the amended language.

5.1.5 Land Division and Density Requirements in Sensitive Habitats (LCP) Allow land divisions in sensitive habitats only when the density and design of the subdivision ate compatible with protection of these resources as determined by environmental assessment and applicable County land use and zoning standards. Apply the following land division and density standards to the habitats listed: (a) Grasslands-Prohibit land division of native and mixed native grassland habitat mapped in the Coastal Zone unless the area to be divided is removed from the mapped grassland habitat area by General Plan-Local Coastal Program amendment. On parcels with existing mapped native and mixed native grasslands and which contain developable land outside those habitats, allow development at the lowest density of the land use designation and require that development be clustered and located outside the habitat areas. Allow one single family dwelling unit per existing parcel of record. Where property owners upgrade grasslands on their parcels outside of mapped areas, through resource management activities, the prevailing General Plan densities shall not be reduced. (b) Special Forests- Prohibit land divisions within designated Special Forests unless the area to be divided is removed from the mapped special forests habitat area by General Plan-Local Coastal Plan amendment. On parcels with existing mapped special forest areas which contain developable land outside that habitat. allow development at the lowest density of the land use designation and require that development be clustered and located outside the habitat areas. Allow one single family dwelling unit per existing parcel of record. Where property owners upgrade special forest areas on their parcels. outside of mapped areas, through resource management activities. the prevailing General Plan densities shall not be reduced.

5.1.6 Development Within Sensitive Habitats (LCP) Sensitive habitats shall be protected against any significant disruption of habitat values; and any proposed development within or adjacent to these areas must maintain or enhance the functional capacity of the habitat. Reduce in scale, redesign, or, if no other alternative exists, deny any project which cannot sufficiently mitigate significant adverse impacts on sensitive habitats unless approval of a project is legally necessary to allow a reasonable use of the land.

5.1.7 Site Design and Use Regulations (LCP) Protect sensitive habitats against any significant disruption or degradation of habitat values in accordance with the Sensitive Habitat Protection ordinance. Utilize the following site design and use regulations on parcels containing these resources. excluding existing agricultural operations: (a) Structures shall be placed as far from the habitat as feasible. (b) Delineate development envelopes to specify location of development in minor land divisions and subdivisions. (c) Require easements, deed restrictions, or equivalent measures to protect that portion of a sensitive habitat on a project parcel which is undisturbed by a proposed development activity or to protect sensitive habitats on adjacent parcels. (d) Prohibit domestic animals where they threaten sensitive habitats. (e) Unlit removal of native vegetation to the minimum amount necessary for structures, landscaping. driveways, septic systems and gardens; (f) Prohibit landscaping with invasive or exotic species and encourage the use of characteristic native species.

5.1.8 Chemicals Within Sensitive Habitats (LCP) Prohibit the use of insecticides, herbicides, or any toxic chemical substance in sensitive habitats, except when an emergency has been declared, when the habitat itself is threatened, when a substantial risk to public health and safety exists, including maintenance for flood control by Public Works, or when such use is authorized pursuant to a permit issued by the Agricultural Commissioner.

5.1.9 Biotic Assessments (LCP) Within 1he following areas, require a biotic assessment as part of normal project review to determine whether a full biotic report should be prepared by a qualified biologist: (a) Areas of biotic concern. mapped; (b) Sensitive habitats, mapped & unmapped.

5.1.10 Species Protection (LCP) Recognize that habitat protection is only one aspect of maintaining biodiversity and that certain wildlife species, such as migratory birds, may not utilize specific habitats. Require protection of these individual rare, endangered and threatened species and continue to update policies as new information becomes available.

5.1.11 Wildlife Resources Beyond Sensitive Habitats (LCP) For areas which may not meet the definition of sensitive habitat contained in policy 5.1.2, yet contain valuable wildlife resources (such as migration corridors or exceptional species diversity), protect these wildlife habitat values and species using the techniques outlined in policies 5.1.5 and 5.1. 7 and use other mitigation m~ identified through the environmental review process.

5.1.12 Habitat Restoration With Development Approval (LCP) Require as a condition of development approval, restoration of any area of the subject property which is an identified degraded sensitive habitat, with the magnitude of restoration to be commensurate with the scope of the project Such conditions may include erosion control measures, removal of non-native or invasive species, planting with characteristic native species, diversion of polluting run-off, water impoundment, and other appropriate means. The object of habitat restoration activities shall be to enhance the functional capacity and biological productivity of the habitat(s) and whenever feasible, to restore them to a condition which can be sustained by natural occurrences, such as tidal flushing of lagoons.

5.1.13 Habitats Damaged from Code Violations (LCP) In all cases where a sensitive habitat has been damaged as a result of a code violation, require that restoration of damaged areas be undertaken in compliance with all necessary permits and that the size of the restored area be in compliance with Department of Fish and Game requirements. Such restoration shall include monitoring over time to ensure the success of the restoration effort.

5.1.14 Removal of Invasive Plant Species (LCP) Encourage the removal of invasive species and their replacement with characteristic native plants, except where such invasive species provide significant habitat value and where removal of such species would severely degrade the existing habitat. In such cases, develop long-term plans for gradual conversion to native species providing equal or better habitat values.

5.1.15 Priorities for Restoration Funding (LCP) Use the following criteria for establishing funding priorities among restoration projects: (a) Biological significance of the habitat, including productivity, diversity, uniqueness of area, presence of rare, endangered or unique species, or regional importance (e.g., waterfowl resting, etc.). (b) Degree of endangerment from development or other activities, and vulnerability to overuse or misuse.

Objective 5.2 Riparian Corridors and Wetlands

5.2.1 Designation of Riparian Corridors and Wetlands (LCP) Designate and define the following areas as Riparian Corridors: (a) 50' from the top of a distinct channel or physical evidence of high water mark of a perennial stream; (b) 30' from the top of a distinct channel or physical evidence of high water mark of an intermittent stream as designated on the General Plan maps and through field inspection of undesignated intermittent and ephemeral streams; , (c) 100' of the high water mark of a lake, wetland, estuary, lagoon. or natural body of standing water; (d) The landward limit of a riparian woodland plant community; (e) Wooded arroyos within urban areas. Designate and define the following areas as Wetlands: Transitional areas between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water periodically or permanently. Examples of wetlands are saltwater marshes, freshwater marshes, open or closed brackish water marshes, swamps. mudflats, and fens. The US Army Corps of Engineers. and other federal agencies utilize a "unified methodology" which defines wetlands as "those areas ~ certain criteria for hydrology, vegetation, and soils."

5.2.2 Riparian Corridor and Wetland Protection Ordinance (LCP) Implement the protection of Riparian Corridors and Wetlands through the Riparian Corridor and Wetland Protection ordinance to ensure no net loss of riparian corridors and riparian wetlands. The ordinance identifies and defines riparian corridors and wetlands, determines the uses which are allowed in and adjacent to these habitats, and specifies required buffer setbacks and performance standards for land in and adjacent to these areas. Any amendments to this ordinance shall require a finding that riparian corridors and wetlands shall be afforded equal or greater protection by the amended language.

5.2.3 Activities Within Riparian Corridors and Wetlands (LCP) Development activities, land alteration and vegetation disturbance within riparian corridors and wetlands and required buffers shall be prohibited unless an exception is granted per the Riparian Corridor and Wetlands Protection ordinance. As a condition of riparian exception, require evidence of approval for development from the US Army Corps of Engineers, California Department of Fish and Game, and other federal or state agencies that may have regulatory authority over activities within riparian corridors and wetlands.

5.2.4 Riparian Corridor Buffer Setback (LCP) Require a buffer setback from riparian corridors in addition to the specified distances found in the definition of riparian corridor. This setback shall be identified in the Riparian Corridor and Wetland Protection ordinance and established based on stream characteristics, vegetation and slope. Allow reductions to the buffer setback only upon approval of a riparian exception. Require a 10-foot separation from the edge of the riparian corridor buffer to any structure.

5.2.5 Setbacks From Wetlands (LCP) Prohibit development within the 100 foot riparian corridor of all wetlands. Allow exceptions to this setback only where consistent with the Riparian Corridor and Wetlands Protection ordinance, and in all cases, maximize distance between proposed structures and wetlands. Require measures to prevent water quality degradation from adjacent land uses, as outlined in the Water Resources section.

5.2.6 Riparian Corridors and Development Density (LCP) Exclude land within riparian corridors in the calculation of development density or net panel size. Grant full density credit for the portion of the property outside 1he riparian corridor which is· within the required buffer setback, excluding areas over 30% slope, up to a maximum of 50% of the total area of the property which is outside the riparian corridor. (See policy 5.11.2.)

5.2. 7 Compatible Uses With Riparian Corridors (LCP) Allow compatible uses in and adjacent to riparian corridors that do not impair or degrade the riparian plant and animal systems, or water supply values, such as non-motorized recreation and pedestrian trails, parks, interpretive facilities and fishing facilities. Allow development in these areas only in conjunction with approval of a riparian exception.

5.2.8 Environmental Review for Riparian Corridor and Wetland Protection (LCP) Require environmental review of all proposed development projects affecting riparian corridors or wetlands and preparation of an Environmental Impact Report or Biotic Report for projects which may have a significant effect on the corridors or wetlands.

5.2.9 Management Plans for Wetland Protection (LCP) Require development in or adjacent to wetlands to incorporate the recommendations of a management plan which evaluates: migratory waterfowl use December 1 to April30; compatibility of agricultural use and biotic and water quality protection: maintenance of biologic productivity and diversity; and the permanent protection of adjoining uplands.

5.2.10 Development in Wetland Drainage Basins (LCP) Require development projects in wetland drainage basins to include drainage facilities or Best Management Practices (BMPs) which will maintain surface runoff patterns and water quality, unless a wetland management plan specifies otherwise, and minimize erosion, sedimentation, and introduction of pollutants.

5.2.11 Breaching of Lagoon, River, Stream or Creek Sandbars (LCP) Do not permit breaching of lagoon sandbars unless the breaching is consistent with an approved management plan for that wetland, river, stream, or creek system.

Objective 5.3 Aquatic and Marine Habitats

5.3.1 Support the Monterey Bay Sanctuary (LCP) Support the mission of the Monterey Bay National Marine Sanctuary to facilitate the long-term management, protection, understanding and awareness of its resources and qualities.

5.3.2 Protecting Shorebird Nesting Sites (LCP) Discourage all activities within 100 feet of shorebird nesting sites during nesting season (March-July). Prohibit dogs from beaches having nesting sites.

5.3.3 Davenport Pier, Rock Cliffs and Outcrops (LCP) Maintain low intensity use, such as nature observation and educational instruction on and adjacent to the Davenport Pier, Rock Cliffs and rock outcrops.

5.3.4 Coastal Dunes and Strand (LCP) Prohibit off-road vehicle use in the coastal dunes and strand, and discourage other uses with the potential to degrade dune habitat. Where trails through dunes are permitted, utilize wooden boardwalks or other techniques to minimize damage to dune habitat

5.3.5 Anadromous Fish Streams Require new water diversions. dams and reservoirs which are constructed on anadromous fish streams to be designed to protect fish populations and to provide adequate flow levels for successful fish production.

5.3.6 Marine Mammal Hauling Grounds (LCP) Prevent access to the bluff top observation points likely to cause disturbance to animals. Discourage access to immediately adjacent beach areas where necessary to minimize disturbance by roping off sensitive areas and posting explanatory signs along fence lines and restricted paths. Fence where necessary to prevent marine mammals from crossing Highway One.

Objective 5.4 Monterey Bay and Coastal Water Quality

5.4.1 Protecting the Monterey Bay National Marine Sanctuary from Adverse Impacts (LCP) Prohibit activities which could adversely impact sensitive habitats of the Monterey Bay National Marine Sanctuary, including the discharge of wastes and hazardous materials. The main sources of concern are wastewater discharge, urban runoff, toxic agricultural drainage water, including that originating outside of Santa Cruz County, and the accidental release of oil or other hazardous material from coastal tanker traffic.

5.4.2 Definition of Wastewater (LCP) Identify “wastewater” as all domestic and municipal sewage and other potentially toxic and/or hazardous materials or effluent resulting from industrial processes or other sources including brine from desalinization plants. Wastewater includes petrochemical compounds, “drilling mud" and associated potentially hazardous substances which may be directly or indirectly discharged into Monterey Bay or other coastal waters of Santa Cruz County as a result of exploratory or other oil drilling. Wastewater shall not include storm water runoff, unless so determined by the California Regional Water Quality Control Board.

5.4.3 Wastewater Discharges Into Coastal Waters (LCP) Require a review of any new and/or increased wastewater discharge into the Monterey Bay or other coastal waters to address the potential marine water quality impacts and determine necessary mitigations.

5.4.4 Disclosure of Chemical and Biological Characteristics of Wastewater (LCP) Require full disclosure of the projected chemical and biological characteristics of all proposed new and/or expansion of wastewater discharges to the Monterey Bay or other coastal waters of Santa Cruz County. Require full disclosure of the projected chemical and biological characteristics of wastewater entering treatment and pretreatment facilities connected with new and/or expansion of wastewater discharges to Monterey Bay or other coastal waters of Santa Cruz County. Particular areas of concern include toxic chemicals, toxic metals, bacteria, virus and other constituents identified as threats to the health and safety of coastal waters.

5.4.5 Levels of Wastewater Treatment (LCP) Require complete information on levels of treatment proposed at the treatment and pretreatment facilities to remove those constituents identified or anticipated in all proposed new and/or expansion of wastewater discharges to the Monterey Bay

and other coastal waters of Santa Cruz County. This information shall also include reliability and efficiency data of the proposed treatment.

5.4.6 Monitoring Wastewater Treatment (LCP) Require a comprehensive monitoring plan for testing of wastewater at treatment and pretreatment facilities for critical constituents or indicators identified or anticipated in all proposed new and/or increased wastewater discharges into the Monterey Bay and other coastal waters.

5.4.7 Location and Methods of Wastewater Discharge (LCP) Require oceanographic studies to determine the most suitable location and methods for wastewater discharge into the Monterey Bay or coastal waters.

5.4.8 Baseline Tests for Wastewater Discharge Sites (LCP) Require tests of ocean waters at proposed wastewater discharge sites and surrounding waters to establish baseline or background levels of toxic chemicals, toxic metals, bacteria and other water quality constituents. These tests must be performed no more than one year prior to submittal of the proposal. Historical data may not be substituted for this requirement.

5.4.9 Toxicity Studies for Proposed Wastewater Discharges (LCP) Require toxicity studies to determine the impacts of the proposed wastewater discharges on marine life, as well as on recreational uses of the coastal waters.

5.4.10 New and/or Increased Wastewater Discharges (LCP) Approve new and/or increased wastewater discharges only if they will not degrade marine habitats; will not create hazardous or dangerous conditions; and will not produce levels of pollutants that exceed any applicable local, state or federal water quality standards.

5.4.11 Land Disposal of Wastewater (LCP) Encourage land disposal of wastewater after adequate treatment to State wastewater reclamation standards to assist in recharging groundwater aquifers and maintaining higher summer stream flows.

5.4.12 Disturbances of Coastal Waters, Wetlands, Estuaries and Lakes (LCP) Prohibit the diking, filling and dredging of open coastal waters, wetlands, estuaries, and lakes. Allow exceptions only for the following purposes and only where there is no other feasible, less environmentally damaging alternative: (a) Incidental public service purposes, including, but not limited to burying cables and pipes or inspection of piers and maintenance of existing intake and outfall lines. (b) Restoration purposes, including the protection and enhancement of existing harbors, and where the activity will maintain and enhance the functional capacity of the wetland or estuary as determined through the County environmental review process in conjunction with the California Department of Fish and Game and U.S. Anny Corps of Engineers. (c) Nature study, aquaculture, or similar resource-dependent activities.

5.4.13 Redistribution of Dredged Materials (LCP) Require the redistribution of dredged materials into the same littoral cell from which it was taken in an effort to continue beach replenishment as long as the materials are suitable and non-toxic and the deposition of the materials will not adversely affect marine environments or recreational uses. The deposition of such materials must be timed and located so as not to interfere with shoreline processes, longshore current systems, and public beach use.

5.4.14 Water Pollution from Urban Runoff (LCP) Review proposed development projects for their potential to contribute to water pollution via increased storm water runoff. Utilize erosion control measures, on-site detention and other appropriate storm water best management practices to reduce pollution from urban runoff.

Objective 5.7 Maintaining Surface Water Quality

5.7.1 Impacts From New Development On Water Quality (LCP) Prohibit new development adjacent to marshes, streams and bodies of water if such development would cause adverse impacts on water quality which cannot be fully mitigated

5.7.2 Minimum Septic System Setback From Natural Waterways (LCP) Prohibit installation of septic tanks or leach fields within 100 feet of all natural waterways including perennial or intermittent streams, seasonal water channels and natural bodies of standing water. An exception may be made for the repair of existing systems, if the 100-foot setback cannot be maintained, and adequate provisions are made for water quality protection.

5.7.3 Erosion Control For Stream and Lagoon Protection (LCP) For all new and existing development and land disturbances, require the installation and maintenance of sediment basins, and/or other strict erosion control measures, as needed to prevent siltation of streams and coastal lagoons. (Also see Erosion policies in section 6.3.)

5.7.4 Control Surface Runoff (LCP) New development shall minimize the discharge of pollutants into surface water drainage by providing the following improvements or similar methods which provide equal or greater runoff control: (a) include curbs and gutters on arterials, collectors and locals consistent with adopted urban street designs; and (b) oil, grease and silt traps for parking lots, land divisions or commercial and industrial development

5.7.5 Protecting Riparian Corridors and Coastal Lagoons (LCP) Require drainage facilities, including curbs and gutters in urban areas, as needed to protect water quality for all new development within 1000 feet of riparian corridors or coastal lagoons.

5.7.6 Maintaining Saltwater Inflow to Coastal Lagoons (LCP) Prohibit new development, site alteration or road projects adjacent to coastal lagoons unless it can be demonstrated that such projects will not restrict, impound or otherwise interfere with the natural drainage patterns and tidal circulation.

5.7.7 Stormwater Discharge Permit Requirements (LCP) Once the State and Regional Water Quality Control Boards promulgate new stormwater discharge permit requirements for municipal and industrial stormwater systems, obtain appropriate permits for all existing storm drainage systems and proposed drainage facilities and adhere to best management practices.

5.7.8 Animal Keeping Require all stables and other animal keeping operations to be managed to prevent discharge of sediment, nutrients, and contaminants to surface and groundwater.

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Appendix B

Site Photographs



Photograph 1. View of the southern extent of Moran Lagoon and the box culvert beneath East Cliff Drive, facing southwest. November 11, 2021.



Photograph 2. View of Moran Lake County Park and East Cliff Drive, facing northeast. November 11, 2021.



Photograph 3. View of Moran Lagoon and the Pacific Ocean, facing southwest. November 11, 2021.



Photograph 4. View of Rincon biologists utilizing a brailed seine to survey aquatic species within Moran Lagoon on November 11, 2021. Photo taken facing northeast.



Photograph 5. View of the southern extent of Moran Lagoon and surrounding brackish wetland habitat, facing west. The fringe of native pickleweed mats can be seen below the lagoon ordinary high water mark, while invasive iceplant mats can be seen above the pickleweed mats. November 11, 2021.



Photograph 6. View of the northern extent of Moran Lagoon, the existing pedestrian trail, and surrounding eucalyptus groves, facing southeast. November 11, 2021.



Photograph 7. View of Moran Creek and surrounding invasive vegetation, facing northwest. The creek conveys stormwater runoff into the northern portion of Moran Lagoon. November 11, 2021.



Photograph 8. View of the eucalyptus groves surrounding the D.A. Porath Sanitation Facility in the northern portion of the Project Area. November 11, 2021.



Photograph 9. View of pickleweed mats at the edge of Moran Lagoon and ice plant mats growing just upslope of the lagoon. Photo taken facing southeast. November 11, 2021.



Photograph 10. View of Moran Lake Beach and the box culvert beneath East Cliff Drive, facing northeast. November 11, 2021.



Photograph 11. View of the eucalyptus groves and newly planted trees in the northwestern portion of the Project Area, facing west. November 11, 2021.



Photograph 12. View of the pickleweed mats around the edge of Moran Lagoon. November 11, 2021.



Photograph 13. View of disturbed riparian scrub habitat surrounding Moran Creek, facing east. Moran Creek flows through a culvert beneath Thirtieth Avenue, at the northeastern boundary of Project Area, and then flows into Moran Lagoon. November 11, 2021.



Photograph 14. View of invasive woody vine species and eucalyptus groves growing around the eroded banks of the lagoon inlet in the northeastern portion of the Project Area, facing northeast. November 11, 2021.



Photograph 14. View of the ruderal land cover type surrounding the existing parking area, facing west. April 1, 2022.



Photograph 15. View the annual grassland vegetation community surrounding the eucalyptus groves near the D.A. Porath Sanitation Facility, facing northwest. April 1, 2022.

Appendix C

Floral and Faunal Compendium

Plant Species Observed within the Project Area on November 11, 2021

Scientific Name	Common Name	Status	Native or Introduced
Herbs			
Achillea millefolium	common yarrow	None	Native
Allium triquetrum	three cornered leek	None	Introduced
Atriplex prostrata	fat-hen	None	Introduced
Bulbine frutescens	stalked bulbine	None	Introduced
Cakile maritima	sea rocket	None	Introduced, Cal-IPC: limited
Carex obnupta	coast carex	None	Native
Carpobrotus edulis	ice plant	None	Introduced, Cal-IPC: High
Chasmanthe bicolor	two-color cobra lily	None	Introduced
Claytonia parviflora	miner's lettuce	None	Native
Conium maculatum	poison hemlock	None	Introduced, Cal-IPC: Moderate
Cotula coronopifolia	brass buttons	None	Introduced, Cal-IPC: Limited
Delairea odorata	cape ivy	None	Introduced, Cal-IPC: High
Echium candicans	pride of Madeira	None	Introduced, Cal-IPC: Limited
Erodium moschatum	musk stork's bill	None	Introduced
Erodium sp.	erodium	None	Introduced
Euphorbia peplus	petty spurge	None	Introduced
Foeniculum vulgare	fennel	None	Introduced, Cal-IPC: Moderate
Frankenia salina	alkali heath	None	Native
Galium aparine	common bedstraw	None	Native
Geranium dissectum	cranesbill	None	Introduced, Cal-IPC: Limited
Hypochaeris radicata	hairy cats ear	None	Introduced, Cal-IPC: Moderate
Jaumea carnosa	marsh jaumea	None	Native
Juncus bufonius	toad rush	None	Native
Juncus patens	spreading rush	None	Native
Juncus sp.	rush	None	Native
Limonium perezii	Perez's sea lavender	None	Introduced
Lysimachia arvensis	scarlet pimpernel	None	Introduced
Malva neglecta	dwarf mallow	None	Introduced
Malva nicaeensis	bull mallow	None	Introduced
Oxalis incarnata	crimson woodsorrel	None	Introduced
Oxalis pes-caprae	bermuda buttercup	None	Introduced, Cal-IPC: Moderate
Pelargonium zonale	geranium	None	Introduced
Plantago coronopus	cut leaf plantain	None	Introduced
Plantago lanceolata	English plantain	None	Introduced, Cal-IPC: Limited
Raphanus raphanistrum	jointed charlock	None	Introduced
Raphanus sativus	wild radish	None	Introduced, Cal-IPC: Limited
Salicornia pacifica	pickleweed	None	Native
Tetragonia tetragonoides	New Zealand spinach	None	Introduced

Scientific Name	Common Name	Status	Native or Introduced
Topaeolum majus	nasturtium	None	Introduced
Medicago polymorpha	California bur-clover	None	Introduced, Cal-IPC: Limited
Medicago sp.	bur-clover	None	Introduced
Rumex crispus	curly dock	None	Introduced, Cal-IPC: Limited
Sisymbrium officinale	hedge mustard	None	Introduced
Sisyrinchium bellum	blue-eyed grass	None	Native
Sonchus oleracus	common sowthistle	None	Introduced
Stellaria media	chickweed	None	Introduced
Verbena lasiostachys	western vervain	None	Native
Vicia sativa	spring vetch	None	Introduced
Vinca major	bigleaf periwinkle	None	Introduced, Cal-IPC: Moderate
Zantedeschia aethiopica	calla lily	None	Introduced, Cal-IPC: Limited
Grasses			
Avena barbata	slender wildoats	None	Introduced, Cal-IPC: Moderate
Avena fatua	wildoat	None	Introduced, Cal-IPC: Moderate
Bromus diandrus	ripgut brome	None	Introduced, Cal-IPC: Moderate
Erharta erecta	panic veldt grass	None	Introduced, Cal-IPC: Moderate
Festuca perennis	Italian rye grass	None	Introduced, Cal-IPC: Moderate
Cynodon dactylon	Bermuda grass	None	Introduced, Cal-IPC: Moderate
Hordeum murinum	foxtail barley	None	Introduced, Cal-IPC: Moderate
Pennisetum clandestinum	kikuyu grass	None	Introduced, Cal-IPC: Limited
Poa annua	annual bluegrass	None	Introduced
Distichlis spicata	saltgrass	None	Native
Shrubs and Vines			
Aeonium arboretum	tree aenium	None	Introduced
Aloe arborescens	krantz aloe	None	Introduced
Cotoneaster lacteus	milkflower cotoneaster	None	Introduced, Cal-IPC: Moderate
Crassula ovata	jade plant	None	Introduced
Delairea odorata	cape ivy	None	Introduced, Cal-IPC: High
Euryops pectinatus	golden daisy bush	None	Introduced
Genista monspessulana	French broom	None	Introduced, Cal-IPC: High
Hedera helix	English ivy	None	Introduced, Cal-IPC: High
Pyracantha sp.	firethorn	None	Introduced
Rosmarinus officinalis	rosemary	None	Introduced
Salvia leucantha	Mexican bush sage	None	Introduced
Salvia mellifera	black sage	None	Native
Sequoia sempervirens	coast redwood	None	Native (planted)
Toxicodendron diversilobum	poison oak	None	Native
Rubus armeniacus	Himalayan blackberry	None	Introduced, Cal-IPC: High
Rubus ulmifolius	elmleaf blackberry	None	Introduced, Cal-IPC

Scientific Name	Common Name	Status	Native or Introduced
Trees			
Acacia dealbata	silver wattle	None	Introduced, Cal-IPC: Moderate
Acacia pycnantha	golden wattle	None	Introduced, Cal-IPC: Watch
Eucalyptus globulus	blue gum eucalyptus	None	Introduced, Cal-IPC: Limited
Eucalyptus rudis	flooded gum	None	Introduced
Hesperocyparis macrocarpa	Monterey cypress	None	Native (planted), Cal-IPC: Limited
Leptospermum laevigatum	Australian tea tree	None	Introduced, Cal-IPC: Watch
Lyonothamnus floribundus	Catalina ironwood	None	Native (planted)
Metrosideros excelsa	New Zealand christmas tree	None	Introduced
Pinus eldarica	Eldarica pine	None	Introduced
Quercus agrifolia	coast live oak	None	Native
Syzygium paniculatum	brush cherry	None	Introduced
Umbellularia californica	California bay laurel	None	Native
Washingtonia robusta	Mexican fan palm	None	Introduced, Cal-IPC: Moderate

Cal-IPC=California Invasive Plant Council Rank

Wildlife Species Observed Within the Project Area on November 11, 2021

Scientific Name	Common Name	Status	Native or Introduced
Birds			
Anas platyrhynchos	mallard	None	Native
Buteo jamaicensis	red-tailed hawk	None	Native
Corvus brachyrhynchos	American crow	None	Native
Egretta thula	snowy egret	None	Native
Junco hyemalis	dark-eyed junco	None	Native
Melanitta perspicillata	surf scoter	None	Native
Mergus serrator	red-breasted merganser	None	Native
Nannopterum auritum	double-crested cormorant	WL (nesting colony)	Native
Pelecanus erythrorhynchos	American white pelican	SSC (nesting colony)	Native
Poecile rufescens	chestnut-backed chickadee	None	Native
Sayornis nigricans	black phoebe	None	Native
Sitta carolinensis	white-breasted nuthatch	None	Native
Zenaida macroura	mourning dove	None	Native
Zonotrichia leucophrys	white-crowned sparrow	None	Native
Mammals			
Thomomys bottae	Botta's pocket gopher	None	Native
Fish			
Eucyclogobius newberryi	tidewater goby	FE	Native
Gasterosteus aculeatus	partially armored threespine stickleback	None	Native
Invertebrates			
Bombus vosnesenskii	yellow-faced bumble bee	None	Native
Danaus plexippus pop. 1	monarch butterfly	FC	Native
Hemigrapsus nudus	purple shore crab	None	Native
Lophopanopeus bellus	black-clawed crab	None	Native
Mytilus californianus	California mussel	None	Native

FE = Federally Endangered
FC = Federal Candidate
WL = CDFW Watchlist Species
SSC = CDFW Species of Special Concern

Appendix D

Special-status Species Potential to Occur Evaluations

Special-status Plant Species in the Regional Vicinity of the Project Area

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Agrostis blasdalei Blasdale's bent grass	None/None G2/S2 1B.2	Coastal bluff scrub, Coastal dunes, Coastal prairie. Sandy or gravelly soil close to rocks; often in nutrient-poor soil with sparse vegetation. 0-150m. Blooms May-Jul.	Not Expected	Coastal scrub and dune habitats are not present.
Amsinckia lunaris bent-flowered fiddleneck	None/None G3/S3 1B.2	Cismontane woodland, Coastal bluff scrub, Valley and foothill grassland. 3-500m. Blooms Mar-Jun.	Not Expected	Coastal scrub and grassland habitats are not present.
Arctostaphylos andersonii Anderson's manzanita	None/None G2/S2 1B.2	Broadleafed upland forest, Chaparral, North Coast coniferous forest. Edges, Openings 60-760m. Blooms Nov-May.	Not Expected	Natural forest habitats are not present and no manzanita species were observed during the site visit.
Arctostaphylos hookeri ssp. *hookeri* Hooker's manzanita	None/None G3T2/S2 1B.2	Chaparral, Cismontane woodland, Closed-cone coniferous forest, Coastal scrub. Sandy 60-536m. Blooms Jan-Jun.	Not Expected	Natural chaparral or woodland habitats are not present and no manzanita species were observed during the site visit.
Arctostaphylos pajaroensis Pajaro manzanita	None/None G1/S1 1B.1	Chaparral. Sandy soils. 30-760m. Blooms Dec-Mar.	Not Expected	Natural chaparral habitats are not present and no manzanita species were observed during the site visit.
Arctostaphylos silvicola Bonny Doon manzanita	None/None G1/S1 1B.2	Chaparral, Closed-cone coniferous forest, Lower montane coniferous forest. Only known from Zayante (inland marine) sands in Santa Cruz County. 120-600m. Blooms Jan-Mar.	Not Expected	Natural chaparral, sand hill, or woodland habitats are not present and no manzanita species were observed during the site visit.
Arenaria paludicola marsh sandwort	FE/SE G1/S1 1B.1	Occurs in sandy substrates and openings within freshwater or brackish marshes and swamps. This species blooms between May and August, and typically occurs at elevations ranging from 3-170 meters.	Not Expected	Natural brackish marsh habitat exists around Moran lagoon but is heavily disturbed and generally lacks suitable openings that contain sandy substrate. The species was not observed during the reconnaissance survey or botanical surveys. There are no documented occurrences of the species within five miles of the Project Area (Calflora 2022, CDFW 2022b).
Calyptridium parryi var. *hesseae* Santa Cruz Mountains pussypaws	None/None G3G4T2/S2 1B.1	Chaparral, Cismontane woodland. Gravelly (sometimes), Openings, Sandy (sometimes) 305-1530m. Blooms May-Aug.	Not Expected	Chaparral and woodland habitats are not present.

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Campanula californica swamp harebell	None/None G3/S3 1B.2	Bogs and fens, Closed-cone coniferous forest, Coastal prairie, Marshes and swamps, Meadows and seeps, North Coast coniferous forest. Mesic 1-405m. Blooms Jun-Oct.	Not Expected	Freshwater bogs and coniferous forests are not present and the Project Area is outside of the known range of the species (Calflora 2022).
Carex comosa bristly sedge	None/None G5/S2 2B.1	Coastal prairie, Marshes and swamps, Valley and foothill grassland. Lake margins, wet places; site below sea level is on a Delta Island. 0-625m. Blooms May-Sep.	Not Expected	Some marsh habitat occurs on site, but the species was not observed during the botanical surveys. There are no documented occurrences of the species within five miles of the Project Area (Calfora 2022, CDFW 2022b).
Carex saliniformis deceiving sedge	None/None G2/S2 1B.2	Coastal prairie, Coastal scrub, Marshes and swamps, Meadows and seeps. Mesic 3-230m. Blooms Jun (Jul).	Not Expected	Marginal quality coastal salt marsh is present. However, the Project Area is outside of the known geographic range of the species.
Ceanothus ferrisiae Coyote ceanothus	FE/None G1/S1 1B.1	Evergreen shrub. Blooms Mar-May. Chaparral, valley and foothill grassland, coastal scrub. Serpentine sites in the Mt. Hamilton range. 150-460 m.	Not Expected	Natural chaparral habitats are not present and no ceanothus species were observed during the site visit.
Centromadia parryi ssp. *congdonii* Congdon's tarplant	None/None G3T1T2/S1S2 1B.1	Valley and foothill grassland. Alkaline soils, sometimes described as heavy white clay. 0-230m. Blooms May-Oct(Nov).	Not Expected	Valley and foothill grassland with suitable soil is not present.
Chorizanthe pungens var. *hartwegiana* Ben Lomond spineflower	FE/None G2T1/S1 1B.1	Lower montane coniferous forest. Zayante coarse sands in maritime ponderosa pine sandhills. 90-610m. Blooms Apr-Jul.	Not Expected	Coniferous forests and Zayante sand hills are not present.
Chorizanthe pungens var. *pungens* Monterey spineflower	FT/None G2T2/S2 1B.2	Chaparral, Cismontane woodland, Coastal dunes, Coastal scrub, Valley and foothill grassland. Sandy 3-450m. Blooms Apr-Jun(Jul-Aug).	Not Expected	Coastal scrub, dune, and grassland habitats are not present.
Chorizanthe robusta var. *hartwegii* Scotts Valley spineflower	FE/None G2T1/S1 1B.1	Meadows and seeps, Valley and foothill grassland. In grasslands with mudstone and sandstone outcrops. 230-245m. Blooms Apr-Jul.	Not Expected	Meadows and seeps, and grassland habitats are not present.
Chorizanthe robusta var. *robusta* robust spineflower	FE/None G2T1/S1 1B.1	Chaparral, Cismontane woodland, Coastal dunes, Coastal scrub. Gravelly (sometimes), Sandy (sometimes) 3-300m. Blooms Apr-Sep.	Not Expected	Coastal scrub, dune, and woodland habitats are not present.

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Collinsia multicolor San Francisco collinsia	None/None G2/S2 1B.2	Annual herb. Blooms March-May. Closed-cone coniferous forest, coastal scrub. On decomposed shale (mudstone) mixed with humus. 30-250m (100-820ft).	Not Expected	Coniferous forests and coastal scrub habitats are not present.
Cordylanthus rigidus ssp. *littoralis* seaside bird's-beak	None/SE G5T2/S2 1B.1	Chaparral, Cismontane woodland, Closed-cone coniferous forest, Coastal dunes, Coastal scrub. Disturbed areas (often), Sandy 0-515m. Blooms Apr-Oct.	Not Expected	Chaparral, cismontane woodland, closed-cone coniferous forest, coastal dunes, and coastal scrub habitat with disturbed, sandy, openings are not present.
Dacryophyllum falcifolium tear drop moss	None/None G2/S2 1B.3	North Coast coniferous forest. Limestone substrates and rock outcrops. 50-275m.	Not Expected	Coniferous forests and rocky outcrops are not present.
Eriogonum nudum var. *decurrens* Ben Lomond buckwheat	None/None G5T1/S1 1B.1	Chaparral, Cismontane woodland, Lower montane coniferous forest. Ponderosa pine sandhills in Santa Cruz County. 50-800m. Blooms Jun-Oct.	Not Expected	Chaparral and coniferous forests are not present.
Erysimum ammophilum sand-loving wallflower	None/None G2/S2 1B.2	Chaparral, Coastal dunes, Coastal scrub. Sandy openings. 0-60m. Blooms Feb-Jun(Jul-Aug).	Not Expected	Chaparral and coastal dunes or scrub habitats are not present.
Erysimum teretifolium Santa Cruz wallflower	FE/SE G1/S1 1B.1	Chaparral, Lower montane coniferous forest. Inland marine sands (Zayante coarse sand). 120-610m. Blooms Mar-Jul.	Not Expected	Chaparral and Coniferous forests are not present and the site is outside this species elevation range.
Fissidens pauperculus minute pocket moss	None/None G3?/S2 1B.2	North Coast coniferous forest. Moss growing on damp soil along the coast. In dry streambeds and on stream banks. 10-1024m.	Not Expected	Coniferous forests and dry streambeds are not present.
Gilia tenuiflora ssp. *arenaria* Monterey gilia	FE/ST G3G4T2/S2 1B.2	Chaparral, Cismontane woodland, Coastal dunes, Coastal scrub. Sandy openings in bare, wind-sheltered areas. Often near dune summit or in the hind dunes; two records from Pleistocene inland dunes. 0-45m. Blooms Apr-Jun.	Not Expected	Chaparral and coastal dunes or scrub habitats are not present.
Hesperocyparis abramsiana var. *abramsiana* Santa Cruz cypress	FT/SE G1T1/S1 1B.2	Chaparral, Closed-cone coniferous forest, Lower montane coniferous forest. Restricted to the Santa Cruz Mountains, on sandstone and granitic-derived soils; often w/Pinus attenuata, redwoods. 280-800m.	Not Expected	Chaparral and coniferous forests are not present and the site is outside this species elevation range. Additionally, this species was not observed during the site visit.

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Hoita strobilina Loma Prieta hoita	None/None G2?/S2? 1B.1	Chaparral, Cismontane woodland, Riparian woodland. Serpentine; mesic sites. 30-860m. Blooms May-Jul(Aug-Oct).	Not Expected	Chaparral and woodland habitats on serpentine soils are not present.
Holocarpha macradenia Santa Cruz tarplant	FT/SE G1/S1 1B.1	Coastal prairie, Coastal scrub, Valley and foothill grassland. Light, sandy soil or sandy clay; often with nonnatives. 10-220m. Blooms Jun-Oct.	Not Expected	Coastal scrub or natural grassland habitats are not present, but this species is often found in disturbed grassy areas. There are eight occurrences of the species documented in the CNDDB within five miles of the Project Area. However, the species was not observed during the botanical surveys.
Horkelia cuneata var. *sericea* Kellogg's horkelia	None/None G4T1?/S1? 1B.1	Chaparral, Closed-cone coniferous forest, Coastal dunes, Coastal scrub. Old dunes, coastal sandhills; openings. Sandy or gravelly soils. 10-200m. Blooms Apr-Sep.	Not Expected	Chaparral, coniferous forests, and coastal dunes or scrub habitats are not present.
Horkelia marinensis Point Reyes horkelia	None/None G2/S2 1B.2	Coastal dunes, Coastal prairie, Coastal scrub. Sandy flats and dunes near coast; in grassland or scrub plant communities. 5-755m. Blooms May-Sep.	Not Expected	Coastal dunes, prairie, or scrub habitats are not present. There is one occurrence (1990) of the species documented in the CNDDB within five miles of the Project Area.
Lasthenia californica ssp. *macrantha* perennial goldfields	None/None G3T2/S2 1B.2	Coastal bluff scrub, Coastal dunes, Coastal scrub. 5-520m. Blooms Jan-Nov.	Not Expected	Coastal dunes or scrub habitats are not present. There is one historic occurrence (1955) of the species documented in the CNDDB within five miles of the Project Area.
Lessingia micradenia var. *glabrata* smooth lessingia	None/None G2T2/S2 1B.2	Chaparral, Cismontane woodland, Valley and foothill grassland. Serpentine; often on roadsides. 120-420m. Blooms (Apr-Jun) Jul-Nov.	Not Expected	Chaparral, woodland, and grassland habitats on serpentine soils are not present.
Malacothamnus arcuatus arcuate bush-mallow	None/None G2Q/S2 1B.2	Chaparral, Cismontane woodland. Gravelly alluvium. 15-355m. Blooms Apr-Sep.	Not Expected	Chaparral and woodland habitats are not present.
Microseris paludosa marsh microseris	None/None G2/S2 1B.2	Cismontane woodland, Closed-cone coniferous forest, Coastal scrub, Valley and foothill grassland. 5-355m. Blooms Apr-Jun(Jul).	Not Expected	Woodlands and coniferous forests are not present. There is one historic occurrence (1957) of the species documented in the CNDDB within five miles of the Project Area.

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Monardella sinuata ssp. *nigrescens* northern curly-leaved monardella	None/None G3T2/S2 1B.2	Chaparral, Coastal dunes, Coastal scrub, Lower montane coniferous forest. Sandy soils. 0-300m. Blooms (Apr)May-Jul(Aug-Sep).	Not Expected	Chapparal, coastal dunes, coastal scrub, and coniferous forests are not present.
Monolopia gracilens woodland woollythreads	None/None G3/S3 1B.2	Broadleafed upland forest, Chaparral, Cismontane woodland, North Coast coniferous forest, Valley and foothill grassland. Grassy sites, in openings; sandy to rocky soils. Often seen on serpentine after burns, but may have only weak affinity to serpentine. 100-1200m. Blooms (Feb)Mar-Jul.	Not Expected	Forest, chaparral, woodland, and valley and foothill grassland habitats are not present. The project area is also outside of the elevation range for the species. There are two historic occurrences (1908, 1935) of the species documented in the CNDDB within five miles of the Project Area.
Pedicularis dudleyi Dudley's lousewort	None/SR G2/S2 1B.2	Chaparral, Cismontane woodland, North Coast coniferous forest, Valley and foothill grassland. Deep shady woods of older coast redwood forests; also in maritime chaparral. 60-900m. Blooms Apr-Jun.	Not Expected	Forest, chaparral, woodland, and valley and foothill grassland habitats are not present. There is one historical occurrence (1884) of the species documented in the CNDDB within five miles of the Project Area.
Penstemon rattanii var. *kleei* Santa Cruz Mountains beardtongue	None/None G4T2/S2 1B.2	Chaparral, Lower montane coniferous forest, North Coast coniferous forest. Sandy shale slopes; sometimes in the transition between forest and chaparral. 400-1100m. Blooms May-Jun.	Not Expected	Suitable habitat for the species is not present. The project area is also outside of the elevation range of the species.
Pentachaeta bellidiflora white-rayed pentachaeta	FE/SE G1/S1 1B.1	Cismontane woodland, Valley and foothill grassland. Open dry rocky slopes and grassy areas, often on soils derived from serpentine bedrock. 35-620m. Blooms Mar-May.	Not Expected	Cismontane woodlands and valley and foothill grasslands are not present, nor are serpentine soils. There is one historic occurrence (1933) of the species documented in the CNDDB within five miles of the Project Area.
Piperia candida white-flowered rein orchid	None/None G3/S3 1B.2	Broadleafed upland forest, Lower montane coniferous forest, North Coast coniferous forest. Sometimes on serpentine. Forest duff, mossy banks, rock outcrops, and muskeg. 30-1310m. Blooms (Mar)May-Sep.	Not Expected	Intact forests are not present, nor are mossy banks or rock outcrops.
Piperia yadonii Yadon's rein orchid	FE/None G1/S1 1B.1	Chaparral, Closed-cone coniferous forest, Coastal bluff scrub. On sandstone and sandy soil, but poorly drained and often dry. 10-510m. Blooms (Feb)May-Aug.	Not Expected	Chaparral, coniferous forest, and coastal bluff scrub habitats are not present.

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Plagiobothrys chorisianus var. *chorisianus* Choris' popcornflower	None/None G3T1Q/S1 1B.2	Chaparral, Coastal prairie, Coastal scrub. Mesic sites. 3-160m. Blooms Mar-Jun.	Not Expected	Chaparral, coastal prairie, and coastal scrub habitats are not present.
Plagiobothrys diffusus San Francisco popcornflower	None/SE G1Q/S1 1B.1	Coastal prairie, Valley and foothill grassland. Historically from grassy slopes with marine influence. 30-150. Blooms Mar-Jun.	Not Expected	Coastal prairie and valley and foothill grassland habitats are not present, but the site does contain invasive grasses with marine influence. There are four occurrences of the species documented in the CNDDB within five miles of the Project Area. However, the site is outside of the known elevation range of the species.
Polygonum hickmanii Scotts Valley polygonum	FE/SE G1/S1 1B.1	Valley and foothill grassland. Purisima sandstone or mudstone with a thin soil layer; vernally moist due to runoff. 210-250m. Blooms May-Aug.	Not Expected	Valley and foothill grassland does not occur on site, nor do suitable soils or elevations for the species.
Senecio aphanactis chaparral ragwort	None/None G3/S2 2B.2	Chaparral, Cismontane woodland, Coastal scrub. Drying alkaline flats. 15-800m. Blooms Jan-Apr(May).	Not Expected	Chaparral, cismontane woodland and coastal scrub do not occur on site, nor do drying alkaline flats.
Stebbinsoseris decipiens Santa Cruz microseris	None/None G2/S2 1B.2	Broadleafed upland forest, Chaparral, Closed-cone coniferous forest, Coastal prairie, Coastal scrub, Valley and foothill grassland. Open areas in loose or disturbed soil, usually derived from sandstone, shale or serpentine, on seaward slopes. 10-500m. Blooms Apr-May.	Not Expected	Suitable intact habitat and disturbed soils derived from sandstone, shale, or serpentine are not present. The species was not observed during the botanical surveys.
Trifolium buckwestiorum Santa Cruz clover	None/None G2/S2 1B.1	Broadleafed upland forest, Cismontane woodland, Coastal prairie. Moist grassland. Gravelly margins. 105-610m. Blooms Apr-Oct.	Not Expected	Upland forest, cismontane woodland, and coastal prairie habitats and gravelly soil along habitat margins are not present.
Trifolium hydrophilum saline clover	None/None G2/S2 1B.2	Marshes and swamps, Valley and foothill grassland, Vernal pools. Mesic, alkaline sites. 0-300m. Blooms Apr-Jun.	Not Expected	Wetland habitat surrounding the lagoon and areas around the freshwater lagoon inlet could provide marginally habitat for this species. The species was not observed during the botanical surveys.

Scientific Name Common Name	Status Fed/State ESA CRPR	Habitat Requirements	Potential to Occur	Rationale
Trifolium polyodon Pacific Grove clover	None/SR G1/S1 1B.1	Closed-cone coniferous forest, Coastal prairie, Meadows and seeps, Valley and foothill grassland. Along small springs and seeps in grassy openings. 5-425m. Blooms Apr-Jun(Jul).	Not Expected	Coniferous forest, coastal prairie, meadows and seeps, and valley and foothill grassland habitats are not present.

Regional Vicinity refers to within a 7-quad search radius of site.

Status (Federal/State)
FE = Federal Endangered
FT = Federal Threatened
FPE = Federal Proposed Endangered
FPT = Federal Proposed Threatened
FD = Federal Delisted
FC = Federal Candidate
SE = State Endangered
ST = State Threatened
SCE = State Candidate Endangered
SCT = State Candidate Threatened
SR = State Rare
SD = State Delisted
SSC = CDFW Species of Special Concern
FP = CDFW Fully Protected
WL = CDFW Watch List

CRPR (CNPS California Rare Plant Rank)
1A = Presumed extirpated in California, and rare or extinct elsewhere
1B = Rare, Threatened, or Endangered in California and elsewhere
2A = Presumed extirpated in California, but common elsewhere
2B= Rare, Threatened, or Endangered in California, but more common elsewhere

CRPR Threat Code Extension
.1 = Seriously endangered in California (>80% of occurrences threatened/high degree and immediacy of threat)
.2 = Moderately threatened in California (20-80% of occurrences threatened/moderate degree and immediacy of threat)
.3 = Not very endangered in California (<20% of occurrences threatened/low degree and immediacy of threat)

Other Statuses
G1 or S1 Critically Imperiled Globally or Subnationally (state)
G2 or S2 Imperiled Globally or Subnationally (state)
G3 or S3 Vulnerable to extirpation or extinction Globally or Subnationally (state)
G4/5 or S4/5 Apparently secure, common and abundant
GH or SH Possibly Extirpated – missing; known from only historical occurrences but still some hope of rediscovery

Additional notations may be provided as follows
T – Intraspecific Taxon (subspecies, varieties, and other designations below the level of species)
Q – Questionable taxonomy that may reduce conservation priority
? – Inexact numeric rank

Special-status Animal Species in the Regional Vicinity of the Project Area

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Invertebrates				
Bombus occidentalis western bumble bee	None/SCE G2G3/S1	Once common & widespread, species has declined precipitously from central CA to southern B.C., perhaps from disease. Occurs at elevations of 0 to 2,000 meters. Require suitable nesting sites, overwintering sites for the queens, and nectar and pollen resources throughout the spring, summer, and fall.	Not Expected	Some suitable foraging habitat and food plant genera may occur within open areas of the Project Area during spring. Eight occurrences of the species are documented in the CNDDB within five miles of the Project Area (CDFW 2022b), but the most recent of these is from 1998 and none are within one mile of Moran Lagoon. The species is now largely confined to high-elevation sites and areas east of the Central Valley (The Oregon Conservation Strategy 2022).
Cicindela ohlone Ohlone tiger beetle	FE/None G1/S1	Remnant native grasslands with California oatgrass and purple needlegrass in Santa Cruz County. Substrate is poorly drained clay or sandy clay soil over bedrock of Santa Cruz mudstone.	Not Expected	Native grasslands on suitable soils are not present. There are four occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b). However, the most recent of these occurrences is from 2000 and the closest is over 2 miles from the Project Area.
Danaus plexippus pop. 1 monarch - California overwintering population	FC/None G4T2T3/S2S3	Winter roost sites extend along the coast from northern Mendocino to Baja California, Mexico. Roosts located in wind-protected tree groves (eucalyptus, Monterey pine, cypress), with nectar and water sources nearby.	Present	Suitable roosting habitat is present and six wintering roosts are known to occur in eucalyptus groves within the Project Area (Santa Cruz County Parks 2010, Xerces Society 2022) There are twenty occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b). Individuals were observed on site during the biological surveys.
Euphilotes enoptes smithi Smith's blue butterfly	FE/None G5T1T2/S1	Most commonly associated with coastal dunes and coastal sage scrub plant communities in Monterey and Santa Cruz counties. Hostplant: *Eriogonum latifolium* and *Eriogonum parvifolium* are utilized as both larval and adult foodplants.	Not Expected	Natural coastal dune habitat with host plant species is not present.

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Polyphylla barbata Mount Hermon June beetle	FE/None G1/S1	Known only from sand hills in vicinity of Mt. Hermon, Santa Cruz County.	Not Expected	Zayante Sand Hills are not present. Two occurrences of the species (2004) are documented in the CNDDB approximately five miles northwest of the Project Area (CDFW 2022b).
Trimerotropis infantilis Zayante band-winged grasshopper	FE/None G1/S1	Isolated sandstone deposits in the Santa Cruz Mountains (the Zayante Sand Hills ecosystem). Mostly on sand parkland habitat but also in areas with well-developed ground cover and in sparse chaparral with grass.	Not Expected	Zayante Sand Hills are not present. There is one historic occurrence (1941) of the species documented in the CNDDB approximately 3.5 miles northeast of the Project Area (CDFW 2022b).
Fish				
Eucyclogobius newberryi northern tidewater goby	FE/None G3/S3	Brackish water habitats along the California coast from Agua Hedionda Lagoon, San Diego County to the mouth of the Smith River. Found in shallow lagoons and lower stream reaches, they need fairly still but not stagnant water and high oxygen levels.	Present	Over six hundred individuals were observed within the lagoon during the aquatic survey in November 2021. The species has also been documented within the lagoon in previous surveys (e.g., Sutter 2018, USFWS 2005). There are eight occurrences of the species documented in the CNDDB within five miles of the Project Area, one of which is within Moran Lake (CDFW 2022b).
Lavinia exilicauda harengus Monterey hitch	None/None G4T2T4/S3 SSC	Slow moving warm freshwater streams, rivers, and ponds with vegetated banks or other cover (down logs, etc.) for juveniles. Occasionally found in brackish water. Highly heat tolerant.	Low Potential	Suitable habitat for the species is present, particularly near downed trees upstream of the lagoon where salinity is low. The species was not observed during the aquatic survey.
Oncorhynchus kisutch pop. 4 coho salmon - central California coast ESU	FE/SE G5T2T3Q/S2	Federal listing includes popualtions between Punta Gorda and San Lorenzo River. State listing includes populations south of Punta Gorda. Require beds of loose, silt-free, coarse gravel for spawning. Also need cover, cool water and sufficient dissolved oxygen.	Not Expected	Anadromous fish are not expected to occur within the lagoon due to the lack of suitable upstream habitat and the altered state of the lagoon mouth that limits connectivity to the ocean. There is one historical occurrence of the species documented in the CNDDB within five miles of the Project Area, within the San Lorenzo River (CDFW 2022b). This occurrence was documented in 1995 and was likely a hatchery fish.

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Oncorhynchus mykiss irideus pop. 8 steelhead - central California coast DPS	FT/SC G5T2T3Q/S2S3	DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, Santa Cruz County, California (inclusive). Also includes the drainages of San Francisco and San Pablo Bays.	Not Expected	Anadromous fish are not expected to occur within the lagoon due to the lack of suitable upstream habitat and the altered state of the lagoon mouth that limits connectivity to the ocean. Suitable habitat for resident *O. mykiss* is also absent within the Project Area. There are five occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b), none of which is within the Moran Lagoon watershed.
Spirinchus thaleichthys longfin smelt	FC/ST G5/S1	Euryhaline, nektonic and anadromous. Found in open waters of estuaries, mostly in middle or bottom of water column. Prefer salinities of 15-30 ppt, but can be found in completely freshwater to almost pure seawater.	Not Expected	Anadromous fish are not expected to occur within the lagoon due to the lack of suitable upstream habitat and the altered state of the lagoon mouth that limits connectivity to the ocean.
Thaleichthys pacificus eulachon	FT/None G5/S2	Found in Klamath River, Mad River, Redwood Creek, and in small numbers in Smith River and Humboldt Bay tributaries. Spawn in lower reaches of coastal rivers with moderate water velocities and bottom of pea-sized gravel, sand, and woody debris.	Not expected	Suitable flows and substrates are not present, and the site is outside this species' known range.
Amphibians				
Ambystoma californiense pop. 1 California tiger salamander - central California DPS	FT/ST G2G3/S3 WL	Lives in vacant or mammal-occupied burrows throughout most of the year; in grassland, savanna, or open woodland habitats. Need underground refuges, especially ground squirrel burrows, and vernal pools or other seasonal water sources for breeding.	Not Expected	Suitable vernal pools or intact upland grassland habitats are not present, and the site is isolated by development.
Ambystoma macrodactylum croceum Santa Cruz long-toed salamander	FE/SE G5T1T2/S1S2 FP	Wet meadows near sea level in a few restricted locales in Santa Cruz and Monterey counties. Aquatic larvae prefer shallow (<12 inches) water, using clumps of vegetation or debris for cover. Adults use mammal burrows.	Not Expected	Suitable wet freshwater meadows are not present, and the site is outside the species' known range and is isolated by development. There is one occurrence of the species documented in the CNDDB approximately five miles northeast of the Project Area (CDFW 2022b).

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Aneides niger Santa Cruz black salamander	None/None G3/S3 SSC	Mixed deciduous and coniferous woodlands and coastal grasslands in San Mateo, Santa Cruz, and Santa Clara counties. Adults found under rocks, talus, and damp woody debris.	Not Expected	Suitable woodland or intact coastal grassland habitats are not present, and the site is isolated by development. There are three occurrences (197X, 1972, 2013) of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b), all at least three miles north of the Project Area.
Dicamptodon ensatus California giant salamander	None/None G3/S2S3 SSC	Known from wet coastal forests near streams and seeps from Mendocino County south to Monterey County, and east to Napa County. Aquatic larvae found in cold, clear streams, occasionally in lakes and ponds. Adults known from wet forests under rocks and logs near streams and lakes.	Not Expected	Suitable forest and cold stream habitats are not present, and the site is isolated by development. There are two occurrences (1987, 2014) of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b), both more than three miles north of the Project Area.
Rana boylii foothill yellow-legged frog	None/SE G3/S3 SSC	Partly-shaded, shallow streams and riffles with a rocky substrate in a variety of habitats. Needs at least some cobble-sized substrate for egg-laying. Needs at least 15 weeks to attain metamorphosis.	Not Expected	Suitable freshwater streams are not present, and the site is isolated by development. There is one occurrence (2021) of the species documented in the CNDDB approximately three miles northeast of the Project Area (CDFW 2022b).
Rana draytonii California red-legged frog	FT/None G2G3/S2S3 SSC	Lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development. Must have access to estivation habitat.	Low Potential	A very limited amount of disturbed freshwater and riparian habitat is present in the northeastern portion of the Project Area within Moran Creek. There are four occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b). However, all of these occurrences are in freshwater ponds near the UC Santa Cruz campus and are at least 4.5 miles west of Moran Lagoon.
Reptiles				
Anniella pulchra Northern California legless lizard	None/None G3/S3 SSC	Sandy or loose loamy soils under sparse vegetation in coastal dunes, chaparral, oak woodlands, desert scrub, sandy washes, or stream terraces. Soil moisture is essential.	Low Potential	Vegetation types preferred by the species do not occur on site and the Project Area is isolated by urban development. However, there is suitable sandy soil and some areas with leaf litter present on site.

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Actinemys pallida (*Emys marmorata*) southwestern pond turtle	None/None G3G4/S3 SSC	A thoroughly aquatic turtle of ponds, marshes, rivers, streams and irrigation ditches, usually with aquatic vegetation, below 6000 ft elevation. Needs basking sites and suitable (sandy banks or grassy open fields) upland habitat up to 0.5 km from water for egg-laying.	Low Potential	Suitable habitat is present, though the site is isolated by development. There are five occurrences of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b), the closest of which was in Schwan Lagoon, approximately one mile west of the Project Area.
Birds				
Accipiter cooperii Cooper's hawk	None/None G5/S4 WL	Woodland, chiefly of open, interrupted or marginal type. Nest sites mainly in riparian growths of deciduous trees, as in canyon bottoms on river flood-plains; also, live oaks.	High Potential	Suitable nest trees are present throughout the site and there are numerous nearby sightings on eBird, including begging juveniles and adults (Cornell Lab of Ornithology 2022b). The species has a high potential to forage and nest within the Project Area.
Agelaius tricolor tricolored blackbird	None/ST G1G2/S1S2 SSC	Highly colonial species, most numerous in Central Valley & vicinity. Largely endemic to California. Requires open water, protected nesting substrate, and foraging area with insect prey within a few km of the colony.	Low Potential (non-nesting)	Suitable foraging habitat for the species occurs around Moran lagoon, though no suitable cattail, agricultural field, or other dense vegetative nesting habitat is present. Two historic occurrences (1973, 1987) of the species are documented in the CNDDB approximately three miles west of the Project Area (CDFW 2022b). One occurrence of the species is documented within one mile of the lagoon in eBird (Cornell Lab of Ornithology 2022b).
Aquila chrysaetos golden eagle	None/None G5/S3 FP WL	Rolling foothills, mountain areas, sage-juniper flats, and desert. Cliff-walled canyons provide nesting habitat in most parts of range; also, large trees in open areas.	Not Expected	Suitable nest trees are present, however open space within the Project Area is likely too small to support golden eagle foraging, and the site is surrounded by development.
Asio flammeus short-eared owl	None/None G5/S3 SSC	Found in swamp lands, both fresh and salt; lowland meadows; irrigated alfalfa fields. Tule patches/tall grass needed for nesting/daytime seclusion. Nests on dry ground in depression concealed in vegetation.	Not Expected	Suitable swamp or wet meadow habitats are not present, and the site is surrounded by development.

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Athene cunicularia burrowing owl	None/None G4/S3 SSC	Open, dry annual or perennial grasslands, deserts, and scrublands characterized by low-growing vegetation. Subterranean nester, dependent upon burrowing mammals, most notably, the California ground squirrel.	Not Expected	Suitable dry upland grassland habitat with ground squirrel burrows is not present, and the site is surrounded by development. Several occurrences of the species are documented within five miles of the Project Area in eBird (Cornell Lab of Ornithology 2022b), the closest of which is approximately 1.5 miles west of Moran Lagoon. There is one occurrence (2014) of the species documented in the CNDDB approximately five miles northwest of the Project Area (CDFW 2022b).
Brachyramphus marmoratus marbled murrelet	FT/SE G3/S2	Feeds near-shore; nests inland along coast from Eureka to Oregon border and from Half Moon Bay to Santa Cruz. Nests in old-growth redwood-dominated forests, up to six miles inland, often in Douglas-fir.	Not Expected	Suitable old-growth redwood forests are not present, and the site is surrounded by development.
Charadrius nivosus western snowy plover	FT/None G3T3/S2 SSC	Sandy beaches, salt pond levees and shores of large alkali lakes. Needs sandy, gravelly or friable soils for nesting.	Low Potential (non-nesting)	A limited stretch of sandy beach is present on site, however, it is heavily impacted by recreational use and development, and no longer provides suitable dune habitat for breeding. There are two historic occurrences (1878, 1887) of the species documented in the CNDDB (CDFW 2022b) approximately two and four miles west of the Project Area. There are multiple occurrences documented in eBird within five miles of the Project Area (Cornell Lab of Ornithology 2022b), though none are documented within the Project Area.
Coturnicops noveboracensis yellow rail	None/None G4/S1S2 SSC	Summer resident in eastern Sierra Nevada in Mono County. Freshwater marshlands.	Not Expected	Suitable freshwater marshlands are not present. There is one historic occurrence (1905) of the species documented in the CNDDB approximately 3 miles northwest of the Project Area (CDFW 2022b).

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Cypseloides niger black swift	None/None G4/S2 SSC	Coastal belt of Santa Cruz and Monterey counties; central and southern Sierra Nevada; San Bernardino and San Jacinto mountains. Breeds in small colonies on cliffs behind or adjacent to waterfalls in deep canyons and sea-bluffs above the surf; forages widely.	Low Potential (non-nesting)	Suitable cliffs or canyons for nesting are not present, though the species has a low potential to fly over or forage within the Project Area. There are four occurrences of the species documented in the CNDDB (CDFW 2022b) and several occurrences documented in eBird within five miles of the Project Area (Cornell Lab of Ornithology 2022b).
Elanus leucurus white-tailed kite	None/None G5/S3S4 FP	Rolling foothills and valley margins with scattered oaks and river bottomlands or marshes next to deciduous woodland. Open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees for nesting and perching.	Moderate Potential	The site is heavily impacted by human activity and is surrounded by urban development, which makes it unlikely that the species would nest or roost in trees onsite. However, many occurrences of the species are documented in eBird within one mile of the Project Area (Cornell Lab of Ornithology 2022b) and the species has a moderate potential to fly within the Project Area.
Falco peregrinus anatum American peregrine falcon	FD/SD G4T4/S3S4 FP	Near wetlands, lakes, rivers, or other water; on cliffs, banks, dunes, mounds; also, human-made structures. Nest consists of a scrape or a depression or ledge in an open site.	Moderate Potential (non-nesting)	Suitable cliffs or other suitable nesting habitats are not present, though foraging habitat and bird prey species are present within Moran Lagoon. Many occurrences of the species are documented within two miles of the Project Area in eBird (Cornell Lab of Ornithology 2022b) and there is a moderate potential for the species to fly over or forage within the Project Area.
Laterallus jamaicensis coturniculus California black rail	None/ST G3G4T1/S1 FP	Inhabits freshwater marshes, wet meadows and shallow margins of saltwater marshes bordering larger bays. Needs water depths of about 1 inch that do not fluctuate during the year and dense vegetation for nesting habitat.	Not Expected	Suitable freshwater marshlands are not present. There is one historic occurrence (1941) of the species documented in the CNDDB approximately three miles northwest of the Project Area (CDFW 2022b).
Pandion haliaetus osprey	None/None G5/S4 WL	Ocean shore, bays, freshwater lakes, and larger streams. Large nests built in tree-tops within 15 miles of a good fish-producing body of water.	Moderate Potential	Suitable nest trees are present and foraging habitat within the ocean exists nearby. Multiple occurrences of the species are documented in eBird within Moran Lake County Park and the surrounding area (Cornell Lab of Ornithology 2022).

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Pelecanus erythrorhynchos American white pelican	None/None G4/S1S2 SSC (nesting colony)	Colonial nester on large interior lakes with well-sequestered islets.	Present (non-nesting)	The species was observed during the field reconnaissance survey in November 2021. Nesting habitat for the species is not present within the Project Area.
Pelecanus occidentalis californicus California brown pelican	FD/SD G4T3T4/S3 FP	Lives year-round in estuaries and coastal marine habitats along the California coast, and forages, rests, and roosts on islands, offshore rocks, breakwaters and other humanmade structures, rocky intertidal areas, mudflats, and beaches. Generally, nests and breeds at offshore Islands in Southern California. Diet includes mostly small fish that school near the surface of the water.	High Potential (non-nesting)	The species has a high potential to fly over, forage, and/or roost within the Project Area, though nesting habitat is not present. There are multiple occurrences of the species documented in eBird within Moran Lake County Park and the surrounding area (Cornell Lab of Ornithology 2022).
Phalacrocorax auritus double-crested cormorant	None/None G5/S4 WL (nesting colony)	Colonial nester on coastal cliffs, offshore islands, and along lake margins in the interior of the state. Nests along coast on sequestered islets, usually on ground with sloping surface, or in tall trees along ocean, lagoon, bay, or lake margins.	Present (non-nesting)	Double-crested cormorants were observed within the Project Area during the site survey and have been frequently documented within Moran Lake County Park and the surrounding area (Cornell Lab of Ornithology 2022b). Suitable nesting habitat is present in eucalyptus groves within the Project Area. However, no nesting colonies were observed during biological surveys.
Rallus obsoletus California Ridgway's rail	FE/SE G3T1/S1 FP	Salt water and brackish marshes traversed by tidal sloughs in the vicinity of San Francisco Bay. Associated with abundant growths of pickleweed, but feeds away from cover on invertebrates from mud-bottomed sloughs.	Not Expected	Some suitable habitat for the species occurs on site, but the Project Area is outside of the species' current known range and there are no documented occurrences within five miles of Moran Lagoon (CDFW 2022b, Cornell Lab of Ornithology 2022b).
Riparia bank swallow	None/ST G5/S2	Colonial nester; nests primarily in riparian and other lowland habitats west of the desert. Requires vertical banks/cliffs with fine-textured/sandy soils near streams, rivers, lakes, ocean to dig nesting hole.	Low Potential (non-nesting)	Suitable banks or cliffs for nesting are not present. Multiple occurrences of the species are documented within five miles of the Project Area in eBird (Cornell Lab of Ornithology 2022b).

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Setophaga petechia yellow warbler	None/None G5/S3S4 SSC	Inhabits riparian areas in close proximity to water. Frequently found nesting and foraging in willow shrubs and thickets, and in other riparian plants including cottonwoods, sycamores, ash, and alders.	High Potential	Some marginally suitable nesting habitat for the species occurs within the disturbed riparian scrub in the northeast portion of the Project Area. There are multiple occurrences of the species documented within one mile of the Project Area in eBird (Cornell Lab of Ornithology 2021b).
Sterna antillarum browni California least tern	FE/SE FP G4T2T3Q	Inhabits the coast from San Francisco to Baja California. Nests on open beaches kept free of vegetation by the tide, and also in open, sparsely vegetated and paved areas close to the coast. California least terns winter in Mexico. When feeding, they follow schools of fish and are sometimes seen as far north as southern Oregon.	Low Potential (non- nesting)	Some marginally suitable nesting habitat is present within the Project Area but the species is not known to nest within Moran Lake County Park, and due to the high level of human traffic, it is unlikely that the species would nest on site. Multiple occurrences of the species are documented in eBird within five miles of Moran Lake County Park (Cornell Lab of Ornithology 2022b). The nearest recent observation (2013) was in Corcoran Lagoon, approximately 0.25 mile from Moran Lagoon. There is a low potential for the species to fly through and forage within the Project Area.
Mammals				
Antrozous pallidus pallid bat	None/None G4/S3 SSC	Found in a variety of habitats including deserts, grasslands, shrublands, woodlands, and forests. Most common in open, dry habitats with rocky areas for roosting. Roosts in crevices of rock outcrops, caves, mine tunnels, buildings, bridges, and hollows of live and dead trees which must protect bats from high temperatures. Very sensitive to disturbance of roosting sites.	Low Potential	Potential roosting habitat for the species occurs within eucalyptus trees and within the box culvert beneath the East Cliff Drive. However, it is unlikely that the species would roost on site given the disturbed nature of the area and the high level of human activity. There is one historic occurrence (1988) of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b).

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Corynorhinus townsendii Townsend's big-eared bat	None/None G4/S2 SSC	Occurs throughout California in a wide variety of habitats. Most common in mesic sites, typically coniferous or deciduous forests. Roosts in the open, hanging from walls and ceilings in caves, lava tubes, bridges, and buildings. This species is extremely sensitive to human disturbance.	Low Potential	Potential roosting habitat for the species occurs within eucalyptus trees and within the box culvert beneath the East Cliff Drive. However, it is unlikely that the species would roost on site given the disturbed nature of the area and the high level of human activity. There are two occurrences (1988, 2014) of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b).
Neotoma fuscipes annectens San Francisco dusky-footed woodrat	None/None G5T2T3/S2S3 SSC	Typically found in forest habitats with moderate to dense understory. Can occur in chaparral, riparian woodlands, and coniferous forests, particularly redwood. Builds middens out of grasses, leaves, and woody debris. This subspecies is found only in the San Francisco Bay region.	Not Expected	No suitable woodland or forest habitat occurs within the Project Area. The eucalyptus groves have an open understory and are not suitable for woodrats, and the site is also isolated by development.
Sorex ornatus salarius Monterey shrew	None/None G5T1T2/S1S2 SSC	Riparian, wetland and upland areas in the vicinity of the Salinas River delta. Prefers moist microhabitats. feeds on insects and other invertebrates found under logs, rocks and litter.	Not Expected	Wetland habitats are present, however, the site is outside of this species' known range and is isolated by development.

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements	Potential to Occur	Rationale
Taxidea taxus American badger	None/None G5/S3 SSC	Most abundant in drier open stages of most shrub, forest, and herbaceous habitats, with friable soils. Needs sufficient food, friable soils and open, uncultivated ground. Preys on burrowing rodents. Digs burrows.	Not Expected	Suitable open upland habitats are not present, and the site is isolated by development. There is one occurrence (1996) of the species documented in the CNDDB within five miles of the Project Area (CDFW 2022b).

Regional Vicinity refers to within a 7-quad search radius of site.

Status (Federal/State)

FE = Federal Endangered
FT = Federal Threatened
FPE = Federal Proposed Endangered
FPT = Federal Proposed Threatened
FD = Federal Delisted
FC = Federal Candidate
SE = State Endangered
ST = State Threatened
SCE = State Candidate Endangered
SCT = State Candidate Threatened
SR = State Rare
SD = State Delisted
SSC = CDFW Species of Special Concern
FP = CDFW Fully Protected
WL = CDFW Watch List

CRPR (CNPS California Rare Plant Rank)

1A = Presumed extirpated in California, and rare or extinct elsewhere
1B = Rare, Threatened, or Endangered in California and elsewhere
2A = Presumed extirpated in California, but common elsewhere
2B= Rare, Threatened, or Endangered in California, but more common elsewhere
3 = Need more information (Review List)
4 = Limited Distribution (Watch List)

CRPR Threat Code Extension

.1 = Seriously endangered in California (>80% of occurrences threatened/high degree and immediacy of threat)
.2 = Moderately threatened in California (20-80% of occurrences threatened/moderate degree and immediacy of threat)
.3 = Not very endangered in California (<20% of occurrences threatened/low degree and immediacy of threat)

Other Statuses

G1 or S1 Critically Imperiled Globally or Subnationally (state)
G2 or S2 Imperiled Globally or Subnationally (state)
G3 or S3 Vulnerable to extirpation or extinction Globally or Subnationally (state)
G4/5 or S4/5 Apparently secure, common and abundant
GH or SH Possibly Extirpated – missing; known from only historical occurrences but still some hope of rediscovery

Additional notations may be provided as follows

T – Intraspecific Taxon (subspecies, varieties, and other designations below the level of species)
Q – Questionable taxonomy that may reduce conservation priority

Appendix B

Xerces Society - Western Monarch Count Protocols and Datasheet

Habitat Assessment Survey Instructions

Protocol for the Xerces Society's Western Monarch Count

Thank you for your interest in conducting a western monarch overwintering habitat assessment. The information that you collect is valuable to document site conditions, boundaries, and threats. And, if used regularly, these assessments can be used to document changes in a site over time. The data may also be useful to site managers and conservation groups to help inform overwintering site restoration and management. To get started, gather the supplies you will need.

Equipment List

- Habitat Assessment Survey Instructions
- Habitat Assessment Datasheet (hardcopies, or set up on the Survey123 app)
- Binoculars
- Pen or pencil (if using hardcopy datasheets)
- Clipboard (if using hardcopy datasheets)
- GPS unit or smart phone w/ GPS capability (helpful but not required)
- Compass or smart phone w/ Compass app (helpful but not required)
- Kestrel pocket weather meter or outdoor weather thermometer (helpful but not required)
- GPS unit or smart phone w/ GPS capability (helpful but not required)
- Plant identification field guide or the Seek by iNaturalist app (helpful but not required)
- Camera or phone for taking pictures (helpful but not required)

Instructions

There are two versions of Habitat Assessment datasheets—the Short Form and the Long Form—feel free to use whichever datasheet you have time and equipment for. Once you have chosen a datasheet, please fill out all fields to the best of your ability. If you are unsure for any fields, no information is better than inaccurate information (please leave fields blank if this is the case). The majority of fields listed on the datasheet are self explanatory; however, we've listed a few definitions and instructions for fields that require further explanation under the section titled "Monitoring Definitions" below.

When and How Often to Count

Habitat Assessments can be conducted at any time, but they are most helpful during the overwintering season when clustering monarchs may be observed. Temperature is less important for the Habitat Assessment surveys, so you should always conduct the Monarch Count first. Please aim to fill out a habitat assessment once a year per site.

Submitting Data

Monarch Count and Habitat Assessment data should be submitted as soon as possible through the Survey123 mobile app or online forms available at WesternMonarchCount.org. Monitoring partners will need to decide who is responsible for submitting their joint datasheet and plan accordingly to avoid submitting multiple reports of the same data. If inconsistencies, missing

data or protocol concerns are noted, a Xerces staff person or regional coordinator will attempt to contact the individual(s) for clarification, using the email provided in their datasheet.

Monitoring Definitions

General Site Information

- **Site ID:** This is the unique 4-digit number assigned to the site from the Xerces Society's Western Monarch Overwintering Sites Database. You can find a Site ID using the interactive map on the project website, WesternMonarchCount.org.
- **Property Owner:** This is the legal owner of the property that the overwintering site is located on. This may be a public agency such as the U.S. National Forest Service or California Department of Parks and Recreation (State Parks), private landowners such as home owners or business owners or non-profit organizations. List multiple owners if applicable. If the property owner is a private landowner, please provide the individual, family, or company's name and contact information, if known.
- **Current Land Use:** This is the primary human use of a specific land area. Some examples include city, regional, county, state or national parks; state or national forests; residential; commercial; industrial; agricultural; golf courses; or other land uses. List multiple land uses if applicable.
- **Site Location/Directions:** Please be as specific as possible, make the directions so that anyone with the directions could find the site, particularly if you are documenting a new site. Be sure to include relevant information such as town names, highway or street names, river or stream names, and distances, if applicable.

Site Access Categories

- **Open Access:** Unrestricted direct access to the site/cluster trees (e.g., public parks or open spaces that remain open all/most hours, public walkways, roadways, or parking lots)
- **Limited Access:** Complete or partial access to the site/cluster trees *with* limitations or restrictions (e.g., fees, limited operating hours, requires site access coordination or special permissions, environmental obstacles, etc.)
- **No Access:** No direct access at this time; however, the site may or may not be visible from a nearby location, such as a public road (e.g., private property, restricted access area, environmental barriers, etc.)

Weather Data

If you have access to a Kestrel pocket weather meter (or similar device), please use this to collect the microclimate data. Be sure to note the metric used (e.g., mph vs. m/s, C vs. F). If you do not have access to this device, please skip the relative humidity data field and use an outdoor weather thermometer to record the temperature data. If you do not have access to any weather device, leave this section blank.

Habitat Information

Answer habitat information questions based off of the core cluster areas where monarchs typically congregate at the site. Clustering is defined as three or more adjacent monarchs with

closed wings. If you do not know where monarchs cluster at the site and do not see any clustering while you are doing this survey, indicate that on the form. You can contact Xerces (wmtc@xerces.org) to get a copy of the site report and any spatial information we have about where monarchs typically cluster so you can refine your search area in advance.

Community Structure

Record a visual estimate of the percentage each forest structure layer (i.e. tree, shrub, herbaceous layer) occupies. Note: The total for all layers combined can be greater than 100%.

- **Tree cover** is measured by imaging that the tree cover is viewed from above in two dimensions as if it were pressed flat against the ground. Densely growing trees would be 80-100% cover, whereas very sparsely growing trees would be 20% or less cover.
- **Shrub cover** includes woody species that do not reach tree height.
- **Herbaceous cover** comprises forbs (most non-woody flowers), grasses, or other plants that are not woody.
- **Leaf litter** cover is the percentage of dead material such as leaves, branches, and tree bark that covers the ground.
- **Bare soil** cover includes all exposed soil not covered by plants or dead material. Consider each layer on its own.

Photopoints

If you are able, please take several photographs of the site. Try to capture images of the monarch cluster trees with notable landmarks visible, any threats or disturbances observed at the site, and any key resources (e.g., wind buffers, nectar/water sources, etc.) that monarchs are using. Record a description of each photopoint and note the GPS coordinates and what each photo is showing. Send in your photos when you submit your datasheet, whether that is via the Survey123 app, online forms, or over email.

Overall Site Sketch/ Location Data

Providing a hand-drawn map, aerial map, Google Maps image, ArcGIS shapefile, or Google Earth kmz file with the site boundaries, cluster locations, and/or other important features clearly marked is very helpful. Draw as much information as you can, including monarch cluster trees, trees within the grove in which monarchs are not roosting, buildings, trails, streams/rivers, adjacent roads or highways, signs, areas with nectar plants, and open areas. Please provide GPS coordinates of the cluster locations and any threats or disturbances observed at the site. If known, note the accuracy of the GPS unit and the datum (i.e. NAD27, NAD83, WGS84) that the data is collected in. Many smartphone compass apps will show coordinates, so please double check on this before monitoring your site. If you do not have access to GPS, leave this section blank on the hardcopy datasheet, and add in location information when you submit data via the online forms.

Thank you for participating in the Western Monarch Count!

Please refer to the resources available at WesternMonarchCount.org for more information.

Habitat Assessment (Long Form) Datasheet

Xerces Society's Western Monarch Count

Date _____ Site ID # _____ Site Name _____

Observers (first & last names) _____

Survey Start Time _____ ☐AM / ☐PM End Time _____ ☐AM / ☐PM

County _____ Property Owner _____

Site Access (defined in protocol document): ☐ Open Access / ☐ Limited Access / ☐ No Access

Site Access Notes (e.g., What coordination is required to gain access to the site? What are the limitations or barriers?)

_____

_____

Directions to Site (e.g., Best parking? Navigating/walking to cluster trees?) _____

_____

Please provide GPS coordinates of the grove's boundaries. If the grove is an odd-shaped polygon or many cluster trees, please draw a map on the back of this sheet, or make a shapefile/kmz using Google Earth or GIS products.

GPS Point of Grove's Northern corner: _____N _____W Accuracy (ft): _____
GPS Point of Grove's Eastern corner: _____N _____W Accuracy (ft): _____
GPS Point of Grove's Western corner: _____N _____W Accuracy (ft): _____
GPS Point of Grove's Southern corner: _____N _____W Accuracy (ft): _____
GPS Point of Cluster tree #1: _____N _____W Accuracy (ft): _____
GPS Point of Cluster tree #2: _____ N _____W Accuracy (ft): ____

Datum of GPS Unit: ☐ NAD27 ☐ NAD83 ☐ WGS84 ☐ Smartphone ☐ Unknown

Weather and Microclimate

Cloud/fog cover: _____ %

Precipitation: ☐ none ☐ drizzle ☐ rain ☐ downpour

Microclimate INSIDE the grove, near the cluster trees

Temperature: _____ ☐ °F ☐ °C
Relative Humidity: _____
Average wind speed _____ (☐ mph / ☐bft) Maximum wind speed _____ (☐ mph / ☐bft)
Wind Direction (direction wind is coming FROM), circle what applies: N, NE, NW, S, SE, SW, W, E

Wind OUTSIDE the grove, away from the cluster trees

Temperature: _____ ☐ °F ☐ °C
Relative Humidity: _____
Average wind speed _____ (☐ mph / ☐bft) Maximum wind speed _____ (☐ mph / ☐bft)
Wind Direction (direction wind is coming FROM), circle what applies: N, NE, NW, S, SE, SW, W, E

Monarchs Observed? ☐ Yes / ☐ No

If so, is there an associated count data sheet? ☐ Yes / ☐ No

If not, roughly how many monarchs were observed? _____

Habitat Assessment (Long Form) Datasheet

Xerces Society's Western Monarch Count

Habitat Information

1. Is there a wind buffer between the cluster trees and the edge of the grove?
   ☐ Yes / ☐ No / ☐ No current cluster trees.
   If so, in what directions (circle all that apply)? N, NE, NW, S, SE, SW, W, E

2. Describe the grove's tree arrangement (e.g., u-shape, linear along a drainage, dense grove with scattered openings, etc.) _____

3. Do the cluster trees get direct sunlight? ☐ Yes / ☐ No / ☐ No current cluster trees.
   If so, during what times of day (circle those that apply)? ☐ Morning / ☐ Midday / ☐ Afternoon / ☐ Other

4. Are there dead/diseased/hazard trees in the grove? ☐ Yes / ☐ No
   If so, please describe their location, # of affected trees, and species _____
   _____

5. Is there fresh water (including dew) available nearby? ☐ Yes / ☐ No
   If so, what is/are the source(s)? ☐ Dew / ☐ Stream / ☐ Pond / ☐ Lake / ☐ Other _____
   How far away is it from the cluster trees? _____ ☐ feet / ☐ meters ☐ yards

6. Are nectar plants currently blooming nearby? ☐ Yes / ☐ No

Record what species are present (check all that apply). If possible, rate the relative amount of blooms available to monarchs per species: A= abundant; M= moderate; S= scarce)

Native Species:	Native Species (cont.):	Non-native Species (cont.):
__Narrow leaf milkweed (*Asclepias fascicularis*)	__ Red alder (*Alnus rubra*)	__ English ivy (*Hedera helix*)
__ Mule fat/seep willow (*Baccharis glutinosa*)	__ Aster (*Aster* sp.)	__ German ivy (*Senecio mikanioides*)
__ Coyote brush (*Baccharis pilularis*)	__ Seaside fleabane (*Erigeron glaucus*)	__ Passionflower vine (*Passiflora* sp.)
__ Arroyo willow (*Salix lasiolepis*)	Other: _____	__ Bull thistle (*Cirsium vulgare*)
__ Other willow (*Salix* sp.)	_____	__ Wild radish (*Raphanus sativus*)
__ Monkeyflower (*Mimulus* sp.)	_____	__ English daisy (*Bellis perennis*)
__ Morning glory (*Calystegia* sp.)	Non-native Species:	__ White nightshade (*Solanum nodiflorum*)
__ Miner's lettuce (*Montia perfoliata*)	__ Tropical milkweed (*Asclepias curassavica*)	__ Ice plant (*Mesembryanthemum* sp.)
__ Dune groundsel/ragwort (*Senecio blochmaniae*)	__ Blue gum (*Eucalyptus globulus*)	__ Field bindweed (*Convolvulus arvensis*)
__ Mock heather (*Ericameria ericoides*)	__ Red gum (*Eucalyptus camaldulensis*)	__ Chrysanthemum (*Chrysanthemum* sp.)
__ Crisp dune mint (*Monardella crispa*)	__ Black mustard (*Brassica nigra*)	__ Klamath weed/tansy mustard (*Senecio* sp.)
__ California blackberry (*Rubus ursinus*)	__ Unknown or other mustard (*Brassica* sp.)	__ Lily-of-the-Nile (*Agapanthus africanus*)
__ Manzanita (*Arctostaphylos* sp.)	__ Common dandelion (*Taraxacum officinale*)	__ Sweet fennel (*Foeniculum vulgare*)
__ Blue blossom (*Ceanothus thyrsiflorus*)	__ Ox-eye daisy (*Chrysanthemum leucanthemum*)	__ Bottlebrush (*Callistemon* sp.)
__ Western goldenrod (*Euthamia occidentalis*)	__ Periwinkle (*Vinca major*)	__ Lantana (*Lantana* sp.)
__ Bluedicks (*Dichelostemma capitatum*)	__ Butterfly bush (*Buddleia* sp.)	__ Lemon (*Citrus limon*)
		__ Pride of madeira (*Echium fastuosum*)
		Other: _____
		_____
		_____

7. How close is the closest nectar source from the monarch cluster trees? _____ ☐ feet / ☐ meters ☐ yards

Habitat Assessment (Long Form) Datasheet

Xerces Society's Western Monarch Count

8. Did you observe monarchs feeding on nectar? ☐ Yes / ☐ No

If yes, which species? _____

9. Record the tree species that monarchs are clustering on (check all that apply).

__ Blue gum (*Eucalyptus globulus*)	__ Coastal redwood (*Sequoia sempervirens*)
__ Red river gum (*Eucalyptus camaldulensis*)	__ Coast live oak *(Quercus agrifolia*)
__ Unknown or other Eucalyptus species (*Eucalyptus spp.*)	__ Western sycamore (*Platanus racemosa*)
__ Monterey pine (*Pinus radiata*)	__ Willow (*Salix spp.*)
__ Unknown or other pine (Pinus spp.)	__ Acacias (*Acacia spp.*)
__ Monterey cypress *(Cupressus macrocarpa*)	Other: _____

10. Record other tree species present at the site that monarchs are <u>not</u> clustering on (check all that apply).

__ Blue gum (*Eucalyptus globulus*)	__ Coastal redwood (*Sequoia sempervirens*)
__ Red river gum (*Eucalyptus camaldulensis*)	__ Coast live oak *(Quercus agrifolia*)
__ Unknown or other Eucalyptus species (*Eucalyptus spp.*)	__ Western sycamore (*Platanus racemosa*)
__ Monterey pine (*Pinus radiata*)	__ Willow (*Salix spp.*)
__ Unknown or other pine (Pinus spp.)	__ Acacias (*Acacia spp.*)
__ Monterey cypress *(Cupressus macrocarpa*)	Other: _____

11. Estimate the community structure composition (total can be >100% for all layers combined).

Tree cover ____% Shrub cover ____% Herbaceous cover ____% Leaf litter ____% Bare soil ____%

12. Record any threats or disturbances you observe at the site (check all that apply).

__ Storm damage	__ Cattle/burro/other livestock grazing
__ Cut trees	__ Pesticide use at site (observed)
__ Trimmed trees	__ Pesticide use at site (likely)
__ Possibly too dense of trees (i.e. too much shade)	__ Fire damage
__ Trees diseased from pitch canker	__ Construction
__ Trees diseased from Eucalyptus leaf beetle	__ Buildings
__ Trees diseased from Eucalyptus lerp psyllid	__ Pavement
__ Trees diseased from Eucalyptus longhorn borer	__ Parking lot
__ Trees diseased from unknown source	__ Mowing/plowing of nectar plants
__ Dead/dying trees from non- disease source	__ Railroad tracks
__ Old/aging trees	__ Extensive trails
__ Utility maintenance	__ Road (within the site)
__ High human visitation load	Other: _____
__ Erosion	_____
__ Campsite	

13. Describe the disturbances/threats in greater detail, if possible. For example, if you observed dead/dying trees, how many did you observe and are they cluster trees? If the site is affected by erosion, what is the cause of the erosion? _____

_____

_____

Habitat Assessment (Long Form) Datasheet

Xerces Society's Western Monarch Count

14. Record any threats or disturbances you observe OUTSIDE but nearby the site (check all that apply).

__ Roads/Highways	__ Parking lot
__ High vehicle traffic area	__ Pesticide/herbicide use in landscape (observed)
__ Housing Developments	__ Pesticide/herbicide use in landscape (likely)
__ Shopping Malls/Restaurants	__ Construction
__ Pavement	Other: _____

15. Record possible FUTURE threats that seem likely to affect this site (check all that apply).

__ High possibility that overwintering trees will be cut	Other: _____
__ Site might become too dense/shady in the future	_____
__ Site might not offer enough wind protection in the future	
__ Proposed housing development	
__ Proposed expansion of facilities or buildings within the site	

16. Is there a staff and/or docent presence at the site? ☐ Yes / ☐ No

If so, from what agencies/groups (list all that apply)? _____

_____

Photopoints

Camerapoint Description: _____

_____

Photopoint #1 Description: _____

_____

Photopoint #2 Description: _____

_____

Notes:

Overall Site Sketch

Provide a sketch here or on the back of the datasheet; utilize aerial maps, ArcGIS, Google Earth, Google Maps, or other programs to provide a more detailed map of the site and its major features, including cluster locations, if possible.

Monarch Count Datasheet

Xerces Society's Western Monarch Count

Date _____ Site ID # _____ Site Name _____

Observers (first & last names) _____

Site Access (defined in protocol document): ☐ Open Access / ☐ Limited Access / ☐ No Access

Access Notes (e.g., ownership, directions, etc.) _____

_____

Count Start Time _____ End Time _____ Cloud/Fog Cover _____ %

Temp (°F or °C) _____ Precipitation: ☐ none / ☐ drizzle / ☐ rain / ☐ downpour

Wind_____ (☐ mph / ☐bft) Wind Direction (direction wind is coming FROM) _____

# Monarchs Clustered	Tree Species	Cluster Height (m)

# of Clustered (sum):	*Tally every butterfly of each category that you observe at the overwintering site.*	**# Dead:**
# of Sunners:		**# Mating:**
# of Fliers:		**# Tagged** *(note tag numbers)*:
# of Loners:		
# of Grounders:		
GRAND TOTAL: *(clustered + sunners + fliers + loners + grounders)*		

Additional rows for monarch cluster data, if needed. Don't forget to add these to your grand total!

# Monarchs Clustered	Tree Species	Cluster Height (m)

Thank You for Participating in the Western Monarch Count!

Please submit your data through the online forms found at WesternMonarchCount.org

Appendix C

U.S. Fish and Wildlife Service Coastal Program Workplan for the Moran Lake Monarch Butterfly Management Update 2021

U.S. Fish and Wildlife Service
Coastal Program for Central California Coast

COASTAL PROGRAM WORK PLAN
Moran Lake Monarch Butterfly Management Plan Update 2021

The conservation project described below is agreed to by the Service, and Santa Cruz County Parks Department.

Description of Project and Objectives: The Santa Cruz County Parks Department will work in partnership with the Service, to update the Monarch Butterfly Habitat Management Plan for the Moran Lake County Park. This project will not be the subject of habitat restoration activities, but it is anticipated that the result of this plan will lead to implementation of habitat improvement activities at the Moran Lake site.

- **Project Location:**

Moran Lake County Park is located within the city limits of Santa Cruz, California and is owned by the County of Santa Cruz. Moran Lake park is a multi-use public park situated immediately inland of the Pacific Ocean. The park is also surrounded by residential neighborhoods on three sides. Specifically, the park is located at 22775 E Cliff Dr, Santa Cruz, CA 95062.

- **Baseline Assessment:**

Monarch butterflies are suffering steep population declines throughout their North American range and especially so with the western population. West coast wintering surveys have shown an almost 100% decline in monarch returns within the last five years. In 2020 the USFWS determined that the monarch butterfly was warranted for listing under the Endangered Species Act (ESA) but that listing precluded by higher priority actions.
Wintering population surveys at the Moran Lake monarch overwintering grove located near Santa Cruz, California is no acceptation. Listed as one of the top-ten highest priority sites by the Xerces Society in 2016, this site had almost no monarch overwinter during the 2020-2021 winter. The County of Santa Cruz owns and manages monarch habitat at Moran Lake County Park and they propose to plan and implement habitat improvements over the next decade. In 2010 the County of Santa Cruz Parks Department developed a "Monarch Butterfly Habitat Management Plan" that needs updating with the most recent monarch population use and habitat information. This proposal will provide an updated Monarch Butterfly Habitat Management Plan for Moran Lake County Park. Other sub-tasks include an updated site assessment and specific management recommendations.

Statement of Problem:

- **Problem Statement 1:** The Santa Cruz County Parks Department (County Parks) lacks a comprehensive, updated, and certified management plan for the monarch butterfly overwintering habitat at Moran Lake County Park.
- **Problem Statement 2** - The lack of a plan inhibits County Parks from implementing appropriate tree management, including replacements, to enhance monarch overwintering habitat as hazardous tree pruning and removal is completed incrementally at the overwintering site.

- **Problem Statement 3** - The lack of a plan also inhibits County Parks from pursuing other park and habitat enhancements such as invasive species removal, increased understory nectar plantings, and additional tree plantings.
- **Problem Statement 4** - County Parks is not able to create an updated management plan without a site assessment and recommendations from a qualified entomologist.

Restoration Hypothesis:

- **Hypothesis 1:** The number of overwintering monarchs present at Moran Lake will increase if County Parks completes habitat enhancements including but not limited to planting additional windscreen trees, establishing additional winter nectar sources, and managing recreational activities to protect overwintering monarchs.

Specific Project Goals and Objectives:

- **Goal 1** - Enhance monarch butterfly habitat at Moran Lake Park.
    - **Objective 1** - By 2023, create an updated site assessment and set of management recommendations, based on monitoring of the overwintering monarch site, to be referenced and considered in a future Monarch Butterfly Habitat Management Plan.
    - **Objective 2** - By 2023, with stakeholder and community input, prepare an updated Monarch Butterfly Habitat Management Plan for Moran Lake County Park, and prepare environmental review document in accordance with the California Environmental Quality Act, bring to the County Board of Supervisors for review and adoption, allowing subsequent objectives to be completed.
        - **Task 1:** Contract a qualified entomologist, specializing in migratory monarchs, to monitor the site and complete an updated site assessment, and to provide a set of recommendations for monarch habitat management at Moran Lake County Park

Specific Landowner Objectives:

- **Objective 1 -** By 2023, establish annual monarch monitoring program in accordance with updated Monarch Butterfly Habitat Management Plan.
- **Objective 2 -** By 2023, establish tree and understory monarch habitat monitoring program in accordance with the updated Monarch Butterfly Habitat Management Plan.
- **Objective 3 -** By 2030, complete other park improvements to be consistent with updated Monarch Butterfly Habitat Management Plan including park trail construction, drainage improvements, interpretive improvements and other public access and ADA improvements.

Additional Unforeseen Habitat Improvements:

In addition to the above the project activities, the partners agree that should any additional or other priority habitat improvements be identified by the Service on this or other lands owned by the landowner(s), such improvements will be incorporated as part of the project with prior written approval of all signatories to the Coastal Program Agreement and/or Work Plan through a Modification. Additional USFWS funding may be obligated to this project through a modification.

Who will manage the project?

- Will Fourt of the County of Santa Cruz Parks Department will be the primary project manager. Shawn Milar and Samantha Marcum of the USFWS staff will provide specific on-the-ground management recommendations and technical expertise.

Habitat Accomplishments Anticipated: Not applicable. This project will produce a habitat management plan. Future habitat restoration activities will likely be informed by this proposed plan but are not anticipated with FY2021 obligated funding. Future funding assistance may be considered for habitat restoration activities.

Accomplishment	Explain	Location Shown in Figure?
1) Monarch Butterfly Habitat Management Plan	**Update to 2010 Moran Lake Monarch Butterfly Management Plan by 2023**	**Figure 1,2**

Additional Reporting Details: In addition to the information presented in the Notice of Award Letter, Santa Cruz County Parks Department will provide the following for your Annual and Final Reports on the project.

- **Annual Reports:**

    a. Annual performance reports should at minimum include:
        i. Activities Completed (what, when, where)
            1. What activities completed since the last reporting period
            2. When? include X Date to X Date.
            3. Where? Ex. - X occurred in the pasture c.
        ii. Photos Before and After (whatever appropriate).
        iii. Statements explaining any problems or delays in implementing project tasks.
        iv. Lessons learned: (if appropriate)
        v. Other Reporting: If submitting reports to other federal, state, and local agencies and the above annual report content met then submitting these reports is acceptable.
    b. Submit annual reports via email to USFWS Project Officer (see below for contact information).

- **Final Report:**

    c. Includes all of above information/headings with a synthesis of all project activities completed.
    d. The final report must be submitted to the USFWS Project Officer before you submit the final invoice for payment on the project. Please note that prior to submitting final report

we require Service review of the draft final report at least 15 days before finalizing to allow for the incorporation of our feedback and comments before going final.

All reports must be submitted to:

USFWS Project Officer

Name: Shawn Milar, Coastal Program Biologist
Address: 1352 Lighthouse Avenue
City/State/Zip: Pacific Grove, CA 93950
Phone: 83-648-0623
Email: shawn_milar@fws.gov

Provide all photos electronically (including those presented in body of reports). By providing these photos, you grant the Service permission to use such photos (submitted by you or your organization) in Service educational publications and/or in the Service Web Page and for other educational non-commercial uses. We will ensure you or your organization receives appropriate credit for such photos.

Special Conditions and Provisions:

A. Joint Obligations: The USFWS and the County of Santa Cruz Parks Department work cooperatively in further developing the monarch butterfly habitat management plan as proposed by this agreement. Further, each shall;

1. Communicate on a regular basis (at least quarterly) to assess project progress, accomplishments, needs, and shortfalls.
2. Jointly prepare a project summary report for the project as outlined in the reporting requirements section.

B. The Service will:

1. Work cooperatively with the County of Santa Cruz County Parks Department to provide project guidance for activities conducted pursuant to this Agreement where appropriate;
2. Ensure that the project complies with the following Federal laws and regulations:
    a. Section 106 of the National Historic Preservation Act
    b. National Environmental Policy Act
    c. Endangered Species Act
3. Assume no liability for damage or injury other than that caused by its own negligence, on the above project site. The Service does not assume jurisdiction over the premises by this Agreement. The landowners participating under this Work Plan retain all rights to control trespass and retains all responsibility for taxes, assessments, and damage claims;
4. Ensure County of Santa Cruz County Parks Department receives appropriate credits for all photos provided to the Service.

C. Santa Cruz County Parks Department will:

1. Serve as administrator of contracts, services, materials acquisitions, and disbursement of the Service's cost-share for activities relating to project completion.
2. Work cooperatively with the Service to carry out this agreement to participate in fish and wildlife conservation activities.
3. Maintain proper books, records, and accounts of all specific project expenditures for the project. (The Service must have the right to review the appropriate documentation to verify project expenditures upon a 30-day notice in writing from the Service.)
4. Work directly with interested parties and project stakeholders to complete the objectives outlined in this agreement;
5. Grant the Service permission to use photos submitted by Santa Cruz County Parks Department in the Service's educational publications and/or in the Service's Web Page and for other educational non-commercial uses;
6. Ensure that the funds provided by and activities conducted pursuant to this Work Plan are not to replace, supplement or otherwise contribute to any mitigation or compensation that may be required of the landowner, or other parties as a result of development or other activities that impact habitat on the project site;
7. Provide substantive written progress reports to the Service, as specified in the Reporting Requirements section of the Notice of Award letter and Additional Reporting section of this Work Plan.

Budget Table

Item (main headings should match 424a budget form's object class categories)	Cost	Coastal Program (USFWS)**
Contractual	***$20,000***	**
TASK 1. Funding for Santa Cruz County Parks Department to contract a qualified entomologist, specializing in migratory monarchs, to monitor the site and complete an updated site assessment, and to provide a set of recommendations for monarch habitat management at Moran Lake County Park		$20,000
Total Project Costs	**$20,000**	**$20,000**
% Cost-shares	**100%**	**100%**

** Coastal Program totals needs to match Object Class Categories on SF 424A Budget form

CONTRIBUTIONS (DETAIL OF FUNDING BY SOURCE)

	Cash	In-kind	Total
Breakdown of Cost-shares			
Coastal Program (USFWS)	$20,000	$0	$20,000
Total Cash and In-kind Contributions	$20,000	$0	$20,000

Budget Narrative:

Task 1. USFWS will provide $20,000 in funding to the Santa Cruz County Parks Department specifically for contracting a qualified entomologist who specializes in migratory monarchs who will monitor the site, complete an updated site assessment, and to provide a set of recommendations for monarch habitat management at Moran Lake County Park.

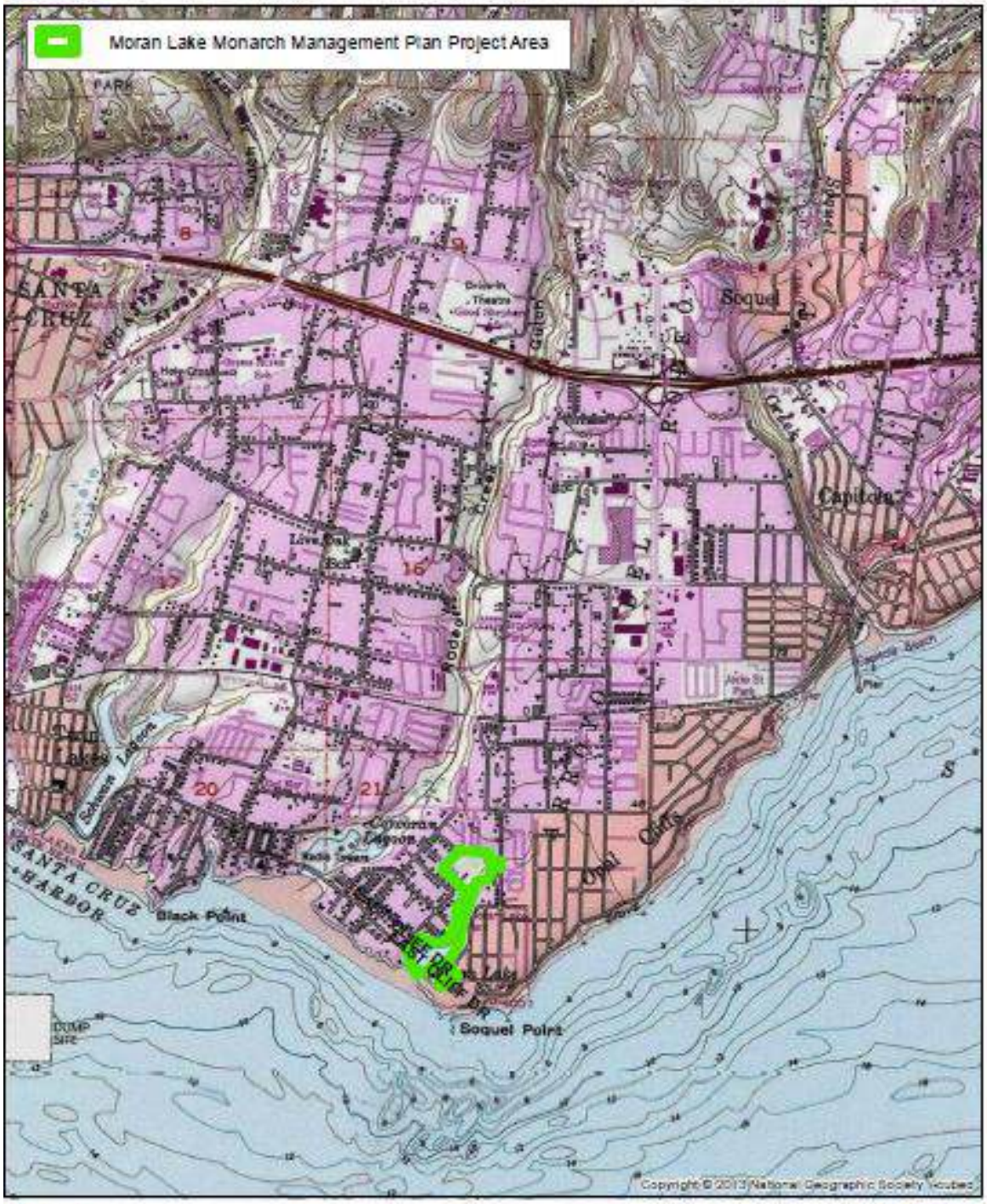


Exhibit 1:
Project Area

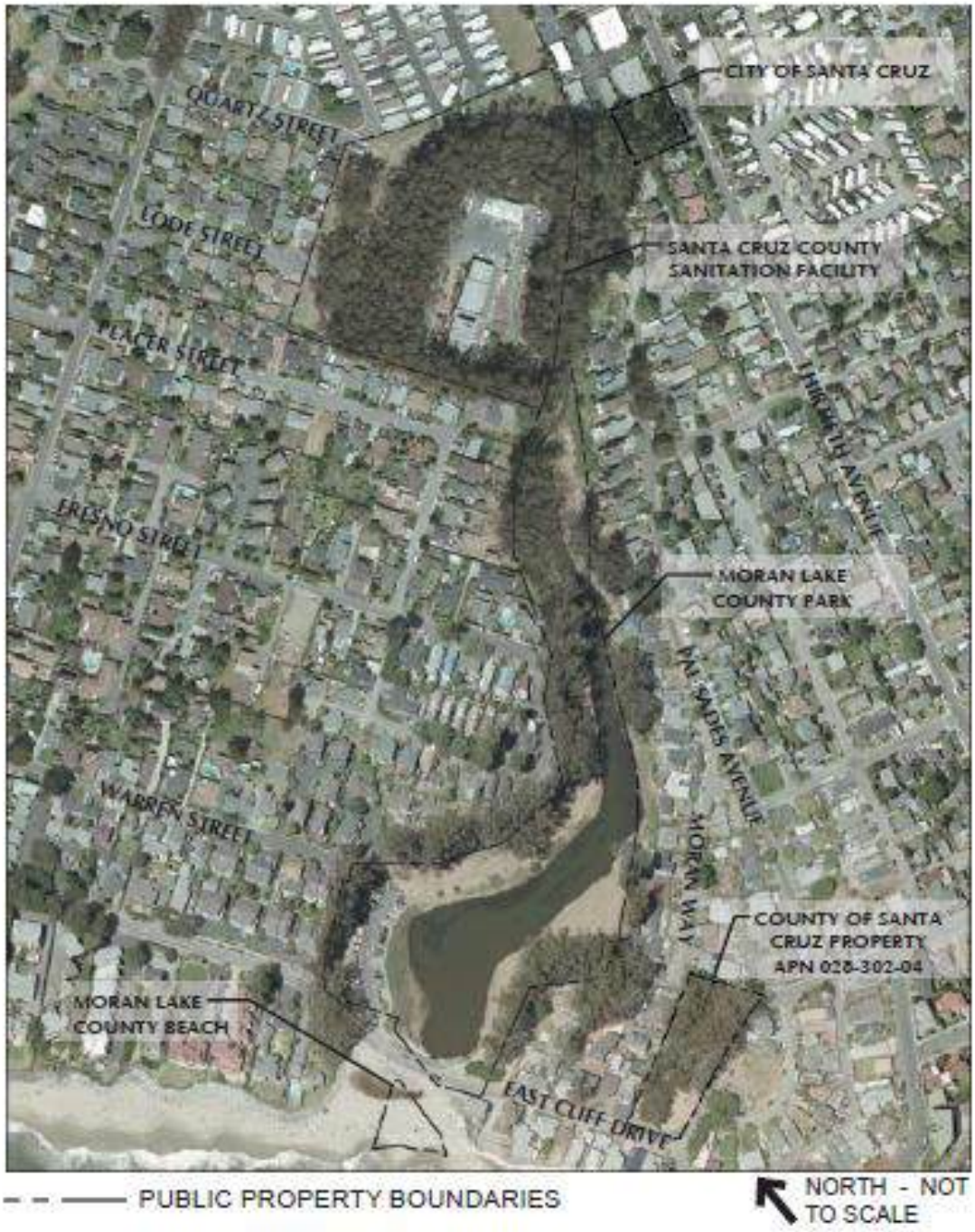


Figure 2, Moran Lake County Park boundary and surrounding infrastructure.

Appendix D

Past Studies and Reports Completed for Moran Lake Monarch Butterfly Management Area

Past Monarch Butterfly Habitat Management Reports - Moran Lake

1982	*Revegetation monitoring*
03/02/1987	*Environmental Baseline Study*. Gery Stern, Paul Courter, Sally Sample.
03/2005	*Technical Report: Moran Lake Water Quality Study & Conceptual Restoration Plan*. John Gilchrist & associates, Fall Creek Engineering, Inc.
08/09/2010	*Moran Lake monarch Butterfly Habitat Management Plan*. Joni L. Janecki & Associates, John Gilchrist & Associates, Fall Creek Engineering, Barrie Coate consulting Arborist, Entomological Consulting Services Ltd, Erica Fielder Studio.
06/14/2017	*Assessment of potential impacts on monarch butterfly wintering habitat at the D.A. Porath Sanitation Facility that may result from proposed vegetation management in the western grove area*. John Dayton
07/17/2017	*Tree Survey and Maintenance Matrix*. Nigel Belton.
07/28/2017	*Tree Survey and Location Map, Lode Street Facility*. Nigel Belton.
08/12/2017	*Revision to tree management report and tree survey & maintenance matrix concerning the blue gum eucalyptus trees on scco sanitation facility property*. Nigel Belton
09/01/2017	*A biotic Assessment of the Potential Impacts on Monarch Butterflies Wintering at Moran Lake that may result from six proposed tree trimmings and removal projects at Moran lake county park and the D.A. Porath Sanitation Facility in Santa Cruz County*. John Dayton
10/10/2018	*Recommendations for the planting of replacement trees and preservation of habitat on the county sanitation facility site at 2750 lode street.* Nigel Belton.
04/18/2020	*Tree Maintenance Matrix*. Nigel Belton
05/04/2021	*Letter to SC Parks RE 40 Moran Way.* John Dayton
07/02/2021	*Moran Lake Monarch Butterfly Habitat Management Plan Update*
04/2023	*Maintenance Activities of the Eucalyptus grove at DA Porath Facility*

Kay

REVEGETATION OF THE SHORELINE AREAS OF MORAN LAKE, SANTA CRUZ, CALIFORNIA

Marine Research Center (MRC) has been involved in the planning for the Moran Lake Enhancement Project since early 1980. MRC staff made observations of the area and subsequent recommendations on the revegetation aspects of the project. The overall goal was to establish an intertidal salt marsh with a wide variety of habitats and food for shorebirds, waterfowl, and wildlife.

Initial planting recommendations were for the development of three contiguous planting zones. The first zone would be the submerged and partially submerged portion of the lake; the second, the shoreline or intertidal zone; and the third, the upper transition zone. Plant establishment elevations of these zones would be determined by the tidal levels fluctuating within the lake.

The water levels, and thus the planting zones, were to be assured by the construction of a large culvert between the lake and the ocean allowing for the re-establishment of tidal influence. Dredging to enlarge the tidal prism within the lake in combination with the culvert could not overcome the littoral buildup of sand on the ocean side of the culvert. This buildup of beach sand blocks the flow of water in and out of the lake, eliminating tidal fluctuations.

With fluctuation of water in and out of the lake impeded, the characteristics of the lake for salt marsh development became very different from those anticipated. The water lake changed to a periodic stagnant situation in which accumulating runoff and detritus are concentrated by evaporation, thereby accelerating eutrophication. In addition, saltwater intrusion by very high tides introduces salts to the lake which are also concentrated through evaporation.

The salinity of the lake varies greatly. On March 18, 1982 salinity of the lake was measured at 1.1 parts per thousand (ppt), but by May 28, 1982, it was 26 ppt. This difference was probably due to the cessation of freshwater runoff from the winter rains which diluted the salinity and the intermittent saltwater intrusion and evaporation.

The lack of intertidal action on the lake has two effects which impede revegetation of the shoreline: (1) it does not permit flushing of the lake to prevent the buildup of nutrients and salinity, and (2) without the tidal flood and ebb on the plants located within the intertidal zone, the establishment of a typical salt marsh would be difficult.

Test Planting

Initial test plantings of typical coastal salt marsh plant species were undertaken on October 12-13, 1981. These plantings were in all three planting zones in grid and transect patterns. Results from these plantings would provide an indication of the growth and percent survival of various species at a variety of elevations and water levels. The test plantings totaled 855 plants and included Spartina foliosa (200), Scirpus robustus (200), Scirpus acutus (5), Typha latifolia (100), Grindelia stricta (50), Juamea carnosa (50), Frankenia pacifica (50), Salicornia pacifica (50), Limonium californicum (50), Distichlis spicata (50), and Atriplex patula (50).

At the time of the test plantings, it was understood that intertidal action was not occurring in the lake, so plantings of intertidal species were placed within ±2 feet of the water level of the lake. This placement should resemble the mean tidal growth level of the plants. It must be understood that salt marsh plants of the intertidal zone are not obligate halophytes (i.e., they do not require saltwater to exist, but rather they are salt-tolerant; however, they do prefer to grow in the intertidal zone where they are submerged and exposed periodically by the water. The placement of test plantings was to determine if they could become established at some level ranging from exposed to partially submerged and grow without intertidal action.

Initial observations on the growth of the test plants indicated that those located on the bank and slope directly in front of the parking lot were undergoing the most severe transplant shock. Observations by Les Galyen and his maintenance staff revealed that these plants died about 6 to 7 weeks after planting. This observation could be death in fact, or it could be the appearance of death due to the dry look of the plants resulting from the transplant shock coupled with the onset of winter dormancy. Later information indicated that high concentrations of Boron and other heavy metals were in the the parking lot slope area which could account for the appearance of the plants.

In any event, the majority of the test plantings were washed away by the high flood waters of the January, 1982 rains. Only a few Salicornia plants survived in the lower zones. In the upper areas there were a few surviving Distichlis and Grindelia plants.

Final planting materials selection would have been based upon the initial test results with best surviving plants and zones being heavily planted.

Final Plantings

Final plantings at Moran Lake were conducted during three planting periods in May, 1982. The total number of plants installed during these periods, excluding those remaining from the test plantings, was 5,040. Plant species selected for the final plantings included Spartina foliosa (1000), Scirpus robustus (1000), Typha latifolia (700), Grindelia stricta (165), Cotula coronopifolia (500), Frankenia grandifolia (50), Salicornia pacifica (200), Distichlis specata (1200), and Atriplex patula (125). In addition to the plants above, 10-20 pounds of Spartina foliosa, Frankenia grandifolia, Limonium californicum, Distichlis spicata, and Isomeris maritima seeds were sown, during each of the three planting periods.

Spartina foliosa, Scirpus robustus, and Typha latifolia sprigs and tumps were planted at elevational zones of ± 1 foot of the existing water level in each of the three planting periods. In the second planting period, the water level had dropped about two feet below the level of the previous plantings. The plants installed during the second planting were placed at the new water's edge. In the third planting period, the water level had risen several feet and was completely inundating the plants of the second period. The final plantings were placed at the higher water level. If the water fluctuates between the levels found during the three planting periods there should be some intermediate zone where the plants will survive and grow. A total of 520 sprigs of these plants were stored at the waterline of the lake for later planting by park staff as the final water level establishes itself (see Table 1 for plants).

The upper transition zones were planted during each of the three periods with combination grids of the remaining plants. Vegetation in these areas should do well and would be helped in its initial establishment if watered by park maintenance staff.

Table 2 lists the species and numbers of each planted in each of ten zones around the lake. The map (Figure 1) shows the corresponding zones. The totals of all species planted and the numbers of each zone are noted on Table 2.

Conclusion

The lack of intertidal action is a critical factor in the success of plant establishment. It is hoped that a zone around the existing water level will support the lower salt marsh zone plants. If the water level should rise for a prolonged period to inundate the plantings, they may not survive.

Information regarding high levels of boron and other heavy metals was obtained only after the final plantings were done. The soil chemistry may contribute to the difficulty of the establishment of the plants in areas where there are high concentrations.

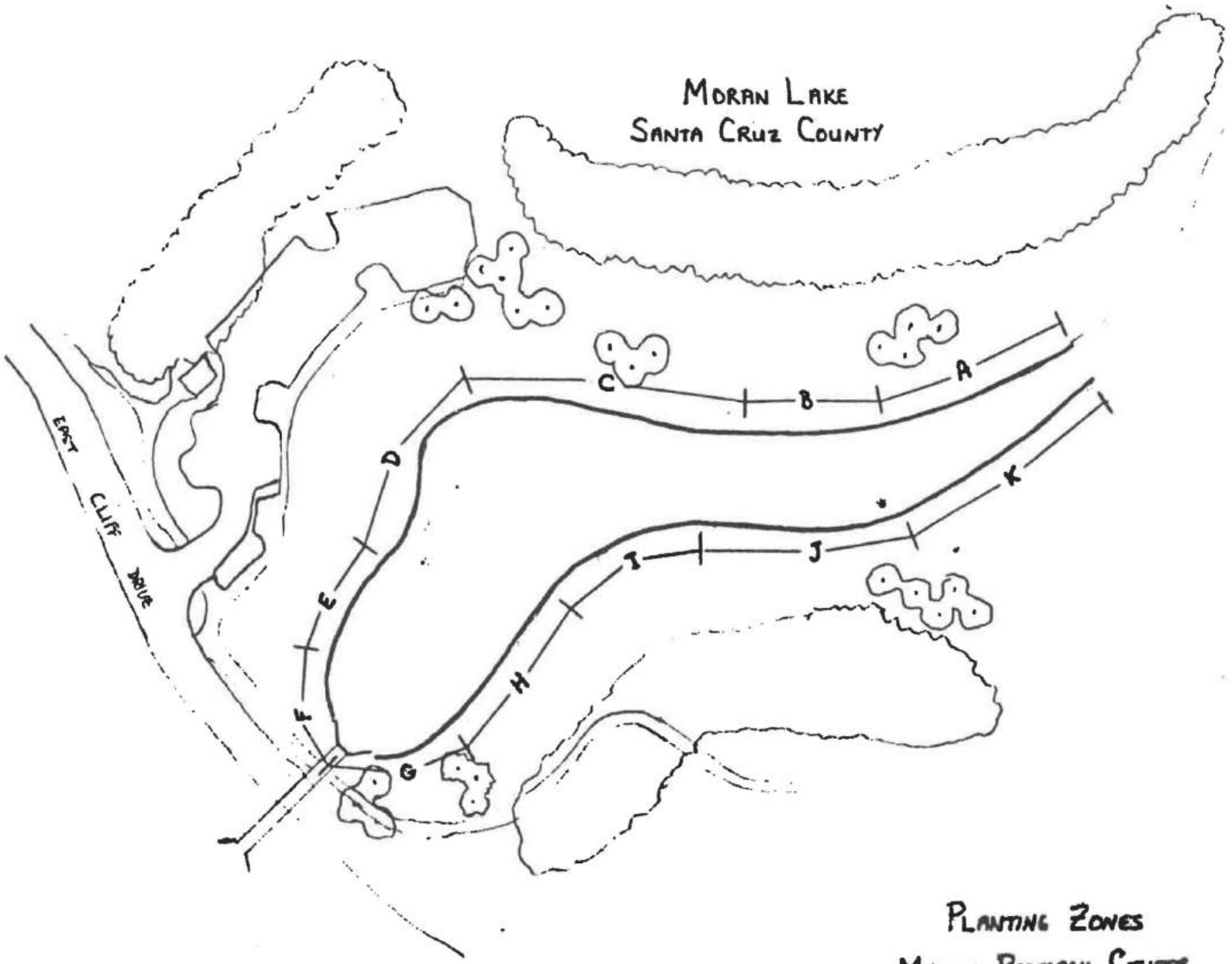
Observations during all three final planting periods showed that shortly after planting the water's edge, the resident duck population moved into those areas to rest, preen and feed. Their behavior seems to indicate an easy acceptance of this new vegetation in preference to the grass slopes they were using.

If any way could be found to open the culvert to constant intertidal action it would assure the establishment of a salt marsh and maintain water quality. But with the present situation, water level, nutrient content, and salinity will be subject to great variation throughout the year and will affect the lake shoreline and biota.

Table 1.

MORAN LAKE - PLANT COUNT

Spartina foliosa	200	1000	(200)	Yes	1200
Scirpus robustus	200	1000	(120)	-	1200
Typha latifolia	100	700	(200)	-	800
Grindelia stricta	50	165	-	-	215
Salicornia pacifica	50	200	-	-	250
Cotula coronopifolia	-	500	-	-	500
Distichlis spicata	50	1200	-	Yes	1250
Atriplex patula	50	125	-	-	175
Jaumea cornosa	50	100	-	-	150
Frankenia pacifica	50	50	-	Yes	100
Limonium californicum	50	-	-	Yes	50
Scirpus acutus	5	-	-	-	5
Isomeris maritima	-	-	-	Yes	-
	855	5040	(520)	-	5895



PLANTING ZONES
MARINE RESEARCH CENTER

Table 2

FINAL PLANTING - NUMBER OF PLANTS EACH AREA

Areas-	A	B	C	D	E	F	G	H	I	J	Stored	TOTAL
Spartina foliosa	-	-	258	129	75	53	70	140	75	-	200	1000
Scirpus robustus	10	20	202	150	100	50	73	145	90	40	120	1000
Typha latifolia	-	-	80	150	100	-	-	-	170	-	200	700
Grindelia stricta	1	15	3	33	18	35	-	4	35	21	-	165
Salicornia pacifica	12	-	50	67	15	11	-	45	-	-	-	200
Cotula coronopifolia	21	12	46	56	125	8	31	88	95	18	-	500
Distichlis spicota	8	12	149	200	340	60	-	224	200	7	-	1200
Atriplex patula	5	6	5	35	20	5	10	30	7	2	-	125
Jaumea carnosa	-	4	33	10	22	-	-	6	25	-	-	100
Frankenia pacifica	-	2	5	7	8	-	-	8	10	10	-	50
												5040

MAR 02 1987

MAR 02 1987

Report on

Environmental Baseline Study

for the

MORAN LAKE ENHANCEMENT PLAN

Santa Cruz, California

prepared for the

State of California-Coastal Conservancy

Spring 1980

by:

Gary Stern and

Paul Courter

under the supervision of:

Sally Sample

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INTRODUCTION

Moran Lake is a 13 acre coastal wetlands area located in the city of Santa Cruz about 1/4 mile west of Soquel Point. As with many California coastal lagoons, increasingly rapid urban development surrounding Moran Lake and within its 620 acre watershed has severely degraded this once healthy and productive estuary.

During the spring of 1980, the first phase of the Moran Lake Enhancement Plan was implemented by one of the sponsering agencies, The State Coastal Conservancy. Baseline data on the exisiting conditions at Moran Lake and the surrounding wetlands was collected and compiled during April, May and June 1980. The investigations at Moran Lake were concerned with the sediment and water quality in relation to biological abundance and diversity prior to site improvements. Biological inventories included vegetation, birds, aquatic invertebrates (benthic and planktonic), fish and mammals. Measurements of the aquatic productivity were collected. Information on the chemical nature of Moran Lake was compiled from new and published data. The results from this baseline study can be used for comparision with post-restoration monitoring at Moran Lake.

DESCRIPTION OF THE
MORAN LAKE WETLANDS

General

At one time a series of five coastal lagoons occured in the Live Oak area of Santa Cruz: Wood's Lagoon, Corcoran's Lagoon, Moran Lake, Schwan Lake and Bonita Lagoon. All of these areas have suffered from the rapid urbanization of Santa Cruz within the last two decades; but of these five, the lagoon ecosystem of Moran Lake has been the most severely disrupted by human activities.

The 13 acre wetlands region of Moran Lake is about 1/4 mile to the west of Soquel (Pleasure) Point. To the west about 1/4 mile is Corcoran's Lagoon. Corcoran's appears to be the only lagoon of the five functioning in a natural state.

History

Little is known about the history of Moran Lake, but past conditions of the lagoon may be interpeted from aerial photos dating back to the 1930's. It is apparent from these photos that no considerable change had occured at Moran Lake until the 1960's. The article appearing in the Santa Cruz Sentinel on May 8, 1963 pretty well sums up the human-made alterations occuring at Moran during this time. The article was titled 'Preparing to make Lagoon into Lake'.

Moran Lake was one of the many coastal areas that suffered from the Santa Cruz Harbor Project of 1961. Material being dredged from Wood's Lagoon for the construction of the harbor was deposited as fill in Moran Lake. From 1961 to 1963 about 3 acres of the lagoon area at Moran Lake was filled, reducing the total water area to the present 5 acres. To accommodate water drainage from the

'new lake' amidst the human-made alterations at the lagoon, a 7 foot diameter pipe was placed between the ocean and Moran Lake. This culvert however, was placed about 5 feet above the mean high tide level and is more often than not blocked with sand. These human modifications of the lagoon's entrance to the sea have greatly restricted the normal tidal influence upon Moran Lake and subsequently lead to the degradation of this lagoon environment.

Tidal Flushing

A lagoon or estuary by definition is a shallow, semi-enclosed areawith a free connection to the open sea. Persumably, before the filling of Moran Lake in the early 60's, the lagoon was subjected to periodic tidal flushing. The mouth of the lagoon in the past permitted ocean water to flow freely to and from the area in response to the daily tidal cycle.

Presently no tidal flushing occurs at Moran Lake. The culvert has completely restricted the water circulation of the lagoon. Waves and tides deposit sand in the culvert blocking off any water exchange between the ocean and Moran Lake about 95% of the time. The impounded waters in Moran Lake are then subject to stagnantion and high rates of evaporation.

During the study period a very irregular circulation of the Lake's waters was observed. Heavy rains on April 22 and May 9 raised the water level of the Lake sufficently high enough to push the sand blockage out of the culvert. On each of these occassions, the lake waters completely drained from the basin exposing the black muddy bottom. (Figure 2) The following high tide filled the lake with ocean water and again blocked the

culvert by sedimentation. An unusally high tide of +6.3' on May 13 washed some new ocean water into the Lake and carried sand into the Lake itself, forming some shallow sand bars near the culvert opening.

The uncommon and irregular flushing activity of Moran Lake has not permitted the lagoon to function in a natural state. The impoundment of the Lake's waters by the sand blocked culvert has created a different type of ecosystem; one that does not have nearly the natural capacity for dealing with waste treatment.

Watershed

The 620 acre watershed of Moran Lake includes both the cities of Santa Cruz and Capitola. Soquel Drive borders the watershed to the north; Twenty-sixth and Thirtieth Avenues on the west and Forty-fifth Avenue on the east. The watershed area includes both suburban and commerical run-off. A 1976 Santa Cruz County Watershed Dept. report identified the watershed of Moran Lake as containing in order of magnitude; single-family residences, commerical-industrial development, grassland (vacant lots) and mobile home parks.

The impervious surfaces of these urban areas in the watershed permit the run-off to collect a number of non-point pollutants such as lead, oil and grease. An intermittent stream which carries mostly storm run-off from this watershed is the only significant source of fresh water for Moran Lake. In 1975 a stormwater detention pond was built on the corner of 38th and Brommer Streets to cope with flood hazards within the watershed. Although it was designed to control storm run-off, no provisions were made for the control of urban pollutants.

The impounded waters of Moran Lake now serve as a catch basin for the sediment and pollutants of the urban run-off. In addition

to the deposition of these materials in Moran Lake, until June 1975, a sewage treatment plant near the Lake periodicly dumped raw sewage directly into the waters. This overflow of sewage during periods of peak wet weather flows, greatly increased the amount of organic wastes into the waters of a lagoon already suffering from a diminished capacity for waste treatment.

Topography

The submerged portion of Moran Lake is fairly uniform except in the area immediately adjacent to the culvert opening. At times a small channel leading directly to the culvert may be 3 to 4 feet under water. However, the deposition of sand by the unusally high tides of May 12 and 13 created very shallow sand bars and the average depth in this same area was only 8 or 10 inches under water.

The average lake depth for most of Moran Lake is less than 2 feet. The bottom sediment is composed of a fine black silty-clay material with about 20 to 30% beach sands. This lake sediment, heavy with organic debris, is 1 to 2 feet deep over most of the Lake basin.

The terrain around Moran Lake is dominated by landfilled areas, thick with grasses and weedy plants. The fill is composed of a variety of materials from course to fine sand, clay, silt, and small pieces of crushed granitic rocks. This light-colored fill material is a relatively poor sandy soil, but has become darkened in some areas by decaying organic matter. Most of the area surrounding Moran Lake is less than 10 feet in elevation. This surrounding acrage drops sharply about 4 or 5 feet directly into the Lake. (See baseline map)

Visitor Use

In March 1975 8 acres including Moran Lake and some of the surrounding wetlands was purchsed for the use as a nature park. The Land and Water Conservation Fund matched funds with the County of Santa Cruz for the purchased and were joined by the State Coastal Conservancy for the restoration of this coastal lagoon.

Visitor use at Moran Lake is presently light to moderate for an area of its size. The trails around the Lake are mostly used by neighborhood residents for access to the beach or to walk their pets. Bicycle riders and joggers frequently use the bike path and other trails in the region. On one occassion I observed two girls riding horseback along the trails near the Lake. Although most visitors use the area for the sole purpose of going to the beach or to walk their dogs, some lake shore residents come down to the lake just to relax and enjoy the quiet serenity offered by the area.

Water Quality

Previous research that has dealt with the effects of urban runoff on coastal lagoons is minimal. For this reason it is useful to consider Moran Lake in relation to its neighboring lagoons, Schwan and Corcoran, which share Moran's geographic location, urban development pattern and history of monitoring.

The three lagoons can be seen to exist along a gradiant of freshwater-to-saltwater, Schwan at the former extreme and Corcoran at the latter. Moran fluctuates between extremes, occasionally becoming more saline than ocean water. Each lake's outlet design determines where the the lake falls along this gradiant. The salinities of each lake can be monitored in the County Watershed's data on conductivity, total dissolved solids and alkalinities for Nov. '79-Feb. '80 (Table 1) as well as previous data.

The three lakes have varying capacities for converting urban runoff to biomass and/or washing it into the ocean. These capacities relate to both size and ocean influx regularity.

Table 2 shows that for the sampling days with the highest previous two-week rainfall period, Jan. 4 and Feb. 26, the nitrate levels of each lake show an increase, with Moran reaching the highest levels. This overall nutrient increase can be attributed to storm runoff, but the excessive nitrate levels found in Moran Lake are due to its diminished capacity for handling nutrient loads.

TABLE 1

	DATE	ELECTRICAL CONDUCTIVITY	TOTAL DISSOLVED SOLIDS	ALKALINITY[1]	NITRATE
Moran Lake	11-1-79	off scale[3]	23,876	201.2	.038
	11-19-79	off scale	6,155	179.4	.109
	11-29-79	off scale	14,940	198.1	.102
	12-13-79	off scale	24,527	266.4	.003
	1-4-80	10-20 thousand mmhos/cm	915	58.0	2.210
	2-26-80	10-20 thousand mmhos/cm	1,430	116.0	5.990
Corcoran Lagoon	11-1-79	off scale	21,585	198.7	.022
	11-19-79	off scale	19,158	202.4	.000
	11-29-79	off scale	16,492	198.9	.008
	12-13-79	off scale	19,437	229.4	.003
	1-4-80	off scale	36,525	112.4	.097
	2-26-80	off scale	26,408	N/A	.144
Schwan Lake	11-1-79	970 mmhos/cm	468	113.1	.013
	11-19-79	904 mmhos/cm	434	115.3	.007
	11-19-79	510 mmhos/cm	416	123.3	.011
	12-13-79	500 mmhos/cm	408	114.6	.006
	1-4-80	230 mmhos/cm	181	64.6	.379
	2-26-80	188 mmhos/cm	184	51.1	.602

1 - In mg/l $CaCO_3$
2 - In mg/l NO_3-N
3 - Greater than 20 thousand mmhos/cm

TABLE 2 - Two-week Rainfall Prior To Sampling[1]

11-1-79	3.56
11-19-79	1.18
11-29-79	1.50
12-13-79	0.00
1-4-80	5.53
2-26-80	3.80

1 - Source: John Harlamoff, Soquel

The storm loads were not mixed with ocean water at Moran Lake as they were at Corcoran. Electrical conductivity, total dissolved solids and alkalinities (Table 1) show that Moran acted as a catch-basin for the freshwater runoff, while Corcoran remained open to the sea. Corcoran's lower nitrate levels on the same days are a result of this more reliable ocean flushing and, also, its greater size.

Schwan Lake's lower nitrate levels appear to relate only to its greater size, with no ocean dilution factor involved. Schwan's size alone cannot be expected to prevent indefinitely the eutrophication process and the next generation of Santa Cruzites may have to confront this.

The average levels of fecal coliform in Moran Lake are also higher than in Corcoran's. This appears to be another symptom of restricted exchange between the Lake and the ocean. High coliform counts in Schwan may be related to the greater longevity of bacteria in freshwater.

The levels of nutrients and fecal coliform in Moran Lake seem to indicate that eutrophication is occuring there. The thick mats of Cladophora and the rise in dissolved oxygen levels during the photoperiod (Figure 1) both attest to the availability of these nutrients. (Tables 3,4,5)

The impoundment of Moran Lake's waters, especially during the summer when the pipe is almost always plugged with sand, has lead to stagnation, evaporation and the subsequent concentration of nutrients (nitrate and phosphate), pollutants (heavy metals, sediment, oil, grease) and salts. Stagnant (non-mixing) conditions are evidenced by high turbidity levels as well as the black cloud of fine organic and inorganic matter that lingers

TABLE 3

Moran Lake Date	11-1-79	11-19-79	11-29-79	12-13-79	1-4-80
Cadmium	ltdl[1]	ltdl	ltdl	ltdl	ltdl
Fecal Coliform	2,700	13;600	600	40	1600
Chromium	.07	.02	.05	.09	ltdl[2]
Lead	.5	.5	.5	.5	.5
Manganese	.55	.43	.44	.56	.06
Calcium	299.2	95.7	171.6	299.2	28.6
Dissolved-O-Phosphate	.294	.517	.629	.116	.198
Sulfate	1675	na[3]	na	na	na
Chloride	12,923	na	na	na	na
Turbidity (NTU)	10	34	21	16	39
Dissolved Oxygen	10.5	7.0	11.9	9.2	8.2
pH	8.5	8.5	7.7	8.1	7.9
Temp.	13.7	11.5	12.7	10.2	12.3
Iron	.48	.25	.47	.48	.58
Potassium	313.1	89.3	158.1	291.2	17.7
Sodium	5700	2000	3400	66040	194
Magnesium	844.3	212.5	411.3	902.0	29.0

1 - Less than detectable limit; .005 for cadmium
2 - Less than detectable limit; .05 for chromium
3 - Not available

in the water when the bottom sediment is disturbed. The hydrogen sulfide odor that accompanies the black cloud indicates the presence of anaerobic sulfur bacteria.

TABLE 4

Corcoran Lagoon					
Date	11-1-79	11-19-79	11-29-79	12-13-79	1-4-80
Cadmium	ltdl[1]	ltdl	ltdl	ltdl	ltdl
Fecal Coliform	20	112	370	59	640
Chromium	.07	.07	.07	.07	.09
Lead	ltdl[2]	ltdl	ltdl	ltdl	.5
Manganese	.35	.25	.36	.33	.43
Calcium	235.4	213.4	211.2	226.6	361.5
Dissolved-O Phosphate	.183	.048	.065	.254	.043
Sulfate	1575	na[3]	na	na	na
Chloride	11722	na	na	na	na
Turbidity(NTU)	13	26	16	3.6	2.8
Dissolved Oxygen	10.7	17.7	11.9	11.1	9.9
pH	8.7	9.4	8.9	8.3	8.0
Temp.	13.4	14.0	12.7	10.2	12.4
Iron	.45	.33	.33	.48	.77
Potassium	271.7	234.3	224.2	231.3	415.1
Sodium	5300	4950	4100	5553	9905
Magnesium	730.7	588.1	492.5	460.0	784.8

1 - Less than detectable limit; .005 for cadmium
2 - Less than detectable limit; .5 for lead
3 - Not available

TABLE 5

Schwan Lake					
Date	11-1-79	11-19-79	11-29-79	12-13-79	1-4-80
Cadmium	ltdl[1]	ltdl	ltdl	ltdl	ltdl
Fecal Coliform	900	2300	1300	430	800
Chromium	ltdl[2]	ltdl	ltdl	ltdl	ltdl
Lead	ltdl	ltdl	ltdl	ltdl	ltdl
Manganese	.13	.23	.23	.18	.17
Calcium	32.1	30.4	33.0	30.8	19.8
Dissolved-O-Phosphate	.350	.229	.103	.055	.113
Sulfate	30	na[3]	na	na	na
Chloride	134.6	na	na	na	na
Turbidity(NTU)	24	20	22	16	37
Dissolved Oxygen	10	7.0	10.1	8.3	6.6
pH	8.7	7.8	8.0	7.8	7.1
Temp.	15.6	12.8	12.0	10.2	11.8
Iron	.38	.23	.23	.28	.73
Potassium	10.17	8.95	9.54	9.80	6.10
Sodium	85.0	75.8	85.0	111.1	40.4
Magnesium	17.3	16.9	17.3	21.2	10.3

1 - Less than detectable limit; .005 for cadmium
2 - Less than detectable limit; .05 for chromium
3 - Not available

Sediment

Sediment samples were taken on Feb. 5, 1980 and analyzed for lead, chromium and cadmium, which had been found in high concentrations in a previous County Watershed report. Also found in that report were: a high oil and grease content, high nutrient levels and a high fecal coliform count.

The new data (Table 6) shows a decrease in Moran Lake's lead, chromium and cadmium levels. The drop in lead concentration, a 90% decrease from the previous report, may be a reflection of the greater use of unleaded gasoline, or a result of community clean-ups of Moran Lake, which removed many possible sources of metal contamination. Corcoran's sediment concentrations of metals may be on the low side because of a sampling site far from the source (nearer the ocean outlet). It is no surprise that Schwan, with no ocean exchange, has the highest levels of each metal. South County sloughs have shown consistantly high heavy metal levels (10 times Moran Lake's chromium and cadmium levels) but the cause of this is not known.

TABLE 6.

Sediment Sampled	Lead Concentration	Chromium Concentration	Cadmium Concentration
Moran Lake	22.84[1]	5.30	.140
Corcoran Lagoon	3.12	4.89	.059
Schwan Lake	24.78	7.31	.366
Moran Lake(1976)	50	9.5	.46

1 - Concentrations in ppm

Aquatic Primary Productivity

Aquatic primary productivity at Moran Lake was measured on May 21 using both the light-dark bottle technique and the interval measurement technique. Map 4 shows the sampling locations for both studies; Figure 1 shows the dissolved oxygen curve for a typical photoperiod at Moran Lake; and Table 7 lists the gross photosynthetic activity and the amount of carbon fixed in one photoperiod. A photograph of the 2-liter bottles and water-sampling kit used is included at the end of this report.

Although the assumptions, variables and sampling non-homogeneity block any attempts for an absolute value of carbon fixation, the numbers derived can be compared with future measurements to gauge changes in the lake's community metabolism.

The range of values seen in the interval measurements may also serve as an approximate range of error for County Watershed data concerning dissolved oxygen.

TABLE 7

Site	Resp. Act.[1]	Net Photosynthetic Activity[1]	Gross Photosynthetic Activity[1]	Mg. C fixed m^3/8 hour photoperiod
1	1.3	2.3	3.6	675
2	.8	1.3	2.1	394
3	1.1	1.1	2.2	413
	1 - Given in change in dissolved oxtgen content 2 - Noon until dusk; overcast			

FIGURE 1

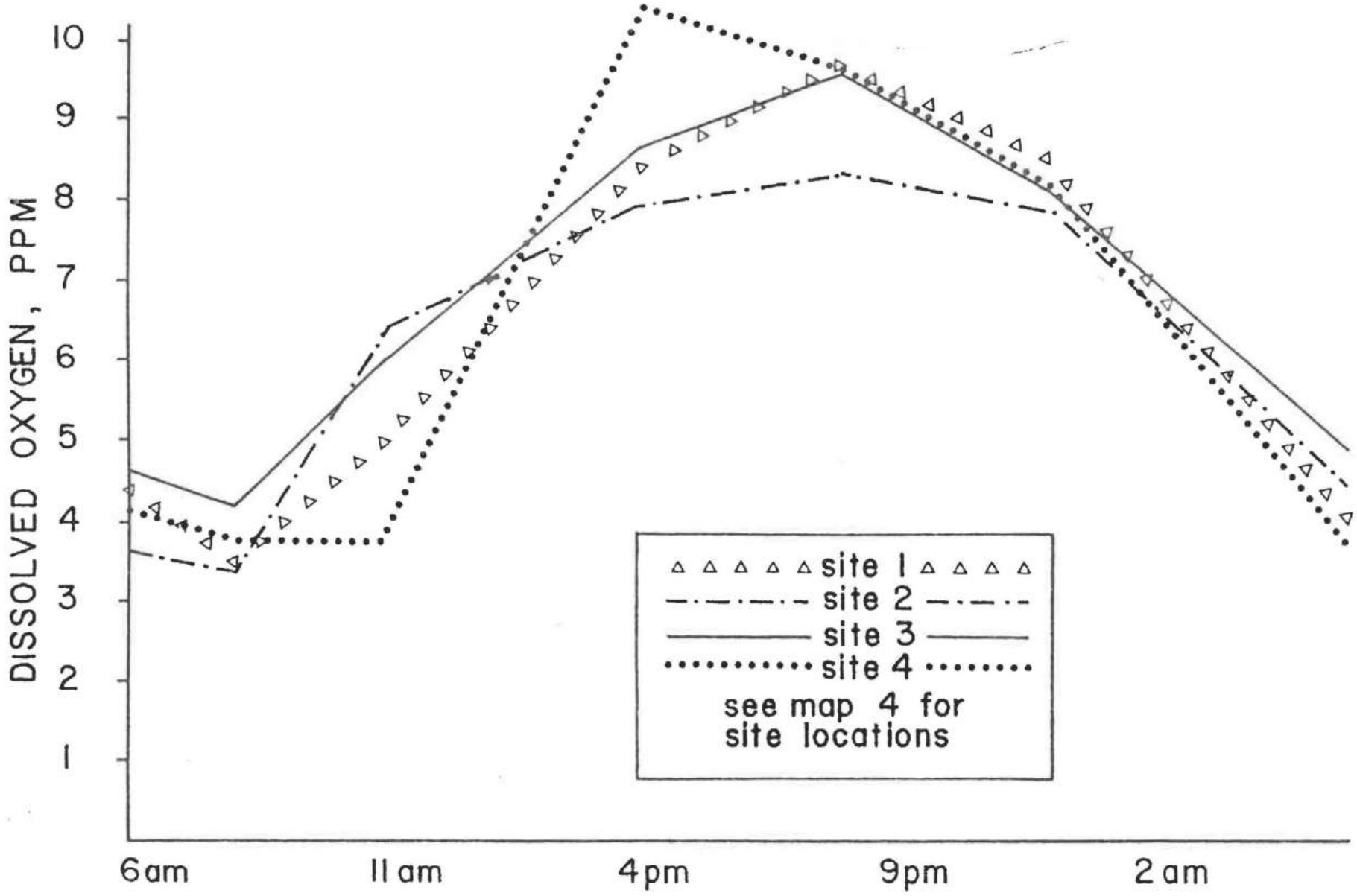
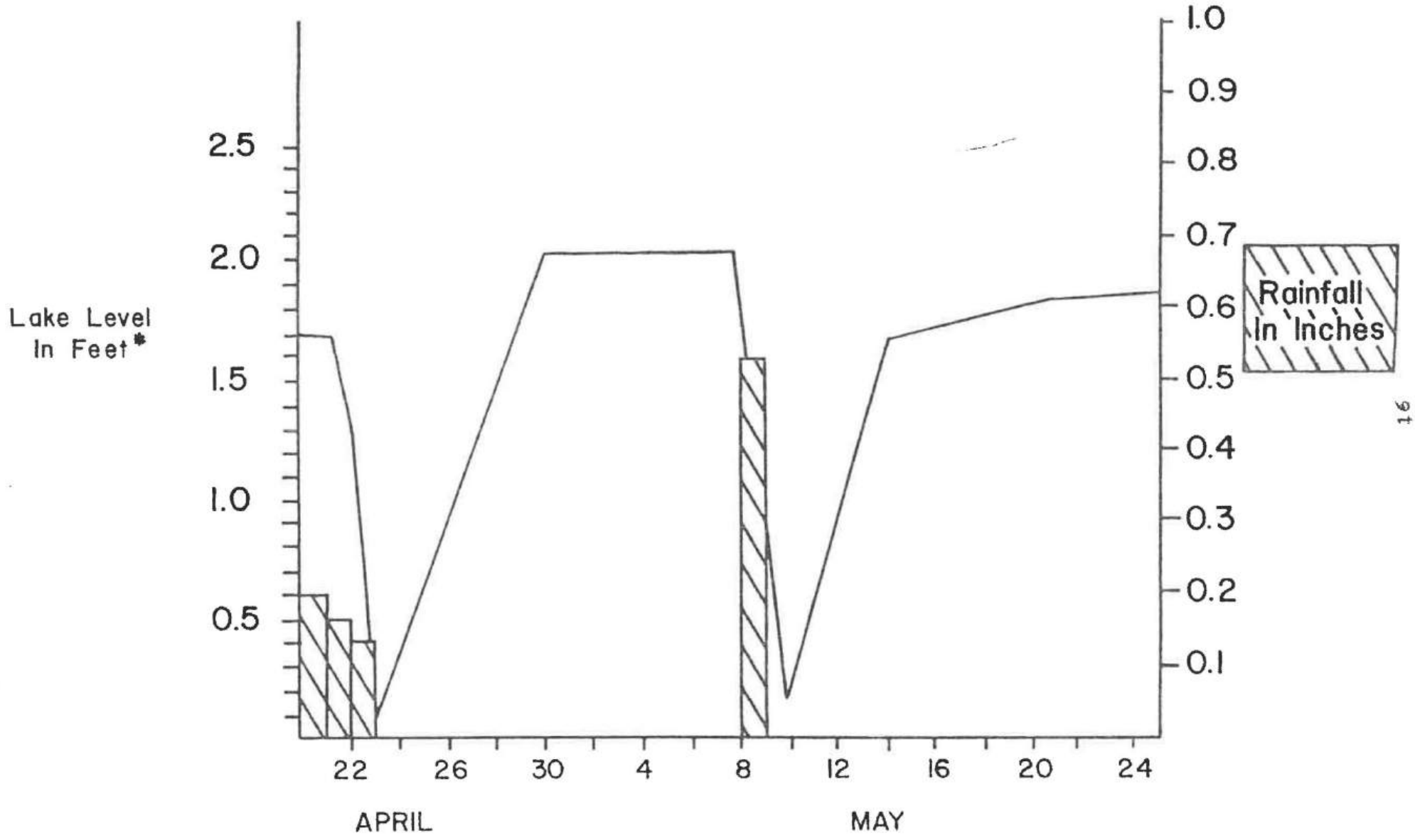

DISSOLVED OXYGEN, PPM
10
9
8
7
6
5
4
3
2
1
6am
11am
4pm
9pm
2am
site 1
site 2
site 3
site 4
see map 4 for
site locations

FIGURE 2



* water levels for comparison only

THE BIOLOGICAL ENVIRONMENT

As required for the development of the Moran Lake Enhancement Plan, a biological inventory was made of the area's habitats and wildlife. To our knowledge, no previous work has been conducted on the organisms inhabitating the Moran Lake wetlands region.

As a result of this field work, it has been determined that presently Moran Lake supports an extremely impoverished fauna of estuarine organisms. The condition of the entrance channel to Moran Lake has drastically affected the water quality and in turn, the quality of the lagoon's wildlife habitats.

This problem is particularly evident when Moran Lake is compared with nearby Corcoran's Lagoon, 1/4 mile to the west. The regular tidal flushing of Corcoran's Lagoon permits the area to support an abundant and diverse population of estuarine animals and plants. The interactions of the varying freshwater and saltwater flows create a complex and productive biological environment. The elimination of the regular marine and fresh water interactions by human alterations at Moran Lake have resulted in a low productivity and poor diversity of organisms.

The highly intermittent flow of fresh and sea water into Moran Lake can not support a stable aquatic faunal population that largely depends upon continous tidal flushing. The stagnant enclosed waters of Moran Lake place severe stress upon all but the most tolerant organisms. Extreme conditions commonly occur at Moran Lake presently. The impounded sea water of the Lake has become as warm as 78°F and the high rates of evaporation can bring the salinity of the lake waters above that of the ocean. (Recorded May [illegible]) Many species are capable of enduring the harsh conditions for a short period, but often the conditions will deteriorate for long periods at Moran Lake (especially in the summer months), and most

organisms will ultimately die, if they can not escape.

Our studies on the exisiting biological environment at the Moran Lake wetlands region identified 45 species of land plants, 18 species of birds, 5 species of mammals (not including domestic pets) and 17 species of aquatic invertebrates.

FAUNA AND FLORA OF MORAN LAKE WETLANDS REGION

Birds

A total of 19 upland and water bird species were observed at Moran Lake during the spring study period. Additional species may frequent the region during other seasons. The bird survey was conducted by weekly morning and evening watches. Each watch was made from one of two observation stations for a duration of one hour. Watches were conducted as close to dawn and dusk as weather and available light would allow. A total of 14 watches were made throughout the study period.

The bird usage of Moran Lake and the surrounding wetlands is extremely light for a coastal lagoon of central California. Moran Lake, persumably, does not offer the preferred habitat and food type desired by the common shore and marsh birds of central California. Only 4 species of aquatic birds were reported at Moran Lake, and it is doubtful that any of these species regularly feed at the lagoon. Increased bird usage of Moran Lake would probably occur if the mudflats and shallow water habitats became more productive. Insects, crustaceans, fish and molluscs are the primary food types sought by shore birds, but the current low productivity at Moran Lake does not support a stable population of these organisms. A slight increase in the number of shore birds and normal feeding behavior by these birds was observed on only two occassions (April 25 and May 12); as it was on these days the lake waters were completely flushed by tidal action.

A resident population of mallard ducks (Anas platyrhynchos) consists of about 15 adults. During the course of this study,

one female mallard successfully raised 13 of an original 19 ducklings. Whether these ducklings will also become part of Moran Lake's resident duck population is not yet clear. These mallards were rarely seen feeding on the aquatic insects and animals, seeds and plants usually consumed by this species (with the exception of the two occassions previously mentioned). Instead, the ducks are fed by the neighborhood residents living around Moran Lake. One elderly woman in particular feeds the ducks bread crumbs twice daily and the ducks gather for these feedings religiously. Data on the distribution of the mallard ducks has been compiled on map overlay #2.

A bird bath in the yard of this same woman is frequented by robins (Turdus migratorius) who bathe there and consume the left-over bread crumbs. A family of 3 starlings (Sturnus vulgarus) were commonly seen in a partially hallow eucalyptus tree on the north shore of the Lake. These birds were observed building a nest in the tree on one occassion and numerous other sightings of these starlings indicate that they are also Moran Lake residents.

Mourning doves (Zenaidura macroura)often frequent the grass-land all around the Lake. These birds were observed on every trip to the area; as they are probably the most abundant species in the region. Western gulls (Larus occidentalis) were observed above the area many times, but never at the Lake itself. Both the killdeer (Charadrius vociferus) and sanderlings (Crocethica alba) infrequently occur on the shores of Moran Lake. Three species of swallows-rough winged swallow (Stelgidopteryx ruficollis), barn swallow (Hirundo rustica), and cliff swallow (Petrochelidon pyrrhonta) were occassionally seen feeding on airborne insects over the Lake.

The eucalyptus trees surrounding the wetlands area are frequented by a number of bird species. The vertical habitat of the tall trees currently receive the most heavy bird use of the region. Two species of sparrows, song sparrows (Melospiza melodia) and white-crowned sparrows (Zonotrichia leucophrys) were often observed. Also very common in these trees are two species of blackbirds, the red-winged blackbird (Agelaius phoeniceus) and brewer's blackbird (Euphagus cyanocephalus).

The following birds were reported from one or two sightings during the spring study period at Moran Lake:

Sparrow hawk-Falco sparverius

Anna's hummingbird-Calypte anna

Scrub jay-Aphelocoma coerulescens

Pygmy nuthatch-Sitta pygmaea

On May 1 and May 15 bird watches were conducted at Corcoran's Lagoon for comparision of the two neighboring areas. Shore birds at Corcoran's were far more abundant and diverse than at Moran Lake. Snowy egrets, American coots, willets and kingfishers are just a few of the birds commonly occuring at Corcoran's Lagoon, but not at Moran Lake; thus indigating the presence of a much healthier estuarine environment at Corcoran's Lagoon than at Moran Lake. The lack of a diverse bird fauna is the most obvious indication of the degraded nature of Moran Lake's ecosystem.

Mammals

Information on mammal abundance and diversity at Moran Lake was obtained by live trapping, animal traces and actual sightings. A total of 5 mammal species, not including dogs and cats, were found at the Moran Lake wetlands area.

Live traps used for the capture of small animals as mice and shrews were small, rectangular steel boxes called "Sherman"

traps (10 inches long, 3 inches wide and 3 inches high). Each trap was baited with rolled oats and peanut butter. Small pieces of cotton were also placed inside to provide some comfort to the captured animal. The trap is open at one end; when the animal walks in, he trips a release which closes the door.

All traps were set in the grassland areas surrounding Moran Lake for a total of 3 nights of trapping. (Map #2) Traps set on May 22 and 28 were placed in a grid of 20; at one meter intervals, 5 were placed in each compass direction. On these same nights, another transect of 10 traps were set on the north shore; along a 10 meter line, traps were placed at one meter intervals. On May 26 a large grid of 48 traps were placed in the grassland along the south lake shore. Traps were set just before dusk and checked early the next morning.

The only capture occured on the first night of trapping, May 22-23. A western harvest mouse (Reithrodontomys megalotis) was found in trap 5 south of the grid. (See map #2)

Other mammals that occur in the Moran Lake wetlands include squirrels, opossums and gophers. On April 23rd, a fox squirrel (Sciurus niger) was sighted in the eucalyptus trees along the north shore. During conversations with local residents of the Moran Lake area, it appears that the gray squirrel (Sciurus griseus) and the opossum (Didelphis marsupialis) are not uncommon to the Lake area, although neither of these animals were actually sighted during the study period. Numerous collapsed burrows and holes have indicated the presence of pocket gophers around Moran Lake. The Botta pocket gopher (Thomomys bottae) commonly occurs in coastal California. Although an animal was never actually seen, on two occassions, I observed plants being pulled into the ground, persumably

by a gopher. The presence of gophers in the area of Moran Lake was confirmed by Lake side residents, who commonly find plants eaten in their gardens and burrows contributing to erosion on some hillsides. Domestic dogs and cats frequently roam the Moran Lake region often without their owners.

Fish

On May 21 numerous fish drags were made in the vicinity of the lower bay area in Moran Lake. A minnow siene net 15' X 4' was pulled through the water to collect any fish that might have been in the Lake. No fish were found to be present in any of the drags. It seems reasonable to assume that at times the influx of ocean water may carry some fish into Moran Lake; however the present environment of Moran Lake does not favor a resident fish population. (Map #2)

Invertebrates

At least 17 species of aquatic invertebrates were found in the waters and sediment of Moran Lake. The exisiting invertebrate fauna is not extremely diverse or characteristic of a healthy coastal lagoon. The invertebrates identified from Moran Lake appear to only those animals tolerant of stressful conditions.

Planktonic organisms carried in to Moran Lake by the influx of ocean water can not survive long in the warm, stagnant conditions typically present at the Lake today. Levels of dissolved oxygen, nutrients, temperature, salinity and larval abundance are strongly influenced by tidal flushing, and these parameters are very important to the composition of the invertebrate fauna. Human modification of the lagoon's tidal entrance has drasticly reduced the relative abundance and diversity of invertebrates at Moran Lake. Inverte-

brates are also an extremely important link in the aquatic food web. Small invertebrates feed larger invertebrates which in turn are consumed by birds and fish. The lack of a stable and diverse invertebrate population in Moran Lake has resulted in a low diversity and productivity of the lagoon's entire aquatic ecosystem. The survey of Moran Lake's invertebrate fauna included both plankton sampling and benthic sampling.

A. Plankton

Planktonic organisms were sampled at Moran Lake on May 7 and June 5. On both days a townet was dragged across a number of areas in the Lake. (Map #1) The plankton townet consisted of of a 70 micron mesh bag on a metal frame fasten to a towline. A collecting chamber was fasten to the end of the net. While wading in the Lake, nets were dragged through the water. Then organisms were carefully rinsed down from the net into the collection chamber.

On May 7 two plankton drags were conducted in the manner discribed above. Samples were examined at U.C. Santa Cruz in the plankton lab of Mary Silver. Mary Silver and her graduates students aided in the identification of the organisms. A far greater number of organisms were collected in the samples then originally expected. The samples of May 7 contained the following:

Calanoid copepods-These copepods were by far the most abundant organism in the samples. An estimated 25 or 30% of the animals contained egg cases.

Oligochaetes-These small white annelid worms were common.

Capitellid polychaetes-These small worms are also annelids but usually occur on the bottom, (They may have been stirred up from the bottom during the tow)

Nematodes - These minute white-colored worms were not plentiful, but were present in low numbers.

The following zooplankton were seen as only one or two individuals in the samples of May 7: Unidentified polychaete worm about 5 mm in lenght, a green flatworm, hydrachnid or water mite, 2 species of unidentified crustaceans and a rotifer.

Four species of phytoplankton occured in these samples: Stauroneis spp. (Diatom), Navicula spp. (Diatom), Oscillatoria spp. (Blue-green algae) and Spirulina spp. (Blue-green algae).

On June 5 another series of plankton drags were conducted in Moran Lake. The three tows on this day were taken to Moss Landing Marine Lab for examine and identification. The samples of these plankton tows contained fewer organisms than on May 7. The organisms identified were all present in the samples of May 7, except for one water bug: Graptocorixa. Graptocorixa spp. commonly known as waterboat men, were extremely abundant in Moran Lake on this day. Graptocorixa is typically a freshwater invertebrate and probably was in the waters of the Lake due to the moderate rainfall on June 4.

Graptocorixa was the only freshwater planktonic organism occuring in the samples. The origin of the other plankton species was certainly from the influx of ocean tides. The surviving plankton in Moran Lake are not only tolerant of the warm, static water conditions, but also a very low oxygen level.

B. Benthos

The benthic organisms of Moran Lake's sediment were sampled on May 27. Dr. John Oliver of the Moss Landing Marine Lab aided in the examination and identification of the benthos in the samples.

The three sites in Moran Lake choosen to be sampled varied slightly in substrate composition and in location. (Map #3) At each of these sites, a total of six samples were collected; three large and three small. Dr. Oliver provided 3 lb. coffee cans for taking the large samples and small plastic cylinders for the smaller samples. A sample was collected by pushing the topless and bottomless can or cylinder into the water-mud interface on the Lake's bottom. The can or cylinder was then capped at both ends to save this material. The bottom sediment collected was then washed through a 1/2 mm screen and the material retained was preserved in 10% formaline. Bengal rose stain was used to color any organisms present in the samples.

Upon the examination of the samples on June 5, the following organisms were identified:

Oligochaetes-These very small white annelid worms were by far the most abundant benthic organisms in Moran Lake. This worm was also present in the plankton samples. Two or three species of oligochaetes may be present. All three sites contained some of these oligochaetes, but they were most abundant at site 1.

Emerita analoga-Juvenile forms of this sand crab were abundant at site 2. The crustaceans only occur at this site because of the sand bars near the culvert opening.

Capitellid polychaete-These annelid worms are larger than the oligochaetes. These worms were only found in the mud of site 1, but were common here.

At site 3 a few other benthos were present in the samples, but in very low numbers. These included: Harpactiloid copepods, a bristle worm, an unidentified insect larva and egg cases.

Vegetation

The Moran Lake area includes the flora of both salt water lagoons and disturbed coastal areas. The Blue gum eucalyptus (Eucalyptus Globulus)surrounding the lake region have in the past outlined the extent of the highest water level for Moran Lake during periods of storm runoff and high tides. The plants now growing in the grassy areas between the trees and the present lake are covering land fill. Most of these grassland plants are well-adapted to withstand the relative salinity of the soil and the cool coastal climate.

Along the southern shore of Moran Lake, about a dozen bunches of bulrush (Scirpus americanus) are growing in the largest area of land fill. This common rush thrives best when the roots are continually damp; indicating that this grassy area adjacent to the lake is a wet-lands region. A small bunch of rushes can also be found in the lake near the north shore of the lower bay area.

Pickleweed (Salicornia subterminalis), which is rarely found outside of a saltmarsh, is found bordering the lake shore in about 5 sites. Salt grass (Distichlis spicata), atriplex (Atriplex patula hastata), and brass buttons (Cotula coronopiflia), all well-adapted to a salt marsh environment, are found bordering Moran Lake in association with the pickleweed.

The grasses hare barley (Hordeum leporinum), ryegrass (Lolium multiflorum),wild oat (Avena fatua), fescue (Festuca californica), sedge (Carex obnupta), and quaking grass (Briza minor) make up the largest portion of the grassland community. Two types of plantains (Plantago lancelolata and P. major) and two crucifers

wild mustard (Brassica campestris) and wild radish (Raphanus sativus) grow profusely within the grassland areas around the lake. The sea rocket (Cakile maritima),also of the Crucifer family, was found growing along the muddy shore in the water around the lake and one specieman was found in the grassland.

The Pea family is well represented around Moran Lake. These legumes appear to do well in disturbed areas such as where the grassland covers land fill around the lake. The Beach pea (Lathyrus maritimus) is very abundant in the grasses all around the lake. Deerweed (Lotus scoparius) covers much of the ground surface in the grassland of the north lake shore. A tangled viney mass of wild vetch (Vicia americana) is growing on top of ice plant just to the east of the culvert on the lake shore. Two species of lupines were found around Moran Lake. A single bush lupine (Lupinus arboreus) is growing almost directly on top of the culvert at the lake opening. Some smaller bush lupine can be found under the eucalyptus trees of the north lake shore. One specieman of sky lupine (Lupinus nanus) was found in between the deerweed on the north shore.

In the well-trampled areas around the lake grasslands, beach burr (Medicago polymorpha) and filaree (Erodium cicutarium) appear to be thriving. Some scarlet pimpernel (Anagallis arvensis) and pearlwort (Sagina procumbens) is found in association with the beach burr. Ice plant is well-adapted to growing in this area of poor soil and salinity. Both Mesembryanthemum chilense and M. edule occur in dense patch in a number of locations along the lake shore and over the culvert to East Cliff Drive.

The dried-out stalks of the pincushion flower (Haplopappus venetus) occur in about 10 sites around the lake not far from

the lake shore. About 5 low-growing coyote bushes (Baccharis pilularis) are scattered around the southern grassland area of Moran lake. The coast hedge-nettle (Stachys chamissonis) reaches 1 or 2 feet above the grasses in a number of places around the lake. The flowers of the California poppy (Eschscholzia californica), the seaside dandelion (Ageroseris apargioides) and the oyster-root (Tragopogon porrifolius) stand out among the grasses around the lake. The less conspicuous red flowers of the sheep sorrel (Rumex acetosella) are common among the grassland. Another sorrel (Oxalis suksdorfii) can be found in the slightly shaded areas of the grassland community. In the wet places of the upper northern lake shore, the tiny purple flowers of Loosestrife (Lythrum hyssopifolia) can be found. A few mallow plants (Malva nicaeenis) were growing in the grassy areas of the southern shore. The marsh plants sweet fennel (Foeniculum vulgare) and water hemlock (Cicuta douglasii) were each represented by one plant also in the southern shore grassland.

Two small Monterey pine trees (Pinus radiata) were found growing near the bike path near the southern end of the area. A few other Monterey pines are growing amongst the eucalyptus trees bordering the Moran Lake region. The garden geraniums under the eucalyptus trees appear to have spilled over from the backyards of nearby homes. The iris plants growing along East Cliff Drive appear to have originated from a similar source. (The plant communities around the Lake have been mapped on overlay #1)

Addendum to the Vegetation of Moran Lake

Due to the seasonality of herbaceous plants in the grassland surrounding Moran Lake, it is difficult to account for all plant species in the short time period of this study. A few flowering plants were discovered near the end of the study period, necessitati this addendum. To compile a truly complete species account, observations must be made over an entire growing season.

Convolvulas occidentalis-Beach morning glory

Rhus diversiloba-Poison oak

Scirpus koilolepis-Rush

Jaumia carnosa-Jaumia

The small salt marsh plant, Jaumia carnosa, was found in a few small areas along the muddy shore of Moran Lake. The few native Jaumia plants now growing at Moran Lake are probably just a remnant from the time when this area was a healthy lagoon. The smaller rush plants on the southern lakeshore were originally thought to be of the same species as those in the lake; however it now appears that these rushes are a smaller species of bulrush, Scirpus koilolepi The large white flowers of the beach morning glory, Convolvulas occidentalis can be found in a few areas in the grassland of the north shore. Rhus diversiloba, poison oak, is growing in a dense viney mat under the eucalyptus trees along the upper north shore of Moran Lake.

Aquatic Plants

The green algae, Cladophora spp. appears to be the only plant actually growing in Moran Lake. This moss-like filamentous algae of both marine and fresh water environments, can be found growing on rocks and wood throughout Moran Lake. The following algae species were found as drift in Moran Lake: Macrocystis pyrifera, Egregia Menziesii, Colloderme califo ica and a sea grass, Phyllospadix.

Vegetation Analysis
Line Intercept Transects

On May 8, four line intercept vegetation transects were conducted in the Moran Lake wetlands. This transect method for vegetation analysis gives a great deal of information about the composition of a stand of vegetation. Data from these transect measurements can be used to determine plant population distribution, species diversity, density, frequency and coverage in a particular region.

Two transects, #1 and #2 were both 10 meters in length. These transects began at the lake shore and continued into the grassland community (Map #1). Along each transect line, the number of individuals and length of intercept was measured for each plant species The two grassland transects, #3 and #4, were both 5 meters in lenght. #3 was located on the south shore of the Lake and #4 was on the north shore (Map #1). Data was collected as in transects #1 and 2, except a bunch of grass was counted as one individual.

Transect sites were representative of the region's vegetation. Although, this data may be somewhat misleading in that it is strongly related to the size of an individual plant. However, this informatic does give a good indication as to the structure and composition of the terrestrial plant community. A summary of the data obtained in these transects is recorded in tables # 8,9,10 and 11.

Summary of Data from Line-Intercept Plant Sampling

Date May 8 Observers

Habitat and stratum Lake Shore into Grassland

Locality North Shore Moran Lake

Total transect length (L) 10 meters

Total number of transect intervals 10 (one meter each)

Species (i)	Number of individuals (n_i)	Linear density index (ID_i)	Relative density (RD_i)	Present in how many transect intervals? (j_i)*	Frequency (f_i)	Relative frequency (Rf_i)	Intercept length (l_i)*	Linear coverage index (IC_i)	Relative coverage (RC_i)	Importance value (IV_i)
Salicornia subterminalis	2	0.2	0.014	1	0.1	0.025	60 cm	6.0	0.099	0.138
Lolium multiflorum	16	1.6	0.110	5	0.5	0.128	51 cm	5.1	0.085	0.323
Carex obnupta	6	0.6	0.042	1	0.1	0.025	10 cm	1.0	0.016	0.083
Avena fatua	60	6.0	0.417	10	1.0	0.256	135 cm	13.5	0.224	0.897
Brassica campestris	10	1.0	0.069	4	0.4	0.102	35 cm	3.5	0.058	0.229
Mesembryanthemum Spp.	3	0.3	0.021	2	0.2	0.051	38cm	3.8	0.063	0.135
Hordeum leporinum	6	0.6	0.042	1	0.1	0.025	3 cm	0.3	0.005	0.072
Festuca californica	4	0.4	0.028	3	0.3	0.076	5 cm	0.5	0.008	0.112
Medicago polymorpha	18	1.8	0.125	6	0.6	0.153	125 cm	12.5	0.207	0.485
Lotus scoparius	19	1.9	0.132	6	0.6	0.153	140 cm	14.0	0.232	0.517
Totals	$\Sigma n = 144$	$\Sigma ID = 14.4$	$\Sigma RD = 1.0$		$\Sigma f = 3.9$	$\Sigma Rf = 1.0$	$\Sigma l = 602$	$\Sigma IC = 60.2$	$\Sigma RC = 1.0$	

Summary of Data from Line-Intercept Plant Sampling

Date May 8 Observers

Habitat and stratum Lake Shore into Grassland

Locality South Shore Moran Lake

Total transect length (L) 10 meters

Total number of transect intervals 10 (one meter each)

Species (i)	Number of individuals (n_i)	Linear density index (ID_i)	Relative density (RD_i)	Present in how many transect intervals? (f_i)*	Frequency (f_i)	Relative frequency (Rf_i)	Intercept length (l_i)*	Linear coverage index (IC_i)	Relative coverage (RC_i)	Importance value (IV_i)
Cotula coronopifolia	6	0.6	0.037	2	0.2	0.048	48 cm	4.8	0.066	0.151
Carex obnupta	22	2.2	0.136	5	0.5	0.121	56 cm	5.6	0.077	0.334
Atriplex patula hastata	2	0.2	0.012	2	0.2	0.049	29 cm	2.9	0.039	0.100
Avena fatua	52	5.2	0.321	8	0.8	0.195	44 cm	4.4	0.060	0.576
Medicago polymorpha	9	0.9	0.055	3	0.3	0.073	55 cm	5.5	0.075	0.203
Erodium cicutarium	17	1.7	0.105	6	0.6	0.140	82 cm	8.2	0.112	0.363
Mesembryanthemum spp.	47	4.7	0.290	9	0.9	0.219	390 cm	39.0	0.534	1.043
Lathyrus maritimus	6	0.6	0.037	5	0.5	0.121	19 cm	1.9	0.026	0.184
Plantago major	1	0.1	0.006	1	0.1	0.024	7 cm	0.7	0.009	0.039
Totals	$\Sigma n = 162$	$\Sigma ID = 16.2$	$\Sigma RD = 1.0$		$\Sigma f = 4.1$	$\Sigma Rf = 1.0$	$\Sigma l = 730$	$\Sigma IC = 73.0$	$\Sigma RC = 1.0$	

n.

Summary of Data from Line-Intercept Plant Sampling

Date May 8 Observers

Habitat and stratum Grassland Southern Shore

Locality Moran Lake Southern Area

Total transect length (L) 10 meters

Total number of transect intervals 10 (one meter each)

Species (i)	Number of individuals (n_i)	Linear density index (ID_i)	Relative density (RD_i)	Present in how many transect intervals? (f_i)*	Frequency (f_i)	Relative frequency (Rf_i)	Intercept length (l_i)*	Linear coverage index (IC_i)	Relative coverage (RC_i)	Importance value (IV_i)
Erodium cicutarium	9	1.8	0.122	3	0.6	0.15	28 cm	5.6	0.081	0.353
Carex obnupta	29	5.8	0.393	5	1.0	0.25	56 cm	11.2	0.162	0.804
Rumex acetosella	15	3.0	0.203	4	0.8	0.20	47 cm	9.4	0.136	0.539
Plantago major	4	0.8	0.054	2	0.4	0.10	14 cm	2.8	0.040	0.194
Lathyrus maritimus	1	0.2	0.014	1	0.2	0.05	3 cm	0.6	0.009	0.073
Juncus effusus	3	0.6	0.041	2	0.4	0.10	87 cm	17.4	0.251	0.392
Avena fatua	12	2.4	0.162	2	0.4	0.10	105 cm	21.0	0.303	0.565
Brassica campestris	1	0.2	0.014	1	0.2	0.05	6 cm	1.2	0.017	0.081
Totals	$\Sigma n = 74$	$\Sigma ID = 14.8$	$\Sigma RD = 1.0$		$\Sigma f = 4.0$	$\Sigma Rf = 1.0$	$\Sigma l = 346$	$\Sigma IC = 69.2$	$\Sigma RC = 1.0$	

Summary of Data from Line-Intercept Plant Sampling

Date May 8 Observers

Habitat and stratum Grassland

Locality Northern Shore Moran Lake

Total transect length (L) 10 meters

Total number of transect intervals 10 (one meter each)

Species (i)	Number of individuals (n_i)	Linear density index (ID_i)	Relative density (RD_i)	Present in how many transect intervals? (j_i)*	Frequency (f_i)	Relative frequency (Rf_i)	Intercept length (l_i)*	Linear coverage index (IC_i)	Relative coverage (RC_i)	Importance value (IV_i)
Plantago major	2	0.4	0.023	2	0.4	0.091	11 cm	2.2	0.064	0.178
Avena fatua	19	3.8	0.215	4	0.8	0.182	18 cm	3.6	0.104	0.501
Brassica campestris	1	0.2	0.011	1	0.2	0.045	10 cm	2.0	0.058	0.114
Lolium multiflorum	42	8.4	0.477	5	1.0	1.136	65 cm	13.0	0.376	1.989
Malva nicaeensis	1	0.2	0.011	1	0.2	0.045	15 cm	3.0	0.087	0.143
Anagallis arvensis	1	0.2	0.011	1	0.2	0.045	3 cm	0.6	0.017	0.073
Hordeum leporinum	11	2.2	0.125	3	0.6	0.136	17 cm	3.4	0.098	0.359
Medicago polymorpha	5	1.0	0.057	4	0.8	0.182	29 cm	5.8	0.168	0.407
Festuca californica	6	1.2	0.068	1	0.2	0.045	5 cm	1.0	0.029	0.142
Totals	$\Sigma n = 88$	$\Sigma ID = 17.6$	$\Sigma RD = 1.0$		$\Sigma f = 4.4$	$\Sigma Rf = 1.0$	$\Sigma l = 173$	$\Sigma IC = 34.6$	$\Sigma RC = 1.0$	

PLANTS OF MORAN LAKE
Species Listed by Communities

TREES	
Eucalyptus Globulus	Blue gum eucalyptus
Pinus radiata	Monterey pine
ICE PLANT	
Mesembryanthemum chilense	Sea fig
M.edule	Hottentot fig
PICKLEWEED	
Salicornia subterminalis	Pickleweed
Atriplex patula hasata	Atriplex
GRASSLAND	
Scirpus americanus	Bulrush
Lolium multiflorum	Rye grass
Avena fatua	Wild oat
Festuca californica	California fescue
Distichlis spicata	Salt grass
Hordeum leporinum	Hare barley
Carex obnupta	Sedge
Briza minor	Quaking grass
Cakile maritima	Sea rocket
Brassica campestris	Wild mustard
Raphanus sativus	Wild radish
Erodium cicutarium	Filaree
Medicago polymorpha	Beach burr
Lupinus arboreus	Bush lupine
L. nanus	Sky lupine
Lathyrus maritimus	Beach pea
Vicia americana	Wild vetch
Lythrum hyssopifolia	Loosestrife
Sagina procumbens	Pearlwort
Oxalis suksdorfii	Wood sorrel
Rumex acetosella	Sheep sorrel
Foeniculum vulgare	Fennel
Tragopogon porrifolius	Oyster-root
Anagallis arvensis	Scarlet pimpernel
Plantago lancelolata	English plantain
P. major	Common plantain
Eschscholzia californica	California poppy
Baccharis pilularis	Coyote bush
Cotula coronopifolia	Brass buttons
Ageroseris apargioides	Seaside dandelion
Haplopappus venetus	Pincushion flower
Cicuta douglasii	Water hemlock
Malva nicaeenis	Mallow
Stachys chamissonis	Coast hedge-nettle
Lotus scoparius	Deerweed
Rhus diversiloba	Poison Oak

BIRDS OF MORAN LAKE

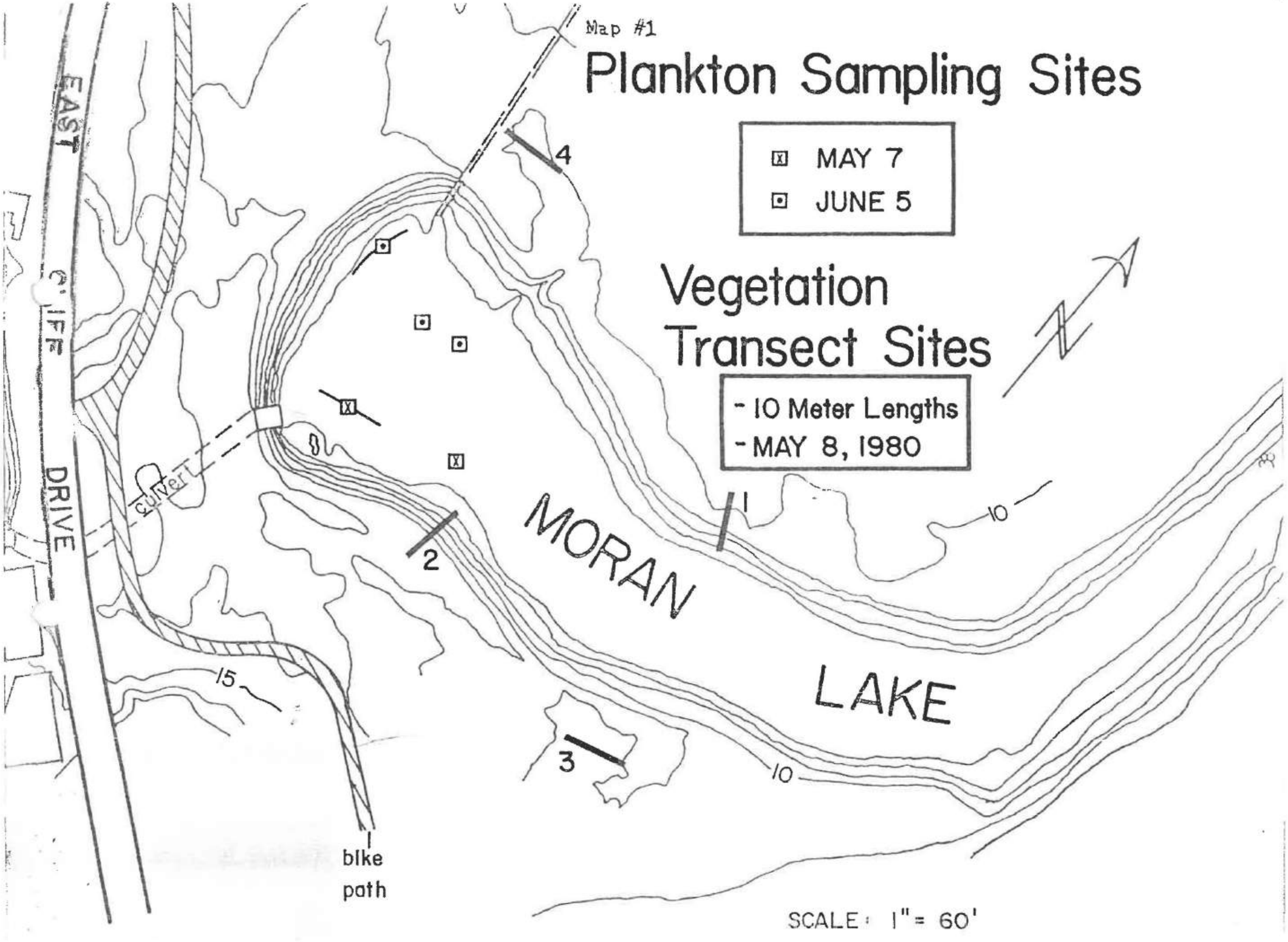
Anas platyrhynchos	Mallard duck
Turdus migratorius	Robin
Sturnus vulgarus	Starling
Zenaidura macroura	Mourning dove
Larus occidentalis	Western gull
Charadrius vociferus	Killdeer
Crocethica alba	Sanderling
Stelgidopteryx ruficollis	Rough-winged swallow
Hirundo rustica	Barn swallow
Petrochelidon pyrrhonta	Cliff swallow
Melospiza melodia	Song sparrow
Zonotrichia leucophrys	White-crowned sparrow
Agelaius phoeniceus	Red-winged blackbird
Euphagus cyanocephalus	Brewer's blackbird
Falco sparverius	Sparrow hawk
Calypte anna	Anna's hummingbird
Aphelocoma coerulescens	Scrub jay
Sitta pygmaea	Pygmy nuthatch

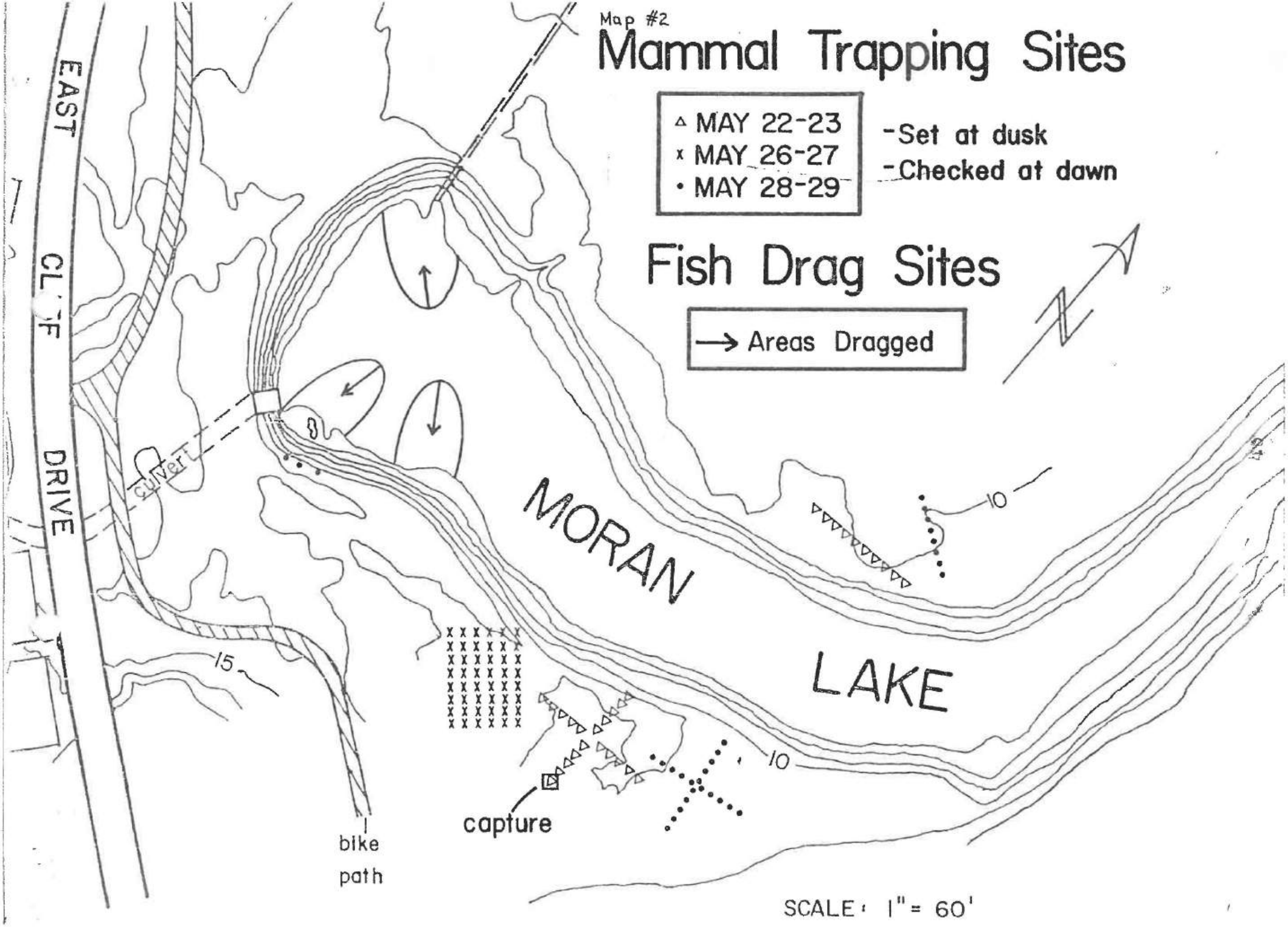
MAMMALS OF MORAN LAKE

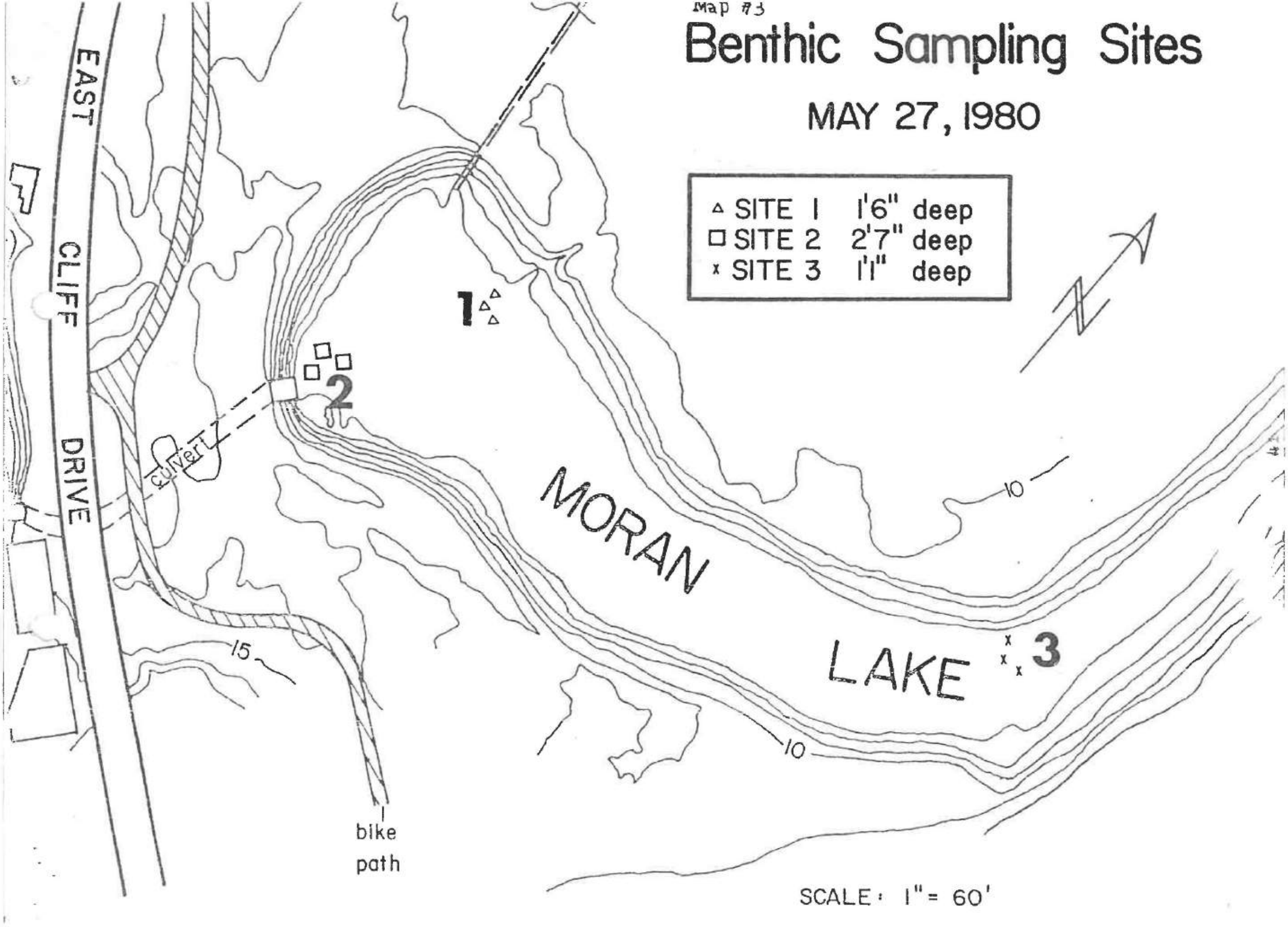
Reithrodontomys megalotis	Western harvest mouse
Sciurus niger	Fox squirrel
S. griseus	Gray squirrel
Didelphis marsupialis	Opossum
Thomomys bottae	Botta pocket gopher
Canis canis	Dog
Felis domesticus	Cat

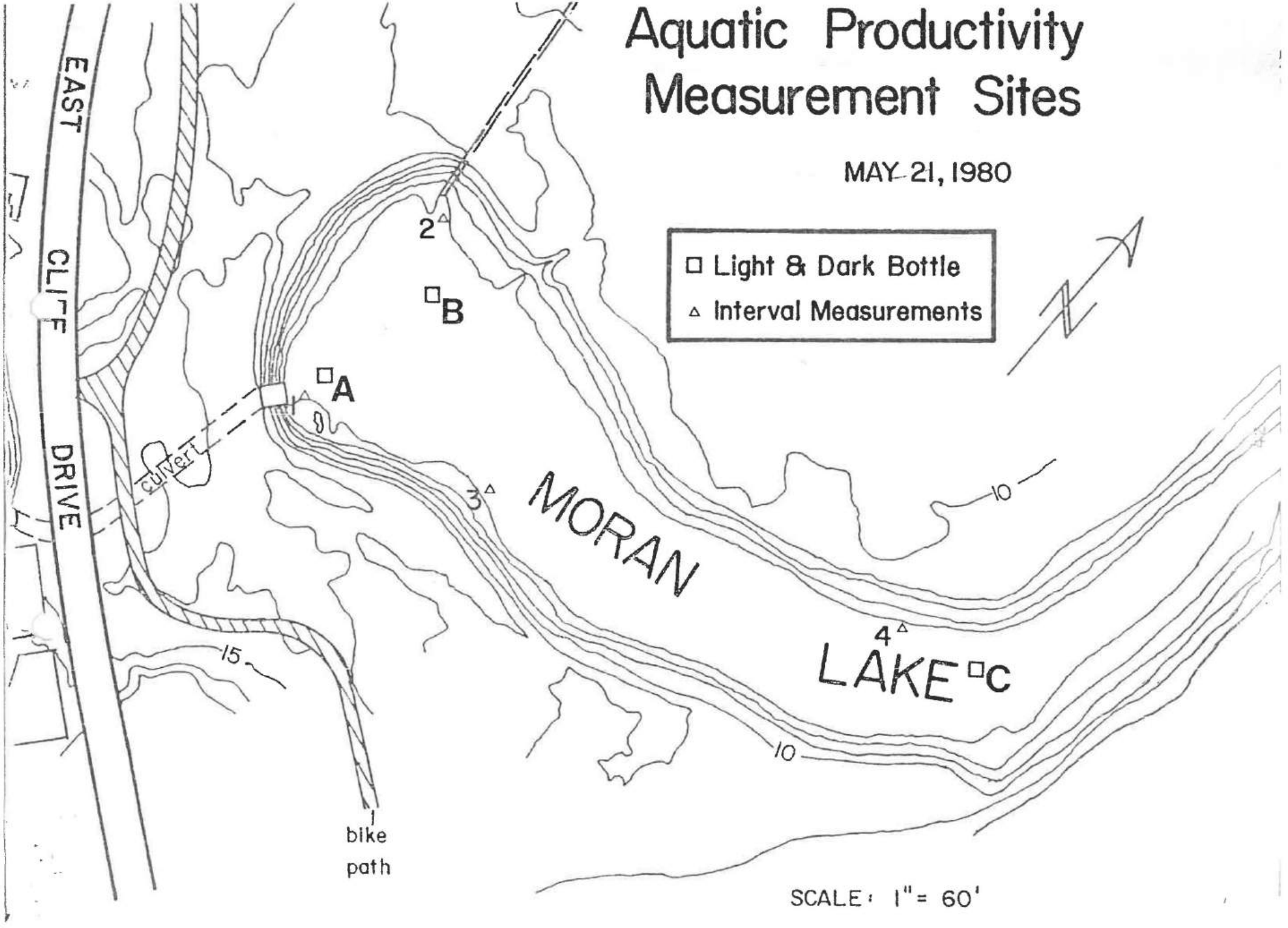
INVERTEBRATES OF MORAN LAKE

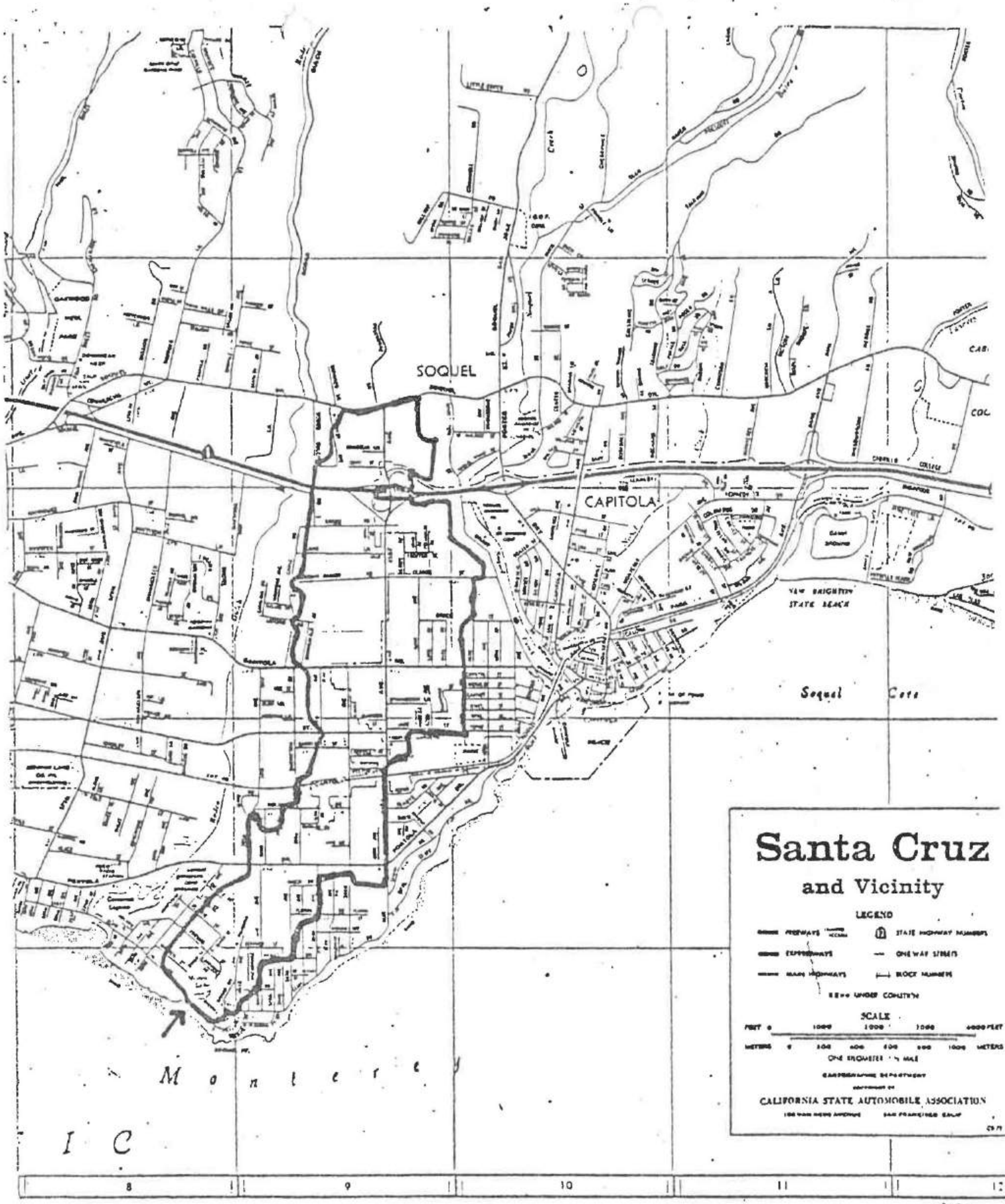
Calanoid copepods (Planktonic)
Harpactiloid copepods (Benthic)
Oligochaete worms-2 or 3 species
Capitellid polychaete worms
Nematode worms
Emerita analoga (Juvenile)


Map #1
Plankton Sampling Sites
MAY 7
JUNE 5
Vegetation
Transect Sites
- 10 Meter Lengths
- MAY 8, 1980
EAST
DRIVE
curve
MORAN
LAKE
bike
path
SCALE: 1" = 60'


Map #2
Mammal Trapping Sites
△ MAY 22-23
x MAY 26-27
• MAY 28-29
-Set at dusk
-Checked at dawn
Fish Drag Sites
→ Areas Dragged
EAST CLIFF DRIVE
culvert
MORAN LAKE
15
10
10
capture
bike path
SCALE: 1" = 60'


Map #3
Benthic Sampling Sites
MAY 27, 1980
△ SITE 1 1'6" deep
□ SITE 2 2'7" deep
x SITE 3 1'1" deep
EAST CLIFF DRIVE
culvert
MORAN
LAKE
1
2
3
10
15
bike path
SCALE: 1" = 60'


Aquatic Productivity
Measurement Sites
MAY 21, 1980
Light & Dark Bottle
Interval Measurements
EAST CLIFF DRIVE
MORAN LAKE
A
B
C
1
2
3
4
culvert
bike path
10
10
15
SCALE: 1" = 60'



62a

Map 5
Moran Lake Drainage

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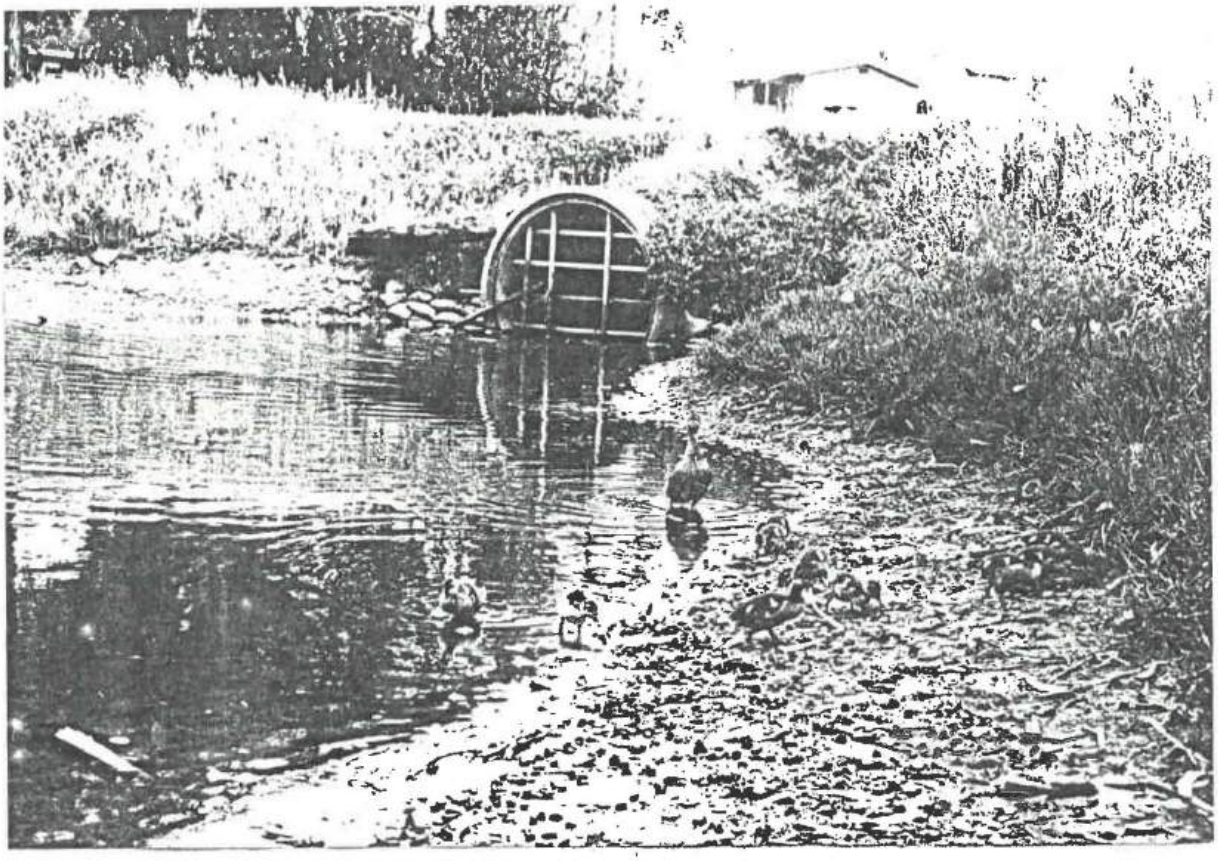
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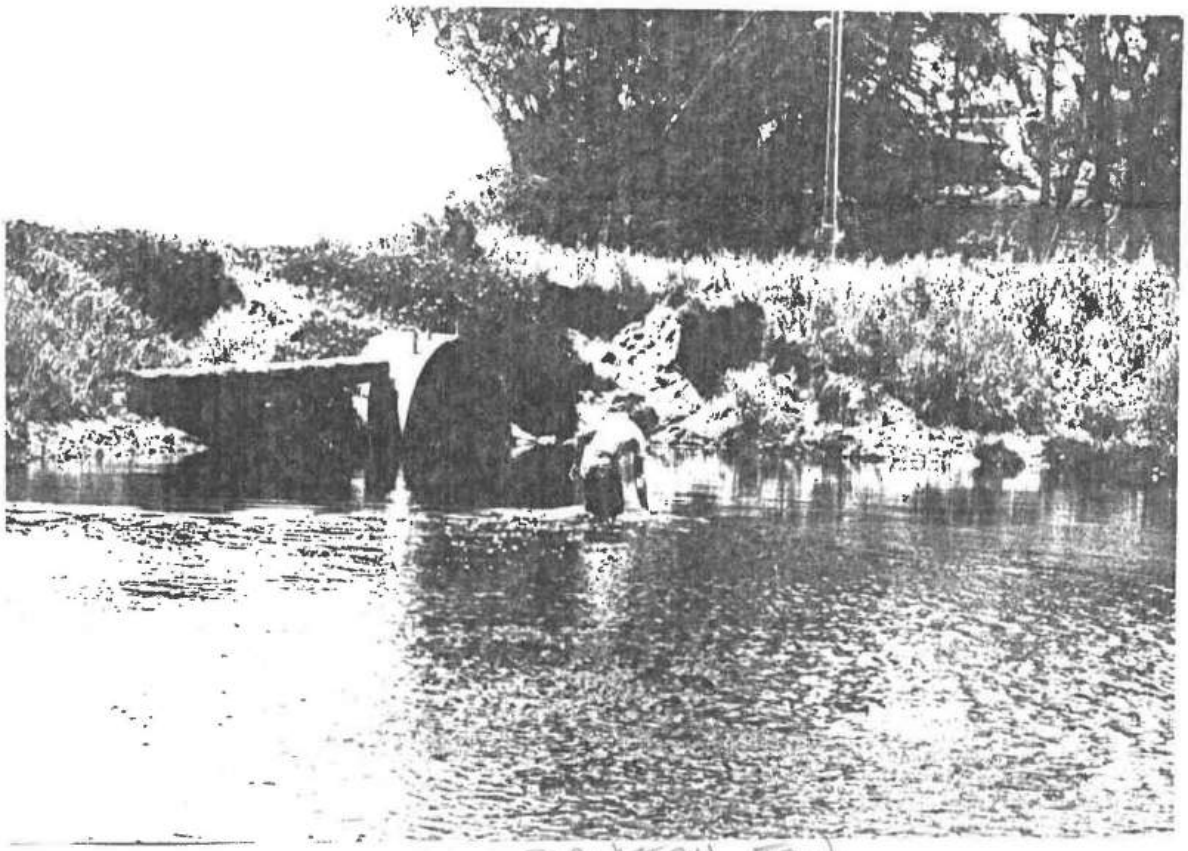
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CULVERT (BEACH)

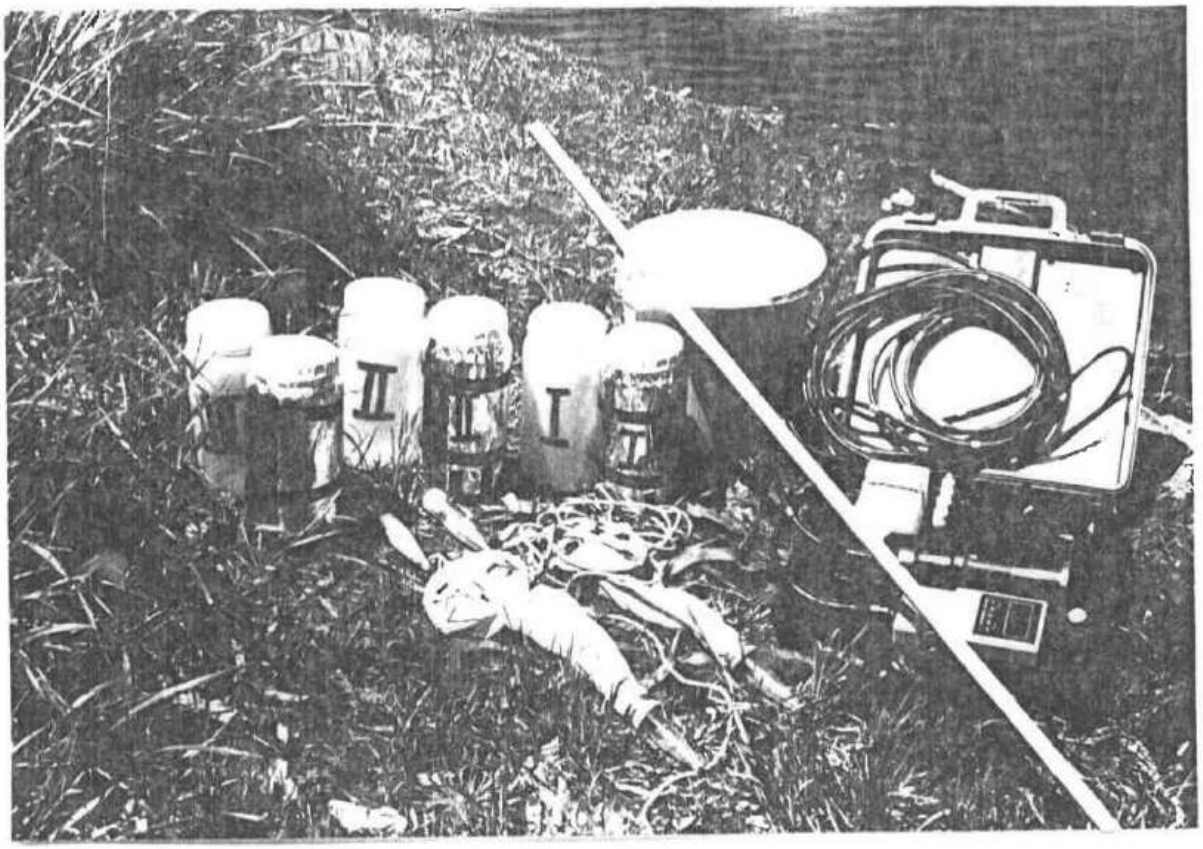
CULVERT (LAKE)





PLANKTON TOW

EQUIPMENT



Technical Report

MORAN LAKE WATER QUALITY STUDY
&
CONCEPTUAL RESTORATION PLAN








Prepared For:

Santa Cruz County Redevelopment Agency

701 Ocean Street, 5th Floor
Santa Cruz, CA 95060

Prepared By:

John Gilchrist & Associates
&
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March 2005

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March 2005

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1. EXECUTIVE SUMMARY & INTRODUCTION

1.1 EXECUTIVE SUMMARY

Moran Lake is a coastal lagoon located in the Live Oak Area of Santa Cruz County that seasonally connects to Monterey Bay. The Moran Lake watershed has been modified as a result of development and land use changes in the area. Increased impervious surfacing has decreased infiltration capacity and increased the volume of water entering Moran Lake and its principal tributary, Moran Creek. Roads, parking lots, commercial and residential land uses have contributed to impaired water quality within the watershed and in Moran Lake. Water and sediment sampling and testing conducted in this and previous studies have documented problems concerning water quality and low biologic productivity in Moran Lake. However, the Lake and its surrounding uplands also support two sensitive species, the tidewater goby and monarch butterfly. Presence of these species must be considered in any lake restoration planning. Vegetation in wetland and upland areas around the lagoon consist primarily of non-native trees, shrubs and herbaceous species. Blue gum eucalyptus is the dominant tree species, and is an important resource for the over-wintering monarch butterfly population. Wildlife surveyed during previous studies included relatively common shore birds, water birds and upland bird and mammal species. Numbers of water-associated wildlife species are lower than nearby lagoons such as Corcoran due to reduced aquatic productivity in Moran Lake.

Moran Lake, like other coastal lagoons, is a body of brackish or saline water impounded by a barrier beach, with a seasonal inlet/ outlet. The size and shape of the lagoon, inlet configuration, watershed drainage and other environmental factors influence the chemistry, water circulation and ecology of a lagoon under natural conditions. Moran lagoon has been altered by artificial fill, reducing its size from nine to five acres in the early 1960's, and by constriction of the inlet with a culvert at East Cliff Drive. The 7-foot diameter culvert was replaced by a larger box culvert in 1981. Although culvert replacement increased water exchange, these changes have confined the lagoon to a relatively fixed configuration, with some limitation on ocean – lagoon water interchange. The box culvert may be slightly undersized to handle the full tidal prism and streamflows entering and exiting the lagoon. However, due to presence of a barrier beach and the current reduced lagoon configuration, replacing the culvert with a bridge or arch culvert may not produce significant changes to winter or summer lagoon conditions. In summer months hyperhaline conditions (high salinity), and algal blooms indicative of a eutrophic water body are prevalent in Moran Lake. During the 2004 study period, streamflow into the Lake was small compared to winter months. Lake bank erosion is a problem during higher winter runoff periods.

Because Moran Lake water quality concerns were the focus of this study, baseline water quality monitoring was undertaken at four locations between June and October 2003. In addition, lagoon sediments samples were collected and analyzed at several water sampling locations in November 2003. Fecal coliform contamination continues to be a problem in the lagoon with likely sources that include leaking sewers, domestic animals

and wildlife. Nutrients, including total phosphorus, nitrate and ammonia were reasonably low during summer months, but were elevated after the "first flush" rainfall event in late October. Sources include urban pollutants such as waste products and fertilizers. Dissolved oxygen levels were low and then relatively high in morning and afternoon sampling which is typical of a eutrophic lake with urban pollutants and large algal blooms. Presence of high concentrations of sodium and chloride in late summer was expected due to hyperhaline conditions in the lake. The concentration of trace metals varied significantly both spatially and seasonally, with highest levels taken from the Moran Creek station and during the "first flush" rain event. Copper and zinc were present at potentially toxic levels. Sediment samples detected the presence of several polyaromatic hydrocarbons (PAHs), commonly known as oils and grease. Principal sources of PAHs are roads, parking lots and vehicle service areas. Several of the PAH compounds detected are carcinogenic and other compounds are potentially detrimental to aquatic life. Sediment testing for organochlorine pesticides and PCB's detected only the pesticide chlordane above threshold levels. This persistent pesticide may also adversely affect aquatic life. Water and sediment sampling yielded results that were generally similar to previous water quality testing for Moran Lake, but some contaminant levels were less than those found in other urban watersheds in the San Francisco Bay area.

Restoration opportunities exist in the Moran Lake watershed to improve water quality and habitat conditions in the lagoon. Many opportunities exist in the immediate vicinity of the lagoon, while other projects and actions can be taken in the upper watershed area. Restoration options include a broad spectrum of activities, including physical restoration projects, storm water management and treatment, recommendations for environmental education, site planning and design standards with the objective of reducing impervious cover in the watershed. Specific Moran Lagoon restoration options include modifying the lagoon inlet-outlet with a bridge or arched culvert to improve ocean-lagoon water exchange, although as noted, the presence of a barrier beach and the current reduced lagoon configuration may limit water quality improvement. The lagoon could also be dredged and expanded, artificially aerated, and/ or artificially breached, although there are constraints to each of these options. Upper watershed streamflow could be augmented with treated wastewater from a small treatment plant at Lode Street, however there are environmental and public perception issues associated with this alternative. There is an opportunity to create a 'treatment wetland' on public lands in the upper lagoon that could improve lagoon water quality and wildlife habitat. Other restoration options at Moran Lake include bank replacement and revegetation of the eroded east slope, removal of exotic plant species and revegetation with natives, and interpretative signing on park trails to inform the public about Moran Lake resources.

Restoration in the upper watershed can also improve Moran Lake water quality. Modification of the 38th Avenue Flood Detention Basin to accommodate a treatment wetland would reduce nutrients, bacteria and heavy metals contained in upper Moran Creek watershed urban runoff. The treatment wetland design would need to insure equivalent flood management currently provided by this facility. There are also opportunities to restore portions of Moran Creek to a functional riparian corridor. A restored flood terrace and native riparian vegetation can reduce upstream pollutant

loadings. Storm water management and treatment practices are also available to reduce pollutants from the urban watershed. Source control and treatment best management practices (BMP) are discussed in Chapter 6 and Appendix A. These include innovative site design practices for new development, storm water treatment devices including drainage inlet filters, bioretention swales and constructed wetlands, and implementation of performance standards for storm water management. Finally, public awareness of maintaining good water quality in Moran Creek and Lake can be developed with informational brochures and volunteer watershed stewardship organizations. Prioritization and cost estimates for these restoration measures are set forth in Chapter 6 of this report.

1.2 INTRODUCTION

1.2.1. Background

Moran Lake, one of several coastal lagoons in unincorporated Live Oak, is located near East Cliff Drive in the Pleasure Point area. Previous studies and water quality monitoring have documented problems concerning water quality and low biologic productivity in the Moran Lake lagoon. These same studies have proposed drainage and water quality improvements in the lagoon and upper watershed.

Spoils from Yacht Harbor dredging were used to fill Moran Lake in the early 1960's reducing the size of the lagoon by over 3 acres. In 1981 a box culvert replaced a smaller culvert allowing increased tidal exchange and flushing of lagoon waters. At the same time, a paved parking lot and restrooms were constructed on part of the Harbor fill sediments and the Lake and adjacent uplands began to be managed by the Santa Cruz County Parks, Open Space and Cultural Services Department. Urbanization in the watershed upstream of the lagoon has increased significantly over the last 35 years, causing drainage and water quality problems for the upstream watercourse, Moran Creek, and for Moran Lake.

1.2.2. Public Concerns and Issues

Since 2001 a group of Live Oak neighbors expressed concerns regarding Moran Lake to Santa Cruz County Public Works, Planning and Redevelopment Departments, County Parks Commission and the Board of Supervisors. Specific concerns included the restriction of tidal flow caused by the box culvert, recent rip-rap installation at the culvert, decrease in lake water quality caused by impervious surfaces and polluted runoff from the watershed, and problems associated with lagoon fill from 1960's harbor dredging. The neighborhood group has asked the County to consider replacing the culvert with a bridge in order to restore tidal exchange and flushing of the lagoon. The group has also expressed concerns regarding expansion of the rip-rap at the outlet and continued deterioration of lagoon water quality from urban land uses in the watershed.

1.2.3. Scope of Project & Project Objectives

Previous studies that described Moran Lake as an impaired water body are over 25 years old. Because changes in the watershed and lagoon itself have occurred over the last 25 years, it is not clear whether water quality problems continue as previously observed in Moran Lake, and if so, the severity or magnitude of the problems.

To address these concerns and to update historical information, the Santa Cruz County Redevelopment Agency (RDA) agreed to undertake a baseline study to assess current conditions. The RDA retained John Gilchrist and Associates to conduct this baseline study. The objectives of the project are as follows:

- Obtain water quality data over a 5-6 month period that will provide information on current lagoon conditions
- Develop a better understanding of lagoon hydrology by reviewing watershed inflows, tidal exchange and lagoon configuration in order to assess potential for water quality improvement options and other lagoon/ watershed management opportunities.

- Review existing biologic information, including data on species of concern, to better understand the interactions between lagoon hydrology, water quality and biology, and recommend possible lagoon enhancement options.

- Provide recommendations on future focused studies or design work needed to implement restoration and enhancement options.

This report presents the results of the baseline study. The document is divided into the following technical sections:

Section 2 - Setting. This section provides an overview of the Moran Lake and watershed setting, including a description of the natural history (geology, hydrology, and biology), historic and present watershed boundaries, jurisdictional boundaries, and land use changes over several decades.

Section 3 - Lagoon and Watershed Hydrology. This section provides a detailed description of the historical and current drainage and morphology of the lagoon. It also provides a description of the hydrologic conditions in the upper watershed areas. Emphasis is placed on the effects that modifications to the lagoon and the watershed have had on the function and conditions of the lagoon and watershed hydrologic processes.

Section 4 – Water Quality. This section provides a review of historical and recent water quality studies of Moran Lake, and presents the results of water quality and sediment testing undertaken as part of this study.

Section 5 – **Restoration Options.** This section provides conceptual restoration opportunities in the Moran Lake watershed to improve water quality and habitat

conditions in the lagoon. Restoration options presented include a broad spectrum of activities, including physical restoration projects, storm water management and treatment, recommendations for environmental education, and site planning and design standards to improve watershed conditions and reduce impervious cover.

Section 6 – Implementation. This chapter provides a general review of planning and implementation activities for each restoration option. Also included are cost estimates for the projects and a preliminary constraint analysis that reviews benefits and constraints for each project. Projects receive a preliminary ranking based on this constraint analysis.

Section 7 – Report References.

Appendix A – Stormwater Best Management Practices

2. SETTING

2.1 Regional Setting

Moran Lake is a coastal lagoon that seasonally connects to the Monterey Bay National Marine Sanctuary in the Pacific Ocean. Moran Lake is located in the Live Oak Area of Santa Cruz County, California, as shown in Figure 2.1. The lake and adjacent land comprise Moran Lake County Park and the Lode Street Sanitation facility, and are the property of the County of Santa Cruz. The 9.2-acre park is located north of East Cliff Drive between Twenty-Sixth and Thirtieth Avenues, south of Portola Drive. Park facilities include restrooms, picnic tables, trails, beach access, and vegetated open space.

The Lode Street facility includes a wastewater pump station, sanitation district offices and surrounding eucalyptus groves. A plan and memorandum of understanding is presently under preparation for management of the eucalyptus and open space lands, with County Parks, Open Space and Cultural Services Department assuming future jurisdiction over these areas together with their existing management of Moran Lake Park lands.

2.2 Natural History

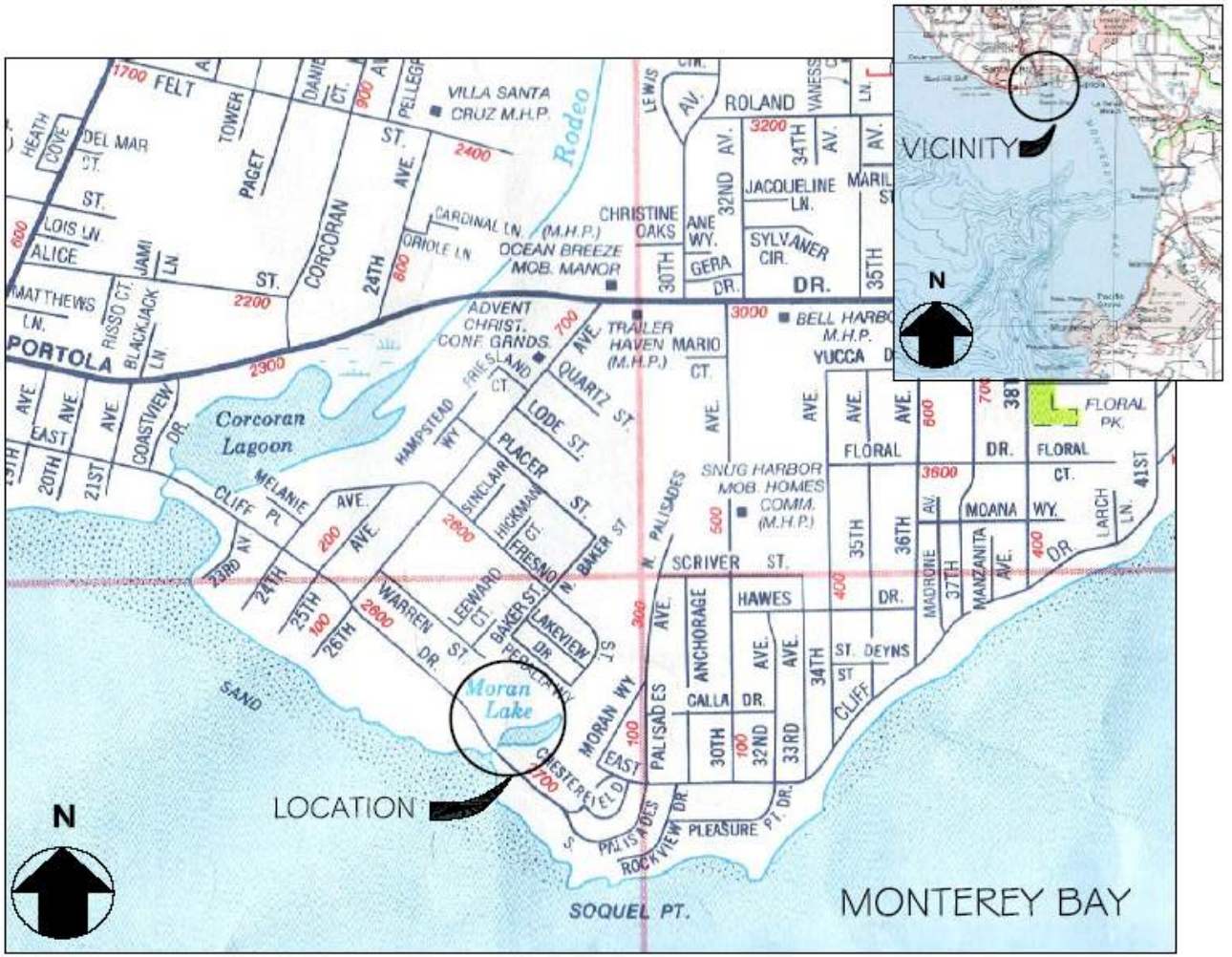
2.2.1 Geology

Moran Lake watershed is located between the Pacific Ocean and the Santa Cruz Mountains. The steep valleys in the mountains transition to relatively flat marine terrace and sea cliffs with narrow beaches parallel to the Monterey Bay. Urban development in the area is generally located in the area between the mountains and the ocean.

Surficial deposits in the area around the lake are described as lowest emergent coastal terrace deposits, originating from the Pliocene Age. The Purisima Sandstone Formation, also of Pliocene Age, underlies the terrace deposits beneath Moran Lake and extends beneath the Monterey Bay.

Two fault systems, the San Andreas fault and the Zayante fault, trend northwest through the Santa Cruz Mountains. Recent significant seismic activity in the vicinity of Moran Lake was recorded in 1989 on the San Andreas Fault, measuring 7.1 on the Richter Scale.

A 1980 environmental study of Moran Lake reports on the soils in the vicinity of the Lake. The bottom one to two feet of sediments in the lagoon are composed of a fine black silty-clay material, enriched with organic matter, with about 20-30 percent beach sands (Stern et.al., 1980). The terrain around Moran Lake, dominated by landfill materials, is composed of a variety of materials from coarse to fine sand, clay, silt, and small pieces of crushed granite rock (Stern et.al., 1980). During this investigation asphalt and concrete debris was also observed around the edge of the lagoon.



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FIGURE 2.1: VICINITY MAP OF MORAN LAKE SANTA CRUZ COUNTY

2.2.2 Hydrology

In the Moran Lake study area precipitation occurs almost entirely as rainfall. Precipitation rates on the coast range from 24 to 28 inches per year, with approximately 80 percent of the precipitation occurring between November and March (Hickey, 1968).

Groundwater in the vicinity of Moran Lake occurs within the sandstone beds of the Purisima Formation between the Zayante Fault and Monterey Bay. Drinking water is pumped from groundwater wells within the Live Oak area from the Purisima Formation. As freshwater is pumped from the Purisima Formation and if water levels are lowered, salt water can enter the freshwater aquifer (Hickey, 1968). Recent studies by the City of Santa Cruz Water Department indicate there is potential for salt water from coastal lagoons to enter groundwater.

The hydrologic response of surface waters in the Moran Lake watershed has been modified as a result of development and land use changes in the area. Increased impervious surfaces have decreased infiltration capacity and increased the volume of water entering Moran Lake, and its principal tributary Moran Creek. The decreased infiltration capacity has also increased the rate at which water moves through the watershed and enters these water bodies immediately after rainfall events. Impervious surfacing also decreases groundwater storage in the watershed, decreasing natural discharge to water bodies during dry months. Moran Creek and its smaller tributary channels have also been channelized, buried, or the riparian corridor reduced, causing impacts to the watershed hydrology.

2.2.3 Biology

Vegetation. Plant communities within the Moran Lake study area consist of annual grassland, disturbed ruderal, brackish wetland and open water. The upland areas of the lagoon have been colonized primarily by non-native plants, including some invasive species. (Species marked with an asterisk are non-native.) Dominant trees include blue gum eucalyptus* (*Eucalyptus globulus*), Monterey cypress* (*Cupressus macrocarpa*) and recent plantings of redwood (*Sequoia sempervirens*). Some black acacia* (*Acacia melanoxylon*) and arroyo willow (*Salix lasiolepis*) is also present in the upper park area near 30th Avenue. The majority of upland shrub and herbaceous species are also non-native. Dominant species include English ivy* (*Hedera helix*), Cape ivy* (*Senecio mikanioides*), French broom* (*Genista monspessulana*), wild radish* (*Raphanus sativus*), sea fig or ice plant* (*Carpobrotus edule, C. chilense*), wild mustard* (*Brassica nigra*), common plantain*(*Plantago major*), English plantain* (*Plantago lanceoloata*), poison oak (*Toxicodendron diversilobum*), mallow* (*Malvia parviflora*), nasturtium* (*Tropaeollum majus*), and curly dock* (*Rumex crispus*). Grass species are largely annual non-natives, including Italian ryegrass* (*Lolium multiflorum*), wild oat* (*Avena fatua*), barley* (*Hordeum leporinum*) and ripgut grass* (*Bromus diandrus*). A significant amount of invasive Himalayan blackberry* (*Rubus discolor*) is located along the upper streambanks near the Lode Street facility, and is preventing other riparian vegetation from becoming established.

Brackish wetland species are found on the lower lagoon slopes, in areas that are periodically inundated when Moran Lake is filled to capacity. Except for one plant, these species are native perennials adjusted to salt or brackish environments with differential tolerances for inundation. Pickleweed (*Salicornia subterminalis*) is found at the lowest zone, with alkali heath (*Frankenia grandifolia*), Jaumea (*Jaumea carnosa*), salt grass (*Distichlis spicata*) and fat hen (*Atriplex patula*) present at somewhat higher elevations, respectively. On the lower east lagoon bank, erosion has removed all wetland plants, while on the lower west side, the aforementioned non-native ice plant extends from the County Park parking lot to the lower Moran Lake shoreline, crowding out native upland and wetland species.

A somewhat disturbing trend is evident from a review of the 1980 Environmental Baseline Study (Stern et. al. 1980). The vegetation survey performed then identified some of the same non-natives found in 2004, but also included a significant number of native shrubs and herbaceous plants not in evidence today. Upland native shrubs identified in 1980 but not in 2004 include deerweed (*Lotus scoparius*), sky lupine (*Lupinus nanus*), bush lupine (*Lupinus arboreus*) and coyote brush (*Baccharis pilularis*). Herbaceous species included California poppy (*Eschscholzia californica*), coast hedge nettle (*Stachys chamissonis*), seaside dandelion (*Agoseris apargioides*) and loosestrife (*Lythrum hyssopifolia*). One native wetland species, *Carex obnupta* (slough sedge), was prevalent in 1980 but confined to one small area just south of the Lode Street facility in 2004. The brackish wetland species, *Scirpus americanus* (bulrush), was found in 12 locations on the lake edge in 1980 but was also absent in 2004. Conversely, the highly invasive non-natives, Himalayan blackberry, French broom, English ivy and Cape ivy were prevalent in 2004 but absent in 1980. Ice plant was found in several patches along the west lake shore in 1980, but did not cover extensive areas of the lagoon bank slope as it does today. Nearly all the dominant plant species in 2004 are non-native with a significant coverage of aggressive invasives.

Wildlife and Aquatic Invertebrates. Wildlife and in-lagoon benthic invertebrate surveys were not conducted as part of this study, although incidental observations of wildlife were made; however, wildlife and aquatic invertebrate populations are expected to be similar to those identified in 1980. Water birds associated with the lagoon include mallard ducks (*Ana platyrhynchos*), coots (*Fulica americana)*, western gulls (*Larus occidentalis*), sanderlings (*Crocethica alba*), western sandpiper (*Ereunetes mauri*), egret (*Cosmerodius albus*) and great blue heron (*Ardea herodias*). Compared with Corcoran Lagoon and other productive coastal lagoons, water bird usage at Moran Lake is comparatively light, with relatively low density and diversity of species. This is probably due to the small size of Moran Lake and the low productivity of small fish and aquatic invertebrates.

Mammal and bird species in upland areas include common species typical of the urban environment. Gray squirrel, opossum, western harvest mouse, gopher and skunk were observed or trapped during the 1980 survey. Avian species included robins, mourning

doves, starlings, swallows, song sparrow, white-crowned sparrow, red-winged blackbird, Brewer's blackbird, Anna's hummingbird and scrub jay.

Examination of plankton samples taken in May 1980 yielded calamoid corepods, oligochaetes (annelid worms), Capitellid polychaetes (worms) and four species of phytoplankton. From benthos sampling in Moran Lake mud sediments performed at the same time, oligochaetes, juvenile sand crabs (*Emerita analoga*), copepods and polychaetes were detected. Generally, the low numbers and diversity of invertebrates found in Moran Lake indicates an aquatic ecosystem that has relatively low productivity and is unable to support large numbers of fish and aquatic birds. Sampling of Moran Lake phytoplankton in 2003 (Swanson Hydrology 2004) showed a vastly different species' composition when the lagoon was closed compared to results when it was open. This characteristic also indicates lack of a stable aquatic community that is probably due to extreme salinity variations under winter and summer conditions (see Water Quality section).

Special Status Species. Two special status species are known to occur at Moran Lake. The federal endangered tidewater goby (*Eucyclogobius newberryi*) has been observed in Moran Lake in the past (Smith 2002); however, the reconfiguration of the lagoon with harbor dredge spoils which removed backwater refuge areas, and annual runoff which empties the lagoon during winter months (see Figure 3.6) may have removed this species. Although no gobies, or other fish species were captured during Moran Lake seining in 1980, recolonization is possible from other nearby known localities such as Corcoran Lagoon and San Lorenzo River lagoon.

Tidewater goby is a small fish (~50mm) that inhabits low salinity coastal lagoons and lower reaches of coastal streams. Gobies have a short one to three year life cycle. Food sources include small crustaceans, aquatic insects, and mollusks including some benthos living in lagoon sediments. It requires backwater areas for long term survival, and threats to its existence include winter flooding, water diversions, water quality degradation from human, industrial and agricultural wastes and physical alterations to lagoons and marshes. The species has been extirpated from 56% of the localities it once occupied in southern, central and northern California.

The second species, monarch butterfly *(Danaus plexippus*) is a state species of special concern. The eucalyptus groves in Moran Lake County Park provide overwintering habitat for monarchs, and the Park is one of the larger and more important cluster sites in California. Destruction or alteration of overwintering sites is of concern for continued survival and conservation of the species. The eucalyptus grove surrounding the Lode Street facility has supported the largest cluster population of butterflies in the Park, although other Moran Lake eucalyptus groves support monarchs in early fall months ("autumnal sites"), or support butterflies as temporary refuge sites. Surrounding trees often function to provide a windbreak and create good microclimate conditions for butterfly roosts. Eucalyptus groves at Moran Lake Park have been adversely affected by resident tree-cutting or pruning, poor drainage and overcrowding. Increases in water and soil salinity is also a concern for future health of these trees. A Management Plan for

Monarch Butterfly Habitat at Moran Lake County Park (Janecki et.al. 2002) has been prepared which provides information on monarch life history and recommendations for enhancement of monarch wintering habitat. An effort has been made to make recommendations in this water quality plan consistent with that document.

2.3 Historic and Present Watershed Boundaries

The conversion of lands from open grasslands to urban, commercial, and residential developments has altered drainage patterns within the Moran Lake watershed. Stormwater management and construction projects in the 1980s diverted approximately 180 acres from the Moran Lake watershed to either the Rodeo Gulch drainage system to the west, or Soquel Creek to the east. Figure 2.2 shows the approximate predevelopment boundary of the Moran Lake watershed, extending north of Highway 1, and the approximate boundary of the current watershed.

2.4 Jurisdictional Boundaries

The Moran Lake Watershed lies within the County of Santa Cruz and the City of Capitola limits. Moran Lake is within the County of Santa Cruz and the upper portions of the Moran Lake watershed, beginning east of 35th Avenue and north of Portola Drive, are within the City of Capitola boundaries. The majority of the land within the watershed is privately owned, and landowner(s) or owner agents are responsible for maintenance of these lands. Public agencies, in this case within the City of Capitola and the County of Santa Cruz, are responsible for maintaining lands with public easements, public right-of-ways, and/or public lands (including roads). Figure 2.3 shows the current watershed boundary in relation to the City of Capitola jurisdictional boundary.

2.5 Land Use

Land use activities in the Moran Lake watershed over the last century have evolved from primarily rural residential and agricultural to almost exclusively commercial, industrial, and urban residential land uses. As part of the land use changes impervious surface area has increased as urban hardscape has been introduced into the watershed to create roads, sidewalks, and parking lots. Aerial photographs taken of Moran Lake and the surrounding areas, beginning in 1931 depict these land use changes.

Figure 2.4 shows Moran Lake and the surrounding areas, including Corcoran Lagoon and Pleasure Point, in 1931. The area around the lake is mostly agricultural fields and rural residential developments. The existing eucalyptus trees have been planted adjacent to Moran Lake and at the current site of the Santa Cruz County Sanitation Lode Street Facility. The purpose of the eucalyptus plantings is unknown, and possible reasons include use for lumber, firewood, medicinal purposes, mosquito abatement, or as a wind break. The riparian corridor and channel of Moran Creek are visible in Figure 2.4 north of Moran Lake on the left side of the photograph.

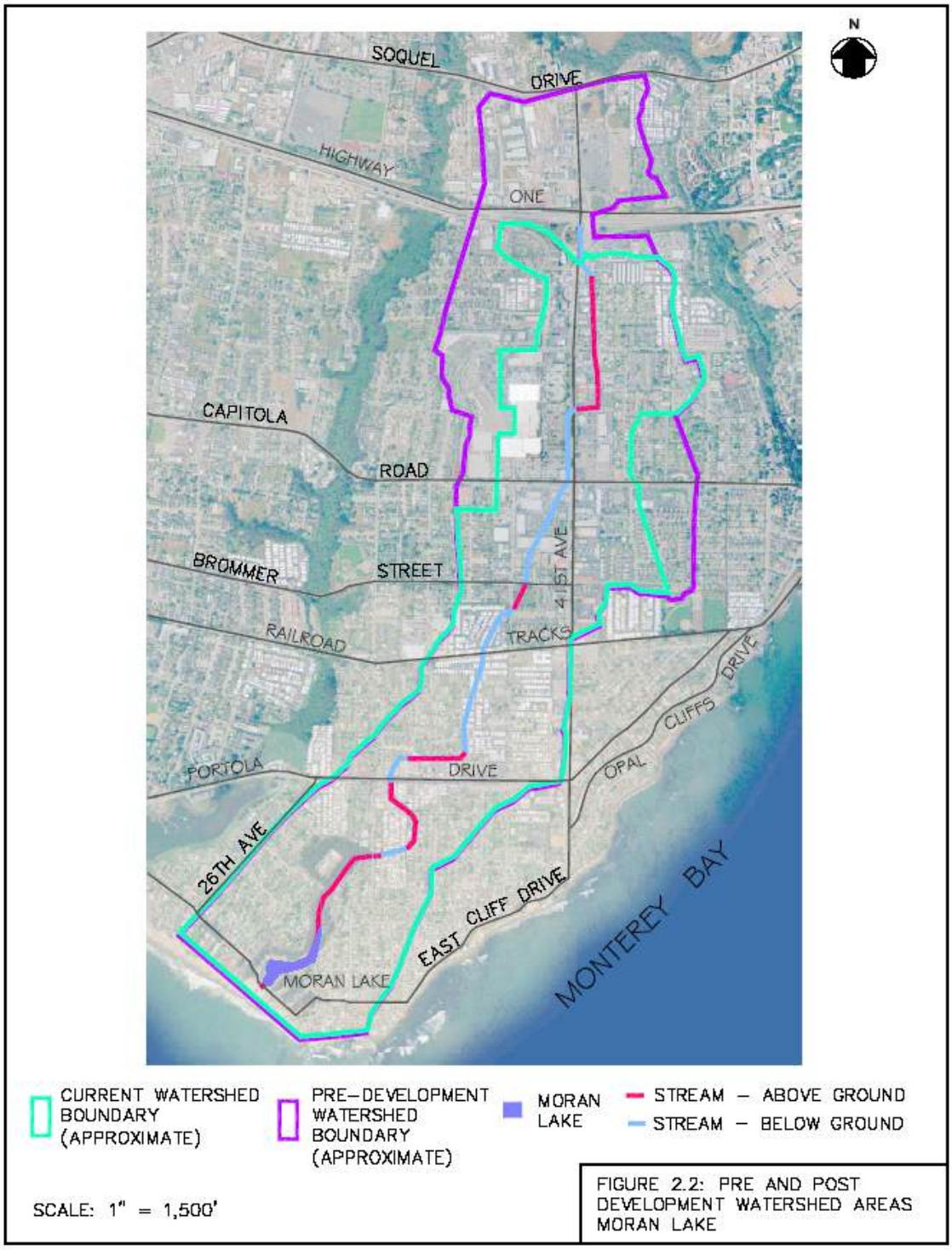


FIGURE 2.2: PRE AND POST DEVELOPMENT WATERSHED AREAS MORAN LAKE

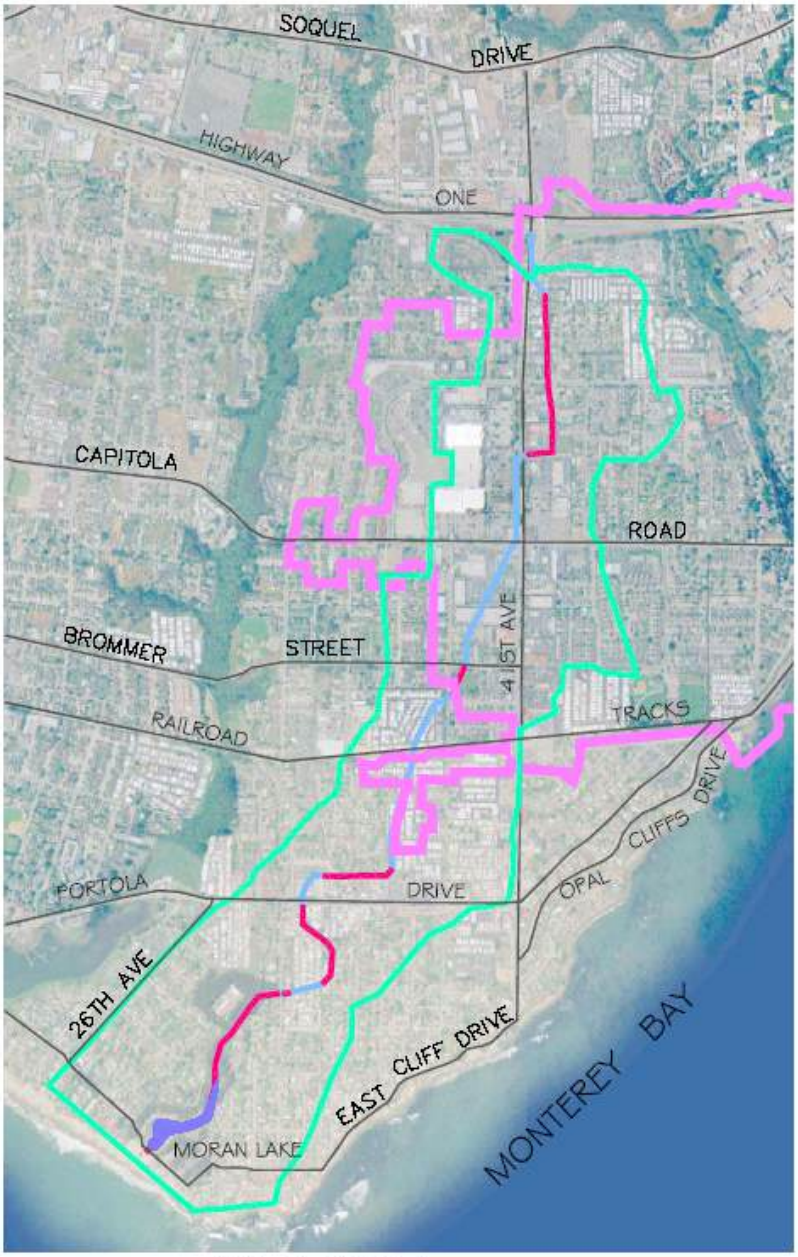


FIGURE 2.3: MORAN LAKE JURISDICTIONAL BOUNDARIES

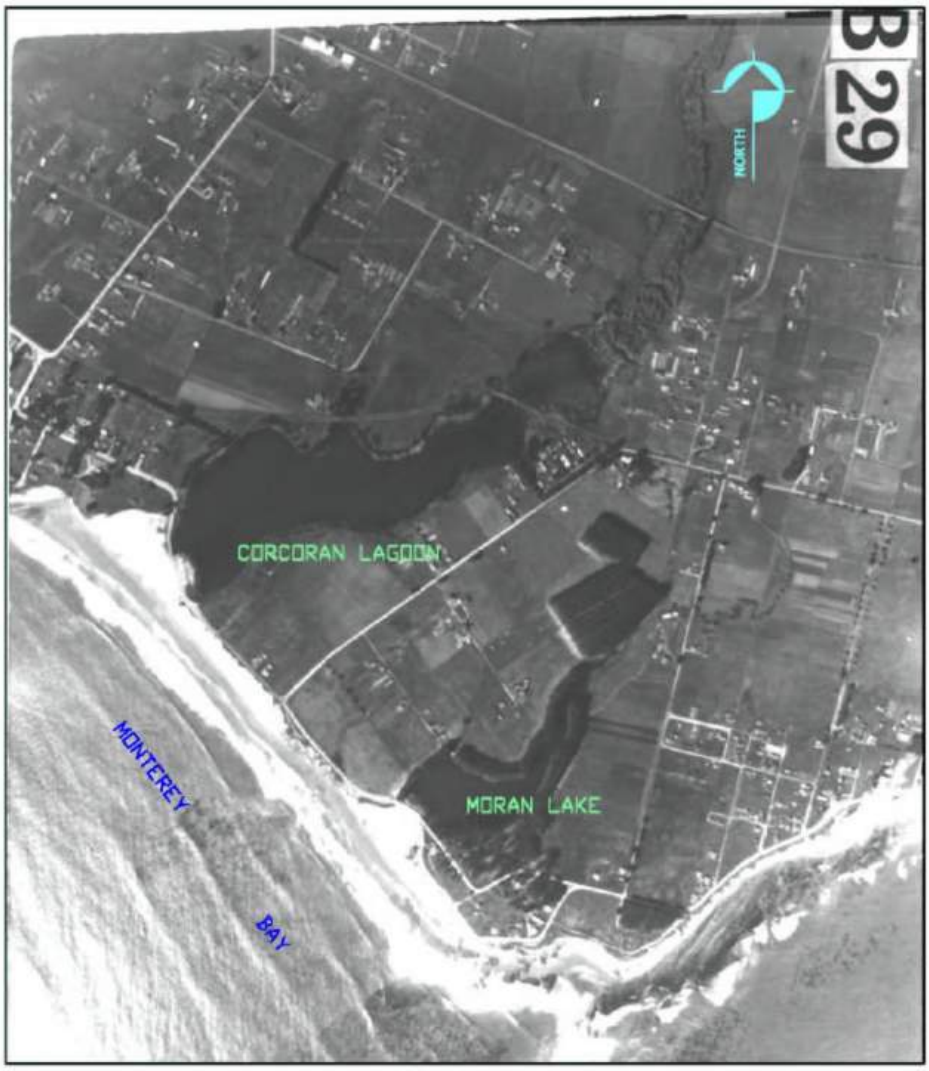


Figure 2.4. Aerial photo of Moran Lake taken April 1,1931



Figure 2.5. Aerial photo of Moran Lake taken August 25, 1953

Figure 2.5 is an aerial photograph taken in 1953 of Moran Lake and the surrounding area. Most of the agricultural lands adjacent to the lagoon have been converted to residential developments since 1931. The site of the current Lode Street Facility has been developed and the riparian corridor and channel of Moran Creek remain visible north of Moran Lake.



Figure 2.6. Aerial photo of Moran Lake taken March 26, 1986

Figure 2.6 shows Moran Lake and the surrounding areas in 1986. The open space and agricultural lands surrounding the lagoon have been almost exclusively converted to residential and urban land uses. The extent of the Moran Creek riparian corridor has diminished, and in some locations it has disappeared where the creek has been placed underground in culverts.

3. LAGOON AND WATERSHED HYDROLOGY

Moran lake is a coastal lagoon. In general terms a coastal lagoon is a body of brackish, marine or hypersaline water impounded by a sandy barrier and having an inlet connecting with the open ocean. Each coastal lagoon differs from all others. These differences fundamentally involve size, shape, tidal range, runoff of tributary streams, climate of the area, number and size of inlets and kind and amount of sediment available. Difference in water movement, chemistry, geology, and ecology result from these basic factors Phleger, 1981).

Using a physiographic classification of estuaries developed by Fairbridge (1980), Moran Lake is best described as a blind estuary with an ephemeral bar that develops in the dry season, creating an inland stagnate pool. Based upon a classification system developed by Kjerfve and Magill (1989), characterizing the type of channel connecting estuaries to the ocean, Moran Lake is a restricted lagoon connected to the ocean by an enclosing barrier. Barrier (bar) built estuaries, such as Moran Lake, occur where barriers enclose coastal embayments, forming extensive, shallow lagoons (Trenhaile, 1997).

Very small or "pocket" lagoons, such as Moran Lake, frequently occur at the seaward end of a stream, which has a small drainage basin and thus limited amount of runoff. Where the rainfall is seasonal, the inlet of such a lagoon is open during the rainy season and is closed by wave action and long-shore drift during the dry season. Under natural conditions these lagoons have significant water exchange with the open ocean by seepage through the porous sandy barrier (Phleger, 1981).

3.1 Historical Drainage and Morphology

Prior to development along the Santa Cruz County Coast, five coastal lagoons existed within the Live Oak area of Santa Cruz: from west to east, Wood's Lagoon, Schwan Lake, Bonita Lagoon, Corcoran Lagoon, and Moran Lake. All of these lagoons have been impacted by urbanization, and only Corcoran Lagoon is considered to be functioning in a relatively 'natural state'. In 1961 Wood's Lagoon was expanded and converted into the Santa Cruz Yacht Harbor, at which time dredge and fill materials from the project were placed in Moran Lake, dramatically altering the lagoon landscape. The following section describes the hydrologic processes occurring within Moran Lagoon, at the inlet and on the beach, prior to 1961 and then following the construction of the Yacht Harbor.

3.1.1 Lagoon Hydrology Prior to Yacht Harbor and Coastal Development

Beach Form and Shoaling. The beach at Moran Lake is one of many 'pocket beaches' along the Santa Cruz coastline. At low tides, prior to extensive development in the Live Oak Area, the development of the Yacht Harbor, and residential developments on East Cliff Drive, it was possible to walk from the Moran Lake beach to Lighthouse Point, on West Cliff Drive, approximately 4 miles north of Moran Lake. Based upon a review of historical aerial photos and observations of naturally functioning lagoon systems in

relatively undisturbed drainage systems, the evolution and seasonal fluctuation of the Moran Lake beach in a natural setting can be hypothesized.

Beginning in late winter and early spring of each year, ocean waves would cause sands to shoal up on the beach forming an ephemeral bar blocking the entrance to the lagoon. The size and steepness of the sand berm would increase through the spring and summer until late fall or early winter when high tides and freshwater flows in the lagoon would breach the sand berm. A sinuous channel would form on a rather broad beach, snaking between the cliff boundaries on the east and west side of the beach. This channel would connect the lagoon to the sea until early spring when sands would again accumulate in the channel and the ephemeral bar would rebuild and block the lagoon entrance. Flushing of salt water into the lagoon would occur periodically throughout the year (but more often during winter-early spring), generally during high tides, or spring tides[1], when water would overtop the beach berm.

Inlet Morphology and Hydrodynamics. Prior to 1961, the inlet morphology, or channel geometry of Moran Lake was likely determined by frequency and volume of tidal events. These important tidal events are defined as the tidal prism; a volume of water in a tidal system contained between two defined tidal datums (low and high tides) (PWA, 1995). Similar to bankfull flows in river channels, the tidal prism in estuary and lagoon systems is influential in forming persistent channel characteristics in tidally influenced systems. The tidal prism or volume of water entering and leaving the natural inlet establishes the equilibrium cross sectional area, width, and depth of tidal channels and inlets. The size or cross-section of an inlet is a function of the amount of water, which flows through it due to tidal prisim and amount of streamflow.

The depth of the channel over the entrance bar, which is the shallowest part of the entrance area is a function of tidal range, amount of streamflow and the size and direction of approach of ocean waves which reach the shore. Waves are critical modifying factor in causing the entrance channel to shoal.

Inlets of small “pocket” lagoons tend to open by a process known as thixotropy. As the lagoon is filled with water, the sand of the barrier becomes saturated with water. If there is heavy surf, the pounding of the saturated sand on the barrier by waves causes sand to become fluid and flow seaward at the position of the previous inlet. Then water flow from the lagoon, where the water levels is higher than in the adjacent ocean, takes over and finishes the opening.

Detailed information about Moran Lake and the characteristics of the inlet and tidal prism prior to development in the lagoon is unknown. From aerial photographs of Moran Lake taken in 1931, it appears the channel inlet was approximately 45 feet wide. The inlet bed location was moveable and the depth would vary from year to year. The inlet channel would be scoured or deepened as result of several conditions, including high tidal storm surge or wave action, and/or high flood events. A review of tidal information for

[1] Spring tides occur when the moon, sun, and earth are in line, during the full moon or new moon cycle.

Monterey Bay in Santa Cruz, indicate that tides can vary from -1.98 feet to 6.55 feet relative to mean sea level (msl).

Lagoon Circulation. Prior to 1961 the lagoon surface area was approximately 9 acres and the principal mechanisms of mixing in the lagoon were wave action generated by tides or winds, and friction between the surface water body and the lagoon channel and bed material. As a result of these mechanisms, freshwater moves downward, mixing with saline water, and saline water moves up into the freshwater. The circulation of the lagoon would vary seasonally based upon freshwater inputs, tidal fluctuations, and the development of the ephemeral bar on the lagoon beach.

For a short period of time, usually in late October, early November after the beginning of winter storms and prior to the breach of the ephemeral bar, water in the lagoon was highly stratified. Low density freshwater from stormwater runoff formed a lens over the saltwater accumulated behind the sand berm during the summer months. During this period of time, wind processes likely provided the only mixing mechanism between the two layers.

In December and January, once the ephemeral bar breached and the lagoon received freshwater and tidal inputs, Moran Lake became somewhat less stratified, or partially mixed.

The lagoon became non-stratified or fully mixed when: (i) there was no or little flow from freshwater inputs causing the lagoon to become primarily filled with saline water, (ii) low tides coincided with large stream inputs causing high contributions from freshwater with little or no flow from the ocean, and (iii) prior to large freshwater inputs and breaching of the ephemeral bar, the lagoon probably experienced a prolonged period of stagnation becoming saline, or possibly hyperhaline.[2]

Many of these same processes continue today, albeit on a smaller lagoon.

Lagoon Opening and Closure. Lagoon opening and closure typically occurs on two different time scales. River flooding is the major natural determinant of inlet conditions on time scales longer than a few years. Over short time periods, ranging from a few months to several years, inlet status is primarily determined by the available tidal prism and littoral sand transport. Results of long-term studies of coastal lagoons in southern California show that natural inlets may remain open 34% of the time. The tendency to remain open is vastly smaller during years of dry weather (12%) versus times of above-average rainfall (66%) (Elwany, et. al., 1998).

Historically, the typical inlet opening and closing sequence at Moran Lake, prior to its modifications, began when a major river flood scoured the lagoon and inlet channels.

[2] Hyperhaline refers to waters with a concentration of salt exceeding the ionic content of seawater with an ocean source.

During severe winter storms flood flows would have most likely scoured the main channel to an elevation well below the equilibrium depth that could be sustained by the maximum available tidal prism. Through the remainder of the year littoral-drift sand, washed into the inlet by tidal processes and wave surges, rapidly filled the entrance and exterior portions of the channel. Then by late fall the inlet would be filled with sand to near the equilibrium depth.

When there were periods of drought or extremely low flows the lagoon would remain closed. Exceptions would occur during unusually high tide events, when large waves temporarily overtop or breach the beach berm.

3.1.2 Watershed Hydrology and Drainage System

Prior to development in the Moran Lake watershed the hydrology and landscape were very different from what they are today. The Moran Lake watershed has a southern orientation, and prior to the installation of drainage infrastructure in the 1980s, which decreased the extent of the Moran Lake watershed by approximately 180 acres, it extended north of Highway 1 between the Rodeo Gulch and Soquel Creek watersheds. Prior to current development the watershed was likely well vegetated, with a high infiltration capacity. The channels were able to migrate and meander within the watershed. The watershed consisted of open grasslands and forested coastal terrace areas with ephemeral tributary streams entering Moran Creek, the principal tributary to Moran Lake.

3.2. Current Drainage and Morphology

Between 1961 and 1963, dredge material removed from Wood's Lagoon for the development of the Santa Cruz Yacht Harbor was deposited in Moran Lake, effectively reducing the surface water area of the lake from approximately nine acres to five acres. At this same time a 7-foot diameter culvert was installed at the lake outlet, approximately five feet above the mean high tide level, blocking the lagoon inlet and transforming the coastal lagoon into an inland lake. In 1981 the 7-foot diameter culvert was replaced with the existing box culvert beneath East Cliff Drive. The bottom (invert) of the box culvert was set at one foot below mean sea level.

Another significant change in the Moran Lake watershed was the transformation from open grassland and forested coastal terrace, to a rural farming community, and then into high density residential and commercial-industrial land uses. The result of these land use changes greatly increased the impervious surface area in the watershed, altering the hydrologic response, timing, volume, and quality of stormwater entering Moran Lake.

3.2.1 Lagoon Hydrology

Beach Form and Shoaling. The current beach form and shoaling processes function similar to historic processes. The Cabrillo College Geology and Oceanography Department has been monitoring the seasonal fluctuation of beach profiles along the

Santa Cruz County coastline, including the beach at Moran Lake for several years. Monitoring data provided by the Department (D. Schwartz, personal communication 2003) showing monthly beach profiles for the 2001 to 2002 season are presented in Figure 3.1. The zero elevation datum on the y-axis represents the elevation of East Cliff Drive, with distance from East Cliff Drive towards the ocean on the x-axis.

Figure 3.1 depicts how the sand on the beach fluctuates seasonally. Beginning in the late winter and early spring sand accumulates on the beach and forms an ephemeral bar across the Moran Lake inlet. The elevation and accumulation of sand on the beach continues through spring until late fall, with saltwater associated with high tides occasionally overtoping the ephemeral bar and entering Moran Lake. Based on discussions with Dave Schwartz, Oceanography Professor at Cabrillo College, in some years the elevation of sand on the beach exceeds the elevation of East Cliff Drive, with the amount and steepness of sand on the beach reaching its peak in the fall months. The graphical data also shows how the first large storm in the late fall or early winter, combined with large wave energy, erodes the ephemeral bar and opens Moran Lake to the ocean. Depending on storm and tide patterns, sand elevations fluctuate throughout the winter. During this time the lagoon bar remains open to the ocean, until early spring when the ephemeral bar closes.

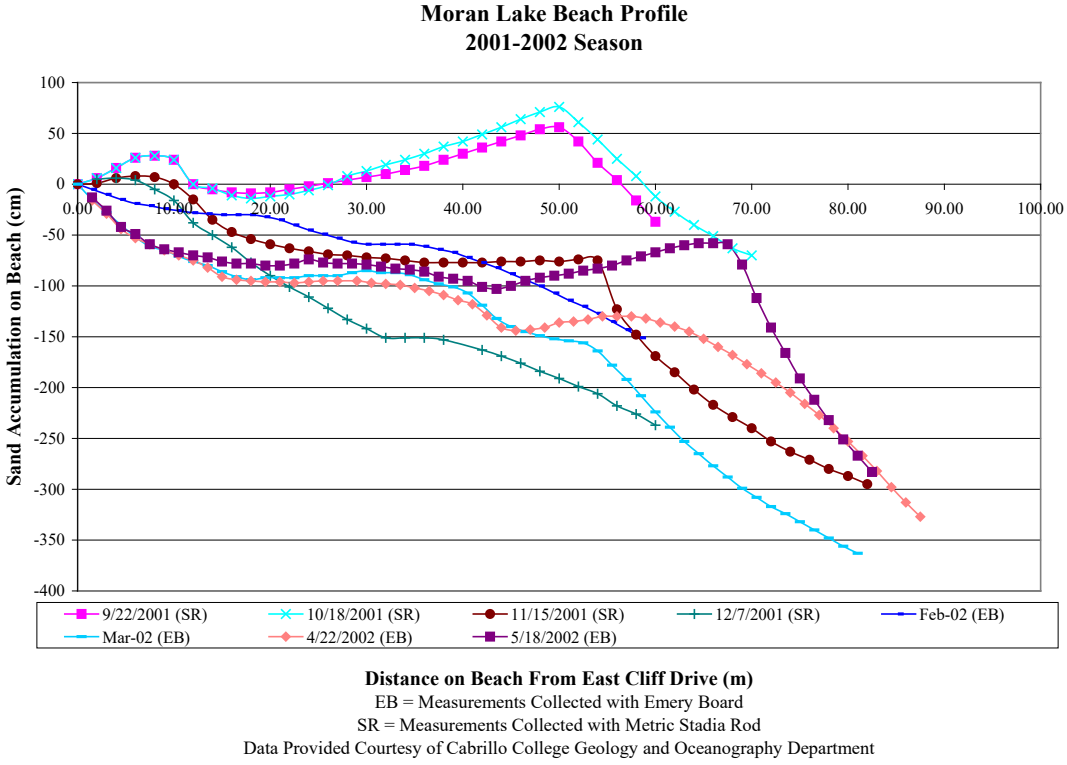


Figure 3.1. Moran Lake Beach Profile, 2001-2002 Season

While the connection remains open, storm surges and waves entering the lagoon carry sediment, primarily sands, that are deposited within the lagoon. At the time of this investigation, deposited material entering the lagoon formed shallow sand bars to the north of the box culvert, though it is anticipated the location and volume of these deposits varies seasonally and annually. The accretion of these sediments within the culvert and on the beach over numerous tidal cycles, eventually rebuilds the beach barrier blocking the connection between the lagoon and the ocean.

From aerial photographs it appears the width of Moran Lake Beach has diminished since the 1900s, possibly due to a combination of influences including the construction of the Harbor jetty and residential development adjacent to the beach.

When the Harbor jetty was built in 1961 it disrupted long shore sediment transport north and south of Wood's Lagoon. Sand accumulation on beaches north of the jetty increased while sand accumulation decreased on southern beaches, such as Moran Lake Beach. Recent changes in timing of harbor dredging and spoils deposition location south of the harbor may increase the amount of sand at Moran Lake Beach. However, more study is necessary to assess the relationship between the management of dredge material from the harbor and changes to the coastline south of the Harbor.

Residential developments and seacliff riprap placed to the north and south of Moran Lake Beach may also have limited sand production and accumulation. Though the Moran Lake Beach was historically small, these developments and the diminished beach size have restricted the development of the lagoon channel on the beach side of East Cliff Drive. Without these changes, a beach side lagoon similar to those existing at Corcoran or Schwan Lake would be expected at Moran Lake.

Lagoon Boundary and Tidal Inlet Structure. Development and infrastructure, such as the construction of East Cliff Drive has confined the lagoon to a relatively fixed configuration. The roadbed and adjoining upland areas are physical barriers to geomorphic changes in the shape and surface area of the lagoon.

The existing box culvert under East Cliff Drive seasonally connects Moran Lake with the Pacific Ocean. The box culvert is 71.6 feet long with 21-foot long wing walls extending into the lagoon. On the ocean side, the culvert extends 12 feet onto the beach and wing walls extend approximately 15 feet on either side of the culvert walls. The depth and width of the box culvert under East Cliff Drive is approximately 12 feet. The box culvert has a fixed bed at an approximate elevation of 1 foot below mean sea level. The box culvert is a grade control structure and limits the depth of the inlet channel to the invert elevation of the culvert.

Lagoon Morphology and Circulation. Water and salinity levels in Moran Lake vary seasonally based on a cycle of inlet blocking, tidal flushing, and freshwater inflow. Circulation and salt/freshwater mixing patterns depend upon seasonal fluctuations of the beach and tidal inlet, stream flow and climatic conditions. Over the course of this study,

four mixing patterns were observed within the lagoon: highly stratified non-mixed, partially mixed, non-stratified freshwater, and non-stratified saltwater.

Highly Stratified Conditions. A highly stratified non-mixed regime was observed within Moran Lake during the first flush event of the season. At the time of the event on October 31, 2003, the ephemeral bar at the lagoon inlet had not been breached and limited interaction between the lagoon and ocean was possible. Rainfall-runoff entering the lagoon created a lens of freshwater above higher density saltwater that had accumulated during the summer months. The density difference between the fresh and saltwater and the lack of physical mixing by tides or winds prevented significant mixing between the two layers. Water quality measurements of salinity and conductivity, indicators of salt or freshwater content, clearly show the stratification of the salt and freshwater. Figure 3.2 shows the lagoon under highly stratified conditions with the transition between saltwater at the lagoon bottom and freshwater at the top. At the lagoon bottom from zero to six inches the water has a salinity of 29.6 parts per thousand (ppt) and a conductivity of 35.6 microSemens (mS). At the water surface the fresh stormwater has a salinity of 0.7 ppt and a conductivity of 0.96 mS.

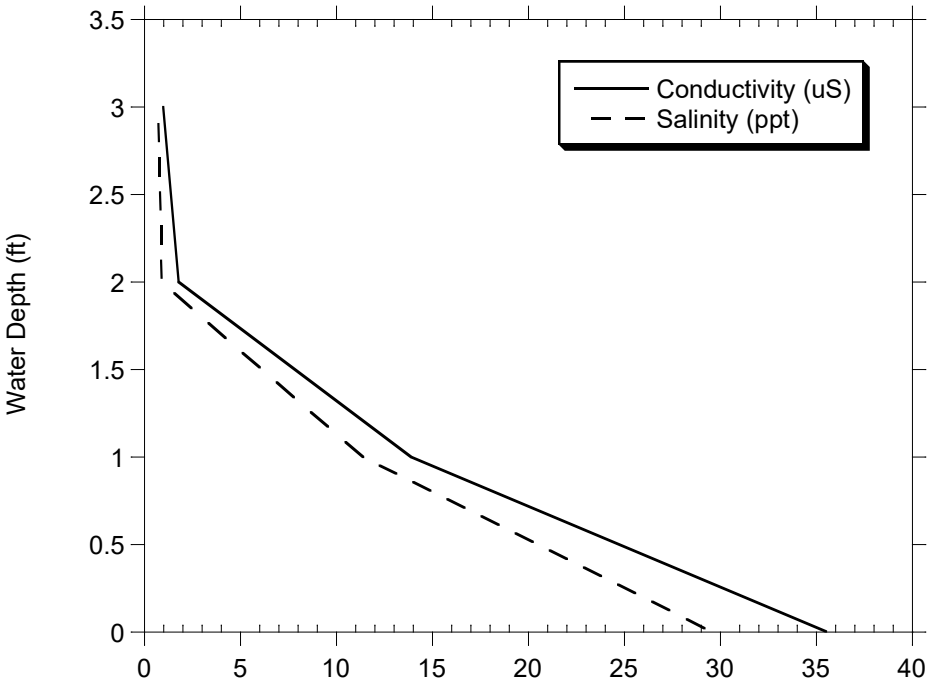


Figure 3.2. Summary of Conductivity and Salinity Measurements Collected During the First Flush Event on October 31, 2003 from Site 2

Partially Mixed Condition. A moderately stratified mixing regime was observed when the ephemeral bar breached, and the beach profile was not low enough to allow a

continuous connection between the lagoon and ocean. Figures 3.3 and 3.4 show the lake and the channel on the beach when ocean and stormwater can enter the lagoon.



Figure 3.3. Moran Lake After Ephemeral Bar has Breached and Lagoon is Partially Mixed – *November 12, 2003*



Figure 3.4. Moran Lake Beach After Ephemeral Bar has Breached and Lagoon is Partially Mixed – *November 12, 2003*

Non-Stratified Freshwater Condition. The lagoon is non-stratified and primarily filled with freshwater when the sand bar elevation has dropped below the bottom or bed

elevation (invert) of the box culvert. When the sand bar drops below the invert of the culvert stream flow does not backup and pond but flows through. In this condition the lagoon is functioning as a stream channel. When the water levels were low in the lagoon, it revealed fine-grained silt and clay sediments on the bottom of lagoon basin. Figures 3.5 and 3.6 shows Moran Lake and the channel on the beach during a low tide when the water in the lagoon is freshwater.



Figure 3.5. Lagoon Outflow Non-Stratified with Primarily Freshwater Flow – *February 2, 2004*



Figure 3.6. Moran Lake when the Lagoon is Non-Stratified with Primarily Freshwater Flow – *February 2, 2004*

Non-Stratified Saltwater Condition. The lagoon is non-stratified and primarily saltwater when the ephemeral bar reforms across the lagoon inlet and the stream flows

are low occurring typically in later spring. The bar closure limits the interaction between the lagoon and the ocean. During this period, extensive algal blooms were observed on the surface of the lagoon, as shown in Figure 3.7. Figures 3.8 and 3.9 show Moran Lake when the ephemeral bar has formed across the inlet and sand has accumulated inside the box culvert.



Figure 3.7. Algal Blooms on the Surface of Moran Lake when the Lagoon is Non-Stratified with Little or No Flow from Freshwater or Tidal Inputs – *October 28, 2003*



Figure 3.8. Moran Lake when the Lagoon is Non-Stratified with Little or No Flow from Freshwater or Tidal Inputs and the Lagoon is Primarily Filled with Saline Water– *October 28, 2003*



Figure 3.9. Moran Lake Box Culvert Closed with Sand– *October 28, 2003*

3.2.2 Watershed Modifications and Hydrology

Moran Creek and Drainage Modifications

The primary stream or drainage channel in the watershed is Moran Creek. Moran Creek is an intermittent stream, approximately 12,295 feet long, with an approximate slope of 0.6%. Approximately 6,395 feet of the channel is above ground, but is characterized by reduced riparian corridor width and discontinuous, mixed vegetation with a large non-native component. Approximately 5,900 lineal feet of channel has been collected below ground in culverts installed beneath roads and residential and commercial properties. Today most of the stream channel and riparian corridor has been encroached upon by urban development and the channel is confined to a very narrow channel. Only a few reaches of the stream remain in a relatively natural condition.



Figure 3.10. Moran Creek—Open Channel with Urban Encroachment

According to the County of Santa Cruz Storm Water Master Plan and Management Program, the Moran Lake watershed is approximately 546 acres in area (KVL, 1998). Urbanization in the watershed has included the installation of a complex drainage network that drains many of the developed lands to Moran Lake. With the shift from rural agricultural land use, runoff rates and volumes to the existing drainage systems have increased. To compensate for these changes the county and state have modified and reduced the drainage area of the watershed. With the construction of Highway One and development projects in the upper watershed areas, a substantial portion of the drainage area has been redirected to Rodeo Gulch and Soquel Creek.

Even with the reduction of the watershed drainage basin, continued urbanization has resulted in localized flooding in some portions of the watershed. To mitigate flood problems in the lower watershed, the County constructed the 38th Avenue Stormwater Detention Basin (Basin), as shown in Figure 3.11. The Basin is located on the southeast corner of the intersection of Brommer Street and 38th Avenue, and receives runoff from approximately 235 acres in the upper Moran Lake watershed. The Basin is designed to temporarily store runoff resulting from events that exceed the 150 cubic feet per second (cfs) capacity of the downstream culvert.



Figure 3.11. 38th Avenue Stormwater Basin

Based on discussions with local residents some reaches of the stream continue to experience localized flooding. These events are primarily attributed to older infrastructure projects, such as undersized culverts that have not been replaced to accommodate increased runoff rates. Ongoing development in the watershed continues to contribute to these problems.

Effects of Urbanization on Watershed Hydrology.

Land use within the Moran Lake watershed includes single family residences, shopping centers and commercial development, grassland, and mobile home parks. It is estimated that approximately 95% of the watershed has been urbanized with a substantial amount of impervious surface coverage. The increased impervious surface has dramatically altered the natural runoff patterns (hydrograph) and groundwater recharge in the watershed. Impervious surfaces, such as roads and parking lots, do not allow rainfall to infiltrate into soil, and shed it to drainage courses in a shorter period of time and at a higher volume than compared to a natural or landscaped area. As groundwater infiltration is reduced, flooding potential increases. Figure 3.12 shows changes that occur as a result of urbanization. As can be seen in the graphs the hydrograph for the urbanized area is much steeper and occurs over a shorter period of time indicating that the lag time between precipitation events and peak stream flows occurring in a stream has been shortened and the peak runoff flow and volume have increased.

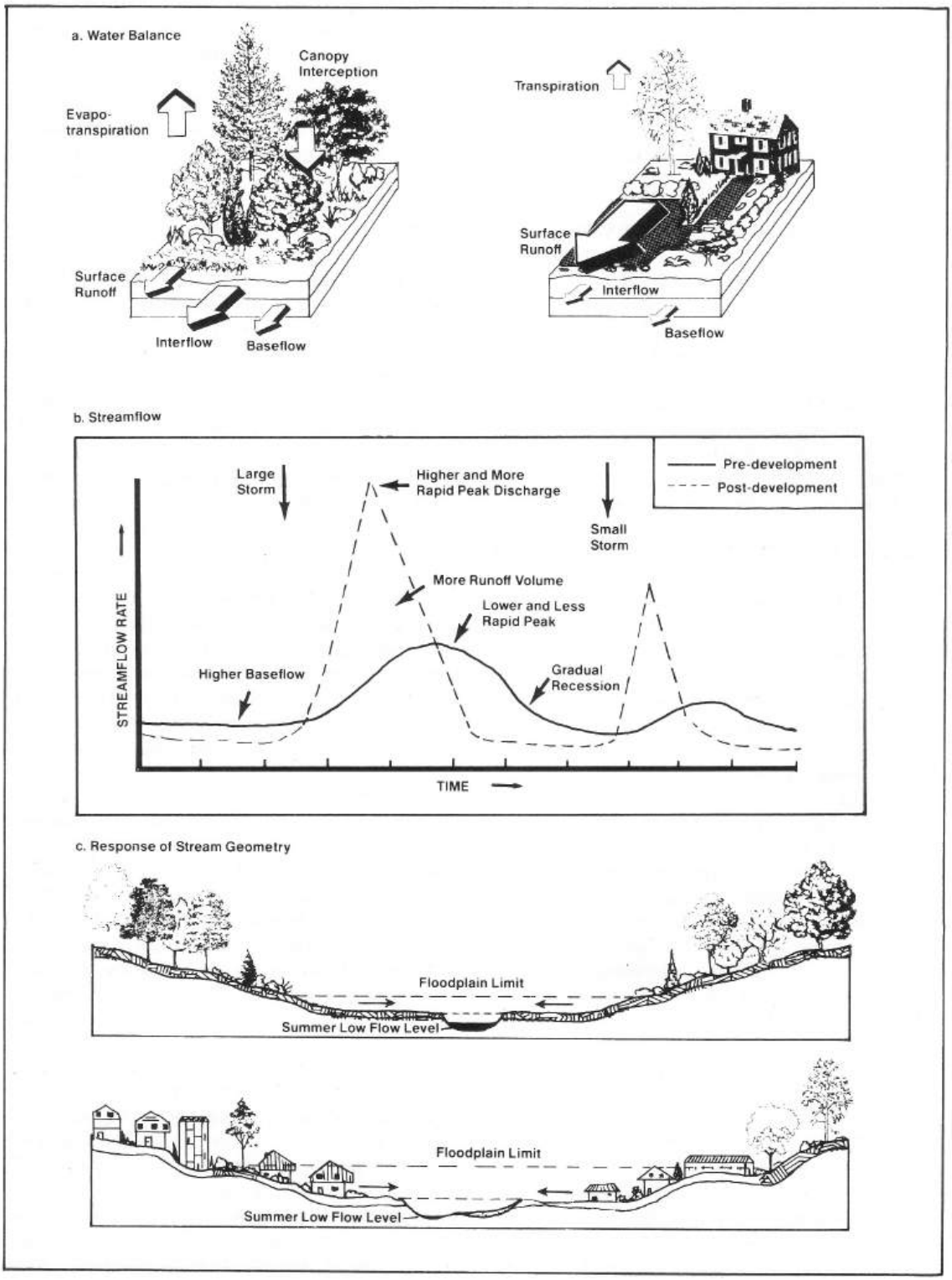


Figure 3.12. Typical Changes in Watershed Hydrology as a Result of Urbanization (Schueler, 1987)

Urban development reduces or eliminates natural rainfall storage within a watershed area. Natural storage areas include trees that intercept rainfall, depressions on the ground surface, and porous surface soils. When these areas are removed due to development activities, the rainfall storage capacity is reduced and rainfall is more quickly converted to runoff. Runoff rates are further accelerated when construction includes impervious surfaces such as rooftops, roads, parking lots, sidewalks, and driveways. Alterations to natural rainfall runoff patterns also change stream hydrology. Impacts to stream hydrology associated with urban streams, such as Moran Creek, can be summarized as follows:

Increased Flooding. The first change in stream hydrology in urban streams is an increased magnitude and frequency of severe floods. It has been estimated that peak discharges in urban watersheds increase two to five times from pre-development levels. The higher magnitude flows occur because natural storage and infiltration areas are reduced or eliminated, increasing the volume of water entering an urban stream channel. The frequency of severe flooding increases because flow magnitudes are higher in urban streams. For example, a flow that would be expected to occur once every two years in an undeveloped watershed can occur as often as three or four times a year in an urban stream.

Increased Bank Erosion and Sedimentation. The second change in stream hydrology is an increased frequency of erosive bankfull and sub-bankfull floods. A bankfull flow occurs once every 2 to 2.5 years and has the greatest influence on channel forming features, such as bank height and location and mid-channel bars. The frequency of a bankfull or sub-bank full flow increases in an urban watershed, causing high energy flows that disrupt the channel equilibrium, accelerating bank and channel erosion and sedimentation in the downstream stream and lagoon. Increased bank erosion can also result in costly damage and/or loss of private and public property and infrastructure. Figure 3.13 shows active bank erosion occurring in the upper stream reach of Moran Lake.



Figure 3.13. Channel Erosion in Upper Reach of Moran Lake

Groundwater Recharge. The third change in stream hydrology is reduced groundwater recharge. Surfaces such as sidewalks, roads, rooftops, and driveways cover areas that once would have absorbed or infiltrated rainfall. The decreased infiltration capacity in urban watersheds decreases the extent of groundwater recharge, and will therefore reduce stream baseflow during dry weather. It is likely that prior to urbanization in the watershed, stream flow in Moran Creek was higher throughout the year (except immediately following storm events).

Loss of Habitat. Urbanization and channelization has substantially reduced the extent of natural habitat along Moran Creek. The loss of natural habitat impacts wildlife and limits future restoration and recreational opportunities in the watershed.

Loss of Flood Plain. Development and covering of the creek has resulted in the loss of the natural floodplain of Moran Creek. In a natural setting a stream is bordered by a floodplain that is periodically inundated when stream flows overtop channel banks. Reducing the width of the stream and confining it to a narrow band prevents the stream from accessing the floodplain, increasing the frequency of flooding and forcing high energy flows to remain in a narrow channel that accelerates channel downcutting and bank erosion.

3.3 Summary and Conclusions

1. The size of the lagoon has been significantly reduced and confined to a small area as a result of dredge material disposal, development and infrastructure projects surrounding the lagoon. These modifications have restricted the natural geomorphic changes that would naturally occur in a coastal lagoon in response to episodic storm events, and have limited the expansion of the lagoon onto the beach west of East Cliff Drive.

2. Preliminary review and analyses indicate that the existing box culvert under East Cliff Drive may be slightly undersized to handle the full tidal prism entering and exiting the lagoon; however, beach profile monitoring at the mouth of the lagoon suggest that the box culvert is not a substantial barrier to flushing. Substituting a bridge or adding a new culvert may not produce significant changes to winter or summer lagoon conditions. This is due to the relatively small lagoon size, rapid formation of the sand bar, and altered runoff volumes from the watershed. Lowering the culvert depth to –2 to -3 feet below MSL may also allow greater water exchange, particularly at low tides, but could cause additional bank erosion and damage to public or private property. If either change is considered, possible effects of increased salinity on lagoon aquatic and upland wildlife habitats must also be reviewed. A more extensive hydraulic modeling study would be required to determine if replacing the culvert with a clear span bridge or arched culvert would substantially improve water circulation and water quality in the lagoon.

3. Urban land use within the Moran Lake watershed has altered the surface water hydrology of Moran Creek. The increased impervious surface has dramatically altered the natural runoff patterns (hydrograph) and groundwater infiltration in the watershed.

4. The change in stream hydrology has increased the frequency of erosive bankfull and sub-bankfull floods, and has accelerated bank and channel erosion and sedimentation in the stream and lagoon. These changes can result in costly damage and/or loss of private and public property and infrastructure.

5. Development in close proximity to the creek, and undergrounding the creek has resulted in the loss of the natural floodplain of Moran Creek. Reducing the width of the stream and confining it to a narrow band prevents the stream flow from accessing the floodplain, increasing the frequency of flooding and forcing high energy flows to remain in a narrow channel that also accelerates channel downcutting and bank erosion. Urbanization and channelization has also substantially reduced the extent of natural habitat along Moran Creek. The loss of natural habitat impacts wildlife and limits future restoration and recreational opportunities in the watershed.

6. In some reaches below the 38th Avenue detention basin some existing culverts on Moran Creek are undersized resulting in localized flooding during peak storm events. More detailed hydraulic analyses would be required to assess the extent of flooding and to determine an appropriate solution to improve conditions along the stream.

4. WATER QUALITY

4.1. Overview

Eutrophic and hyperhaline conditions in Moran Lake have been well documented since the mid 1970's. Several factors are contributing to this, including poor circulation and flushing during the summer months and nutrient rich runoff entering the lagoon from urbanized lands.

Historical and recent testing continue to detect high concentrations of fecal coliform bacteria indicating the lagoon is receiving contaminated runoff from the surrounding urbanized areas. Although historic testing may have indicated sewage overflows from the treatment plant that once existed at Lode Street, it is likely that present coliform contamination comes from multiple sources, including domestic animals, leaking sewers, and wildlife (most notably water fowl) residing in the lagoon or riparian corridor.

A reduction in lagoon surface area and volume has diminished the ability of Moran Lake to dilute and assimilate contaminants.

Eutrophic or highly enriched watercourses, such as Moran Lake show highly varying levels of dissolved oxygen (DO). During early morning periods DO is suppressed with low concentrations, while in the late afternoon DO may be very high due to algae and other aquatic vegetation releasing oxygen into the water column. Urban pollution and storm water runoff act to decrease dissolved oxygen concentrations in lake water. Polluted runoff containing degradable organic matter introduced to a water body such as Moran Lake, exert an oxygen demand during the assimilation and decomposition of these waste products. This oxygen demand can deplete DO concentrations, creating unsuitable conditions for aquatic organisms.

General mineral analyses conducted in June, July and October 2004 clearly indicate that during the summer months the lagoon is filled primarily with salt water and the major ions in solution include chloride and sodium. During the first flush event, the water condition in the lagoon shifted rapidly to freshwater.

The concentration of trace metals varied significantly both spatially and seasonally. During the summer months the trace metals concentration was very low. However, the highest concentrations during this period were routinely detected in the samples collected from Moran Creek which receives dry weather runoff from urbanized areas. Dry weather runoff includes runoff from streets and driveways, construction- related washing activities, car washing, and over spray from landscape irrigation systems. A sample collected in late October during the first significant rainfall event ("first flush" event) contained significantly higher concentrations of these metals, which could adversely affect aquatic organisms. Comparing the test results to the different water quality criteria indicate that during the first flush event, the three metals tested were measured at concentrations that exceed several water quality criteria. The test results indicate that

runoff from urbanized areas in the watershed discharge significant and potentially toxic levels of copper and zinc to Moran Lake.

Sediment samples detected the presence of several polyaromatic hydrocarbons (PAHs), commonly known as oils and grease. Principal sources of PAHsare roads, parking lots and vehicle service areas. Several of the PAH compounds detected are carcinogenic compounds and other compounds are potentially toxic to aquatic life. Comparing the PAH concentrations with different sediment quality benchmarks indicate that the phenanthrene, chrysene, benzo(a)anthracene and benzo(a)pyrene exceed criteria established by the British Columbia Ministry of Water, Land and Air Protection for protection of freshwater organisms. The total concentrations of PAHs is elevated, but are below the low and median effects levels established by the National Oceanic and Atmospheric Agency (NOAA). Based on the more conservative and contaminant specific criteria established by British Columbia, the levels of PAHs detected in the sediment may be impairing benthic and other aquatic life in the lagoon. Sediment test results detected total chlordane levels well above the probable and threshold effects levels established by several agencies. The results indicate that the residual and persistent chlordane levels in lagoon sediments may adversely affect aquatic life in the lagoon.

The following chapter provides a review of historical and recent water quality studies of Moran Lake, and the results of water quality and sediment testing undertaken as part of this study.

4.2. Review of Historical Water Quality Studies and Monitoring Activities

Staff Report on Moran Lake, 1976 (prepared by S. Singer and R. Aston)

Santa Cruz County Watershed Management staff conducted a water and sediment quality assessment of Moran Lake in 1976. The assessment provided a description of the watershed and the lagoon. The study also included a summary of summer field observations conducted on three separate occasions through the summer months. Two rounds of water quality and one round of sediment testing were performed as part of the study. Urban runoff loading calculations were also completed to estimate the amount of pollutants that could potentially enter the lagoon. The study concluded that there were two major water quality issues: (1) poor circulation and flushing during the summer months leading to euthrophic and hyperhaline conditions, and (2) urban development in the Moran Lake watershed that changed the amount, timing, and quality of surface runoff entering the lagoon. The report noted relatively high levels of nutrients, fecal coliform, oil and grease and heavy metals in the lagoon. Several alternative “corrective measures” are presented, including installing and maintaining a channel to “improve tidal flushing” and replacing the previous culvert with a bridge (The culvert was replaced with the present box culvert in 1981). The study also recommended ongoing summer maintenance to maintain the outlet channel open throughout the summer; installation of a tidal gate to prevent tidal flushing into the lagoon to maintain lower salinity levels in the lagoon; reshaping the lake by removing some of the fill material to try and improve mixing and flushing action; initiating public education efforts to reduce pollutant levels in

runoff entering the lagoon; and finally, installing a treatment system for urban stormwater runoff.

Environmental Baseline Study for the Moran Lake Enhancement Plan, 1980 (prepared by G. Stern and P. Courter)

During the spring of 1980, the first phase of the Moran Lake Enhancement Plan was undertaken and summarized in this report. The study was sponsored by the California Coastal Conservancy, and was conducted to evaluate biological abundance and diversity in relation to sediment and water quality. Water quality testing was performed from November 1979 to February 1980 in several coastal lagoons, including Moran Lake, Corcoran and Schwan Lagoons. Water quality results showed an increase in nutrients attributed to storm water runoff in Moran Lake. The results of the study also indicated that the lake or lagoon had a "diminished capacity for handling nutrient loads". Fecal coliform levels in Moran Lake were higher than in neighboring Corcoran, which was attributed to the "restricted exchange between the lagoon and ocean". The high fecal coliform counts and nutrients were interpreted as signs of eutrophication. The results of the sediment sampling showed decreased levels of lead, chromium, and cadmium in Moran Lake as compared with the 1976 County study. A decrease in lead concentration was attributed to the use of unleaded gasoline, or removal of debris from the lake by community groups, which may have also removed other possible sources of metal contamination.

Santa Cruz County Environmental Health Monitoring Activities

The Santa Cruz County Environmental Health Agency has conducted periodic water quality testing at several locations in the Moran Lake watershed, including up and down stream of East Cliff Drive, at 30th Avenue, the 38th Avenue Stormwater Detention Basin, and at the intersection of 38th Avenue and Brommer Street. From 1976 through 1980 the County performed several tests at the 38th Avenue detention basin primarily for total suspended solids, turbidity and fecal coliform bacteria. The results routinely detected elevated levels of fecal coliform in Moran Creek. From 1979 through 1992 the County conducted field measures in the Lagoon for temperature, pH, conductivity and dissolved oxygen. During this period water samples were also collected from the lagoon and analyzed for general minerals, fecal coliform bacteria and trace metals. Field measurements and general mineral concentrations are very similar to results obtained during this study effort and indicate that the lagoon water quality is quite variable seasonally but relatively constant from year to year. Limited tests for metals detected elevated levels of chromium and lead in the early 1980's.

2003 Technical Summary: Comparative Lagoon Ecological Assessment Project (prepared by Swanson Hydrology and Geomorphology)

The Comparative Lagoon Ecological Assessment project is a phased 3-year project (2003-2006) funded by the California Coastal Conservancy and administered by the Santa Cruz County Resource Conservation District. A key goal of the study includes

documenting the existing water quality, physical and ecological conditions of Santa Cruz County lagoons. In 2003, data collections efforts were undertaken to compare an array of physical, chemical and vegetation data from 11 lagoons on the Central Coast, including Moran Lake. The comparative information was used to generally assess the physical alterations and current land use pressures associated with the quality of each lagoon system, and evaluate the relative nutrient loading and summer function of each lagoon. The results indicated that Moran Lake had very high concentrations of phytoplankton when the lagoon was closed, with a low diversity of plankton consisting of 85% Pyrrhophytes, 13% Chrysophytes and 2% Cryptomonads. The predominant aquatic plant community is composed of submerged aquatic vegetation. A preliminary habitat conditions' ranking indicated that Moran is impaired as a result of reduction in surface area, reduction in summer inflows, urbanization in the watershed, substrate complexity, and excessive algae. Due to funding limitations, Moran Lake was not one of the five lagoons selected for further study under this project.

4.3. Water Quality Monitoring

Baseline water quality monitoring was undertaken as part of this study effort. Over a five-month period from June 2003 through October 2003, field measurements were taken at several locations in and upstream of the lagoon. In late October 2003 additional water samples were gathered after a significant rainfall event for general minerals, bacteria, nutrients, and trace metal concentrations. In November sediment samples were collected at several of the water sampling sites and analyzed by Toxscan and Soil Control Laboratories in Watsonville, California (both state certified laboratories). Water samples were analyzed by the Santa Cruz County Environmental Health Agency's Water Quality Laboratory for general minerals, bacteria, nutrients, and trace metal concentrations. Sediment samples were analyzed for trace metals, persistent pesticides, hydrocarbons and nutrients.

The objectives of the water quality monitoring included:

1. Establishing current baseline water quality conditions in the lagoon that can be compared to historical data and to other environmental criteria data to assess the general health of the lagoon;

2. To ascertain how and why water quality changes, both spatially and temporally in the lagoon; and

3. To guide future monitoring efforts.

The following sections provide a description of the program methods and a summary of the results and field observations.

4.3.1. Methodology

Monitoring and Sampling Locations. The consulting team in consultation with the Santa Cruz County Environmental Health Laboratory, selected four locations for regular water quality and sediment sampling. Three locations are within the lagoon and one is upstream of the lagoon in Moran Creek, as shown in Figure 4.1. The sampling locations are described as follows:

Site 1. Site 1 is located immediately upstream of the box culvert at the lagoon inlet.

Site 2. Site 2 is located ten feet from the west shore of the lagoon, approximately 420 feet north of the box culvert.

Site 3. Site 3 is located two feet from a storm drain outfall entering the lagoon from Lakeview Drive

Site 4. Site 4 is located on Moran Creek east of 30th Avenue, approximately three feet downstream of a culvert which is located between 30th and 34th Avenues, as shown in Figure 4.2.



Figure 4.2. Sampling Location #4, Moran Creek East of 30th Avenue

Water Quality Field and Laboratory Tests. Water quality measurements were taken in the field on ten separate events. On five occasions, water samples were also collected for analysis at the Santa Cruz County Environmental Health Lab. Field measurements were collected at one-foot increments throughout the depth of the water column at each

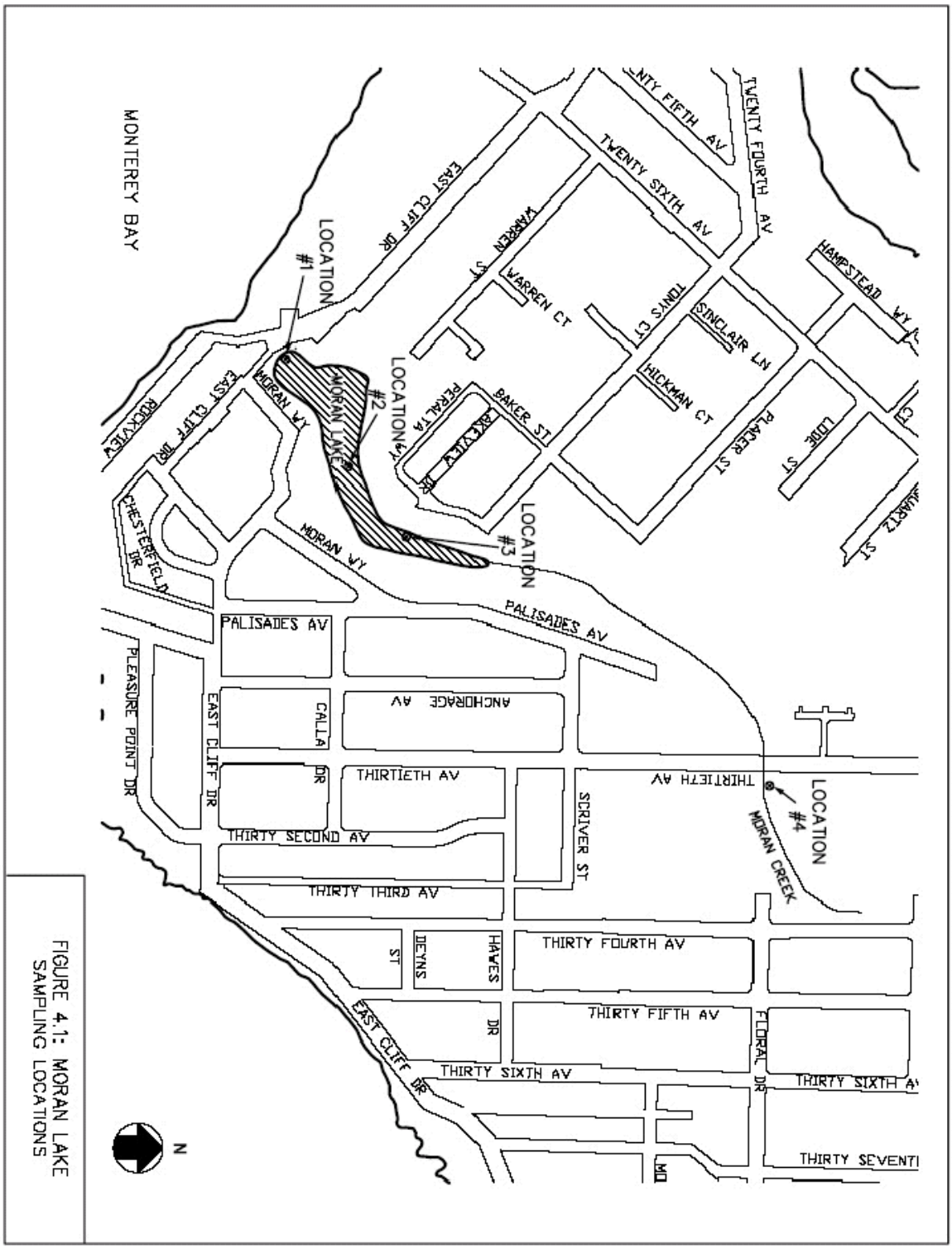


FIGURE 4.1: MORAN LAKE SAMPLING LOCATIONS

sampling location. Field measures were conducting using a multi-parameter meter and a portable turbidimeter for the following parameters:

- Water Temperature (°C)
- Dissolved Oxygen
- pH
- Conductivity
- Salinity
- Turbidity (NTUs).

Five samples collected for laboratory analysis were analyzed for the following parameters:

Total and Fecal Coliform	Total Suspended Solids
Alkalinity	Chloride
Nitrate-Nitrogen	Ammonia-Nitrogen
Organic-Nitrogen	Total Phosphorus
Total Sulfate	Sodium
Potassium	Magnesium
Calcium	Lead
Copper	Zinc

Grab samples were collected from the lagoon. Careful attention was taken to insure that the samples were not contaminated during sampling process. Samples that contained preservative were filled to just below the bottle lip to ensure no preservative was washed out. Samples were stored on ice (4 °C) during transportation to the laboratory.

On July 8, 2003, samples were collected in the morning and late afternoon to assess and measure diurnal variations in water quality, primarily fluctuations in dissolved oxygen. Water quality samples were also collected during the first flush event of the 2003-2004 water year, on October 31, 2003. The first flush event was defined as the first storm event of the season large enough to generate sheet flow across impervious surfaces in the watershed.

Sediment Quality Sampling. On November 25, 2003, sediment samples were collected at three locations within Moran Lake. Surface sediment samples were collected with bucket samplers at Sites 1, 2, and 3. At Sites 2 and 3, three soil samples were collected, at the right and left channel banks and one in the center of the channel. The three samples were composited prior to analysis. One additional sample was collected at Site 2 at a depth of six to eight inches below the surface. The samples were analyzed for the following parameters:

- Trace Metals
- Polynuclear Aromatic Hydrocarbons (PAHs)
- Organochlorine Pesticides
- Polychlorinated Biphenyls (PCBs)

- Nutrients (nitrogen and phosphorus species)
- General Minerals
- Iron and Manganese
- Oil and Grease
- pH and Conductivity

4.3.2. Results and Field Observations

This section provides a summary of the field and laboratory results. For the majority of parameters the results are presented graphically to illustrate the conditions measured either temporally (over time) or spatially (over the an area or depth in the lagoon). In some instances the results are compared to water quality standards or objectives that have been established to assess the potential impacts to water quality.

pH

Specifically, pH is a measure of the activity of hydrogen ions in water, and is defined as the logarithm of the reciprocal of the concentration of free hydrogen ions in a water sample. The pH scale ranges from 1 to 14, where neutral water will have a pH around 7 and a low pH water typically will have a pH of 4.5. The pH of natural waters is generally in the range of 6 and 9. However, in nutrient rich (or euthrophic) ponds or lakes, such as Moran Lake, pH can vary significantly throughout a day to due to photosynthesis and respiration. During the day aquatic vegetation, including algae and aquatic grasses uptake oxygen and release carbon dioxide, which reacts with hydrogen and results in an increase to pH, while during the evening and early morning aquatic plants respire and decompose consuming carbon dioxide and release hydrogen ions back into the water causing the pH to lower. This process is referred to as a diel fluctuation.

pH measurements were taken at the four sampling sites, at a depth of six inches below the water surface on nine events. The field measurements are presented in Table 4.1. pH values were generally within the range of natural waters, ranging from 6.6 to 9.3. The pH values varied spatially across the lagoon and temporally through the sampling period, as shown in Figure 4.3. In general the pH of the lagoon tended to increase as the lake became more eutrophic and saline. When the lagoon sand bar breached and the lagoon was primarily freshwater the pH dropped dramatically.

Table 4.1. pH Field Measurements

Date	Monitoring Location			
	Site 1	Site 2	Site 3	Site 4
06/05/03	6.0	6.0	6.1	5.2
06/26/03	7.3	7.3	7.2	8.0
07/08/03 (am)	7.7	7.3	6.9	7.7
07/08/03 (pm)	7.7	7.8	7.3	8.0
07/25/03	8.6	7.6	7.5	7.8
08/12/03	9.3	8.4	7.8	7.5
09/11/03	8.7	8.6	8.3	7.9
09/30/03	8.9	8.5	8.0	7.5
10/28/03	8.4	8.5	8.2	7.1
10/31/03	6.9	7.0	6.6	6.6

A daily fluctuation of pH was observed during a morning and afternoon sampling event on July 8, 2003. Morning and afternoon pH measurements showed diurnal variations of pH, which is attributed to photosynthesis of algae in the lagoon.

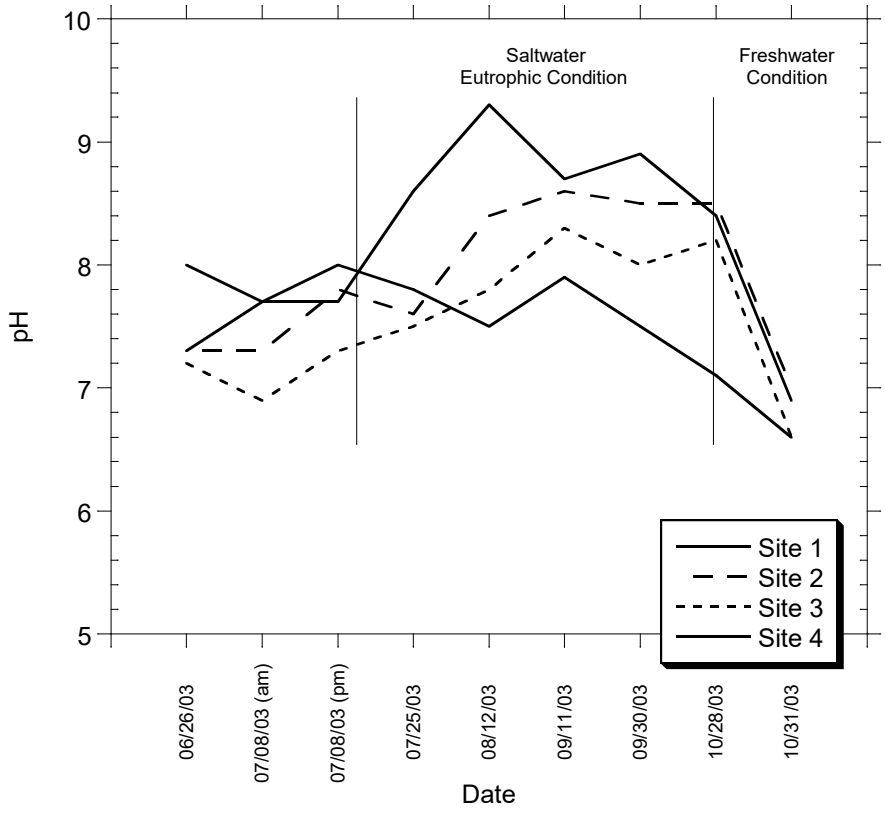


Figure 4.3. pH in Moran Lake (June 26, 2003 to October 31, 2003)

Dissolved Oxygen

Dissolved oxygen (DO) measures the concentration of molecular oxygen dissolved in water. Fish and other aquatic organisms assimilate dissolved oxygen in water through their gills and into their blood, and require a certain quantity of DO in water to survive. DO concentrations in water are dynamic depending on oxygen producing processes such as photosynthesis, and oxygen depleting processes such as respiration and decomposition. DO concentrations fluctuate daily, seasonally, with depth and at locations where physical factors increase water turbulence and water contact with atmospheric oxygen. Photosynthesis occurs near the water surface in the phototrophic zone where sunlight penetrates the water column. Decomposition occurs primarily on the lagoon bottom in the benthic zone where microorganisms decompose organic matter consuming oxygen. The concentration of DO in water is also temperature dependent. Colder water has the capacity to hold more DO than warmer water due to the density and pressure of the liquid.

Eutrophic or highly enriched watercourses, such as Moran Lake will show highly varying levels of DO. During early morning periods DO may be suppressed and very low concentrations, while in the late afternoon DO may be very high due to algae and other aquatic vegetation releasing DO into the water column. Urban pollution and storm water runoff often act to decrease dissolved oxygen concentrations in lake water. Polluted runoff containing degradable organic matter introduced to a water body such as Moran Lake, exert an oxygen demand during the assimilation and decomposition of these waste products. This oxygen demand can deplete DO concentrations, creating unsuitable conditions for aquatic organisms. In natural waters normal DO may fluctuate from 5 to 10 mg/L.

DO measurements were taken at each of the four sampling locations on ten separate events. Measurements were taken from the water surface to the lake bottom in one-foot increments. The DO data are presented in Table 4.2.

Each of the four sampling locations had unique patterns of DO fluctuation, likely related to their position within the lagoon. Figures 4.4.1 through 4.4.4 show the dissolved oxygen concentration measured at the surface and near the bottom of the lagoon at each monitoring site.

At Site 1 (Figure 4.4.1) the dissolved oxygen concentration was relatively constant throughout the water column, but varied significantly over time. During the early summer just prior to the lagoon closing the DO concentrations were relatively low, ranging between 4 to 6 mg/L. However, after the lagoon closed and became highly euthrophic daily DO concentrations increased significantly from mid july through September until the lagoon opened up again. DO concentrations were well above 10 mg/L in proximity to the culvert. DO concentrations were relatively constant at depth, which is attributed to the lagoon being well mixed due to wind action.

Table 4.2. Dissolved Oxygen Concentration (mg/L) Measurements

Date (Sample time)	Sample Location							
	Site 1		Site 2		Site 3		Site 4	
	Depth (ft)	DO (mg/L)	Depth (ft)	DO (mg/L)	Depth (ft)	DO (mg/L)	Depth (ft)	DO (mg/L)
06/05/03 (10:30)	0.0	5.73	0.0	6.08	0.0	4.32	0.0	8.38
	1.0	5.21	1.0	5.83	1.0	3.56		
	2.0	5.45	2.0	3.82	2.0	3.42		
	3.0	5.88	2.4	4.02	3.0	0.55		
	4.0	2.63			4.0	0.14		
06/26/03 (11:30)	0.0	4.95	0.0	6.33	0.0	4.86	0.0	11.40
	1.0	5.30	1.0	5.85	1.0	5.71		
	2.0	4.84	2.0	5.28	2.0	4.88		
	3.0	4.58	3.0	5.07	3.0	3.93		
	4.0	4.80						
07/08/03 (am) (08:30)	0.0	5.65	0.0	8.23	0.0	5.26	0.0	8.74
	1.0	5.44	1.0	6.40	1.0	4.32		
	2.0	4.34	2.0	5.49	2.0	0.17		
	3.0	4.04	2.5	4.02	2.5	0.06		
	3.5	4.20						
07/08/03 (pm) (16:30)	0.0	9.32	0.0	9.15	0.0	7.98	0.0	10.17
	1.0	8.94	1.0	9.39	1.0	7.99		
	2.0	8.56	2.0	8.71	2.0	7.09		
	3.0	8.99	2.5	8.33	2.5	0.27		
	3.5	8.22						
07/25/03 (11:30)	0.0	10.78	0.0	2.99	0.0	1.04	0.0	12.85
	1.0	9.83	1.0	3.27	1.0	0.83		
	2.0	11.90	2.0	6.65	2.0	1.20		
	3.0	12.12						
08/12/03 (9:30)	0.0	10.79	0.0	6.68	0.0	6.06	0.0	8.2
	1.0	10.3	1.0	6.08	1.0	0.81		
	2.0	10.29	2.0	6.07				
	2.5	10.0						
09/11/03 (3:30)	0.0	10.69	0.0	12.69	0.0	3.91	0.0	9.94
	1.0	9.8	1.0	13.38				
	2.0	10.15	1.9	15.06				
09/30/03 (9:30)	0.0	11.31	0.0	5.47	0.0	0.96	0.0	8.77
	1.0	11.7	1.0	1.50				
	2.0	11.94	1.5	0.35				
10/28/03 (11:30)	0.0	4.82	0.0	9.34	0.0	4.94	0.0	9.97
	1.0	3.2	1.0	4.64				
	2.0	5.43	1.5	1.28				
10/31/03 (6:45am)	0.0	10.74	0.0	11.27	0.0	16.65	0.0	11.28
	1.0	10.1	1.0	10.37	1.2	11.01		
	1.5	6.24	2.0	5.66				
			3.0	0.62				

At Site 2 the dissolved oxygen concentrations at the surface and near the lagoon bottom tended to vary seasonally. Eight of the ten sampling events showed a decrease in dissolved oxygen concentration with depth. During the summer months, when the lagoon

was closed to tidal flushing and had limited freshwater flows the dissolved oxygen at the surface was typically higher at the surface than near the bottom. The stratification of DO with depth at this location is likely influenced by surface photosynthesis of algae and decomposition of organic material on the lagoon bottom. This condition was also observed at Site 3 where DO at the bottom of the lagoon was less than 1 mg/L on several occasions, as shown in Figure 4.4.3. Urban runoff likely contributes sediments, surfactants, oil and grease from adjacent urban areas, which can effect DO concentrations. During the first flush event in later October the DO concentration increased substantially at Site 2 and on the surface at Site 3, as a result of highly aerated runoff entering the lagoon.

Figure 4.4.4. shows the DO concentration measured in Moran Creek upstream of the lagoon. DO at Site 4 in Moran ranged from 8.2 to 12.85 mg/L. Shallow water depths prevented multiple depth sampling at this location. Compared to the other sampling locations the DO concentrations at Site 4 were generally higher. The observed DO concentrations were likely influenced by turbulent flow conditions in the stream immediately upstream of the monitoring point.

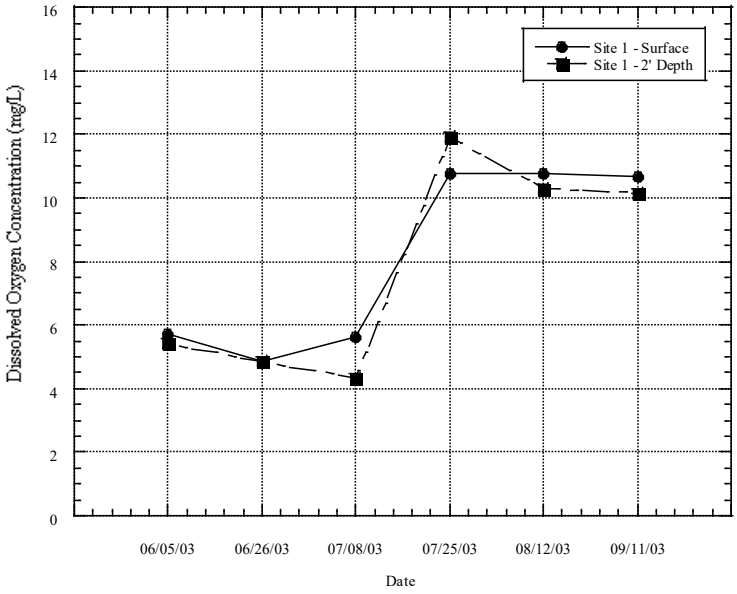


Figure 4.4.1. Dissolved Oxygen Concentrations at Lagoon Inlet (Site 1)

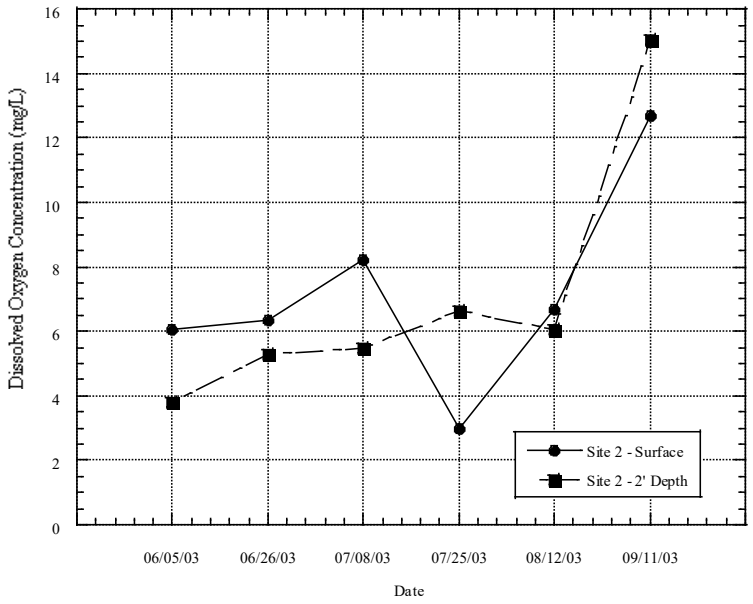


Figure 4.4.2. Dissolved Oxygen Concentrations at Site 2

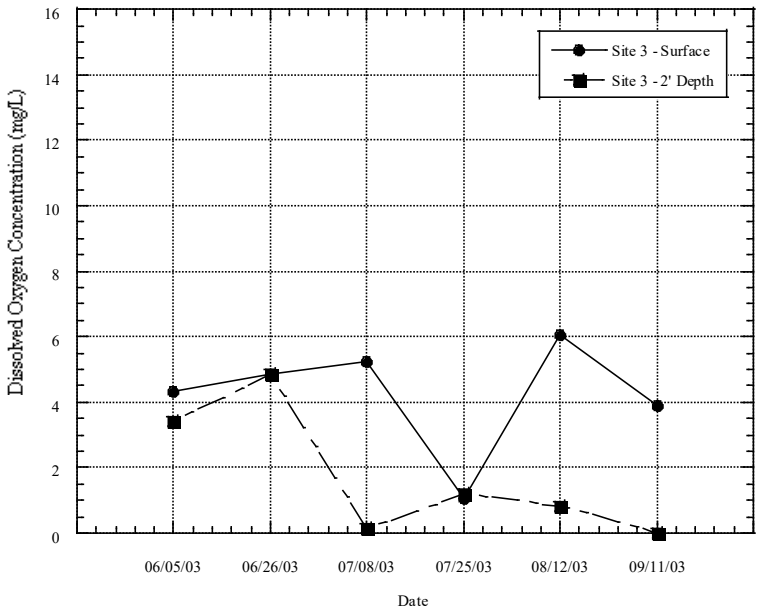


Figure 4.4.3. Dissolved Oxygen Concentration at Site 3

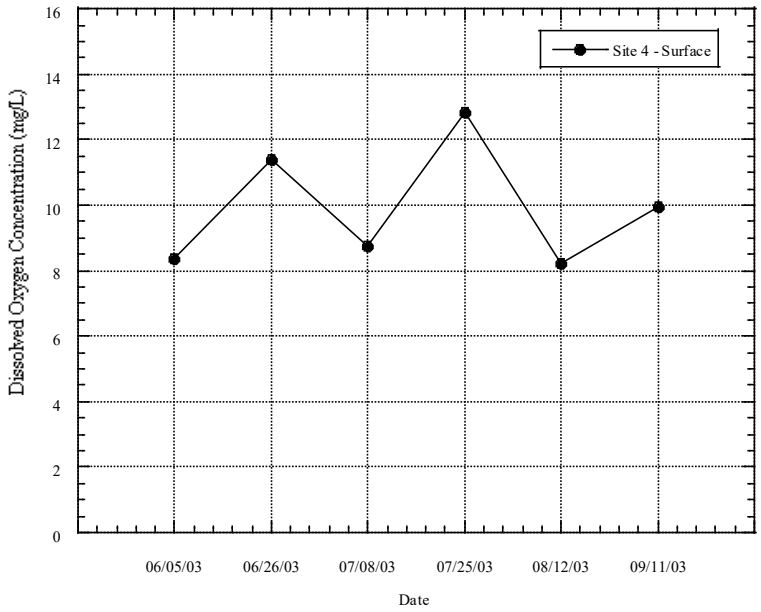


Figure 4.4.4. Dissolved Oxygen Concentration in Moran Creek

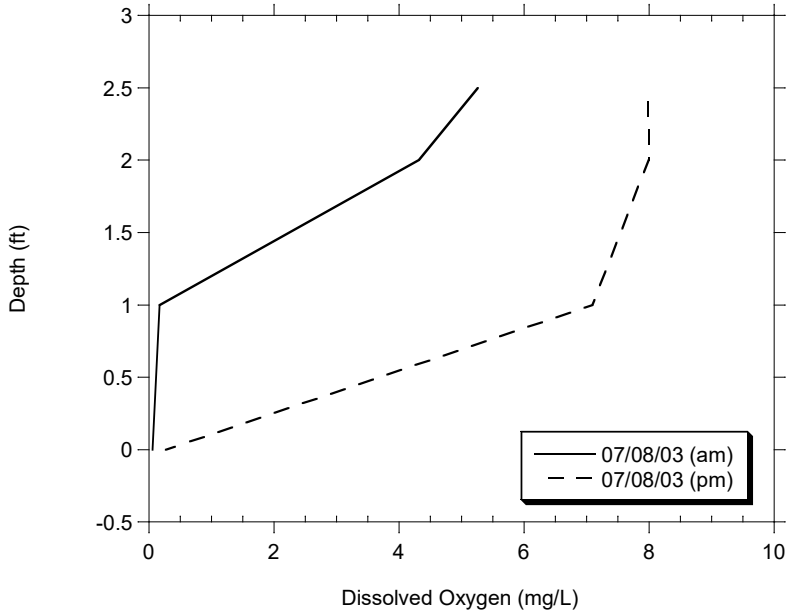


Figure 4.5. Morning and Afternoon Dissolved Oxygen Concentrations at Site 3

On July 8, 2003 DO measurements were conducted in the morning and afternoon at all four sampling locations. DO concentrations measured during the morning were less than recordings taken in the afternoon, as shown in Figure 4.5. The increase in DO during the

daylight hours is a result of oxygen production by photosynthetic algae in the water column. Low or depressed DO concentrations results from the high DO demand exerted by the substantial algal blooms occurring in the lagoon, which is expected under highly euthrophic conditions that are present in the lagoon.

Temperature

At Moran Lake, temperature measurements were taken at each of the four sampling locations, from the water surface to the lake bottom in one-foot increments on ten separate monitoring events. As expected, water temperature generally increased from July to early September and began to decrease in late September and October (Table 4.3). Water temperature within the lagoon was generally higher (between five to ten degrees) in the lagoon than at Site 4 in Moran Creek, as shown in Figure 4.6. The increased temperature in the lagoon is likely the result of the high heat capacity of the lagoon resulting from the thick biomass in the water column, combined with shallow water depths. Figure 4.6 also shows a daily increase in water temperature, observed on July 8, 2003 during a morning and afternoon sampling event.

Table 4.3. Temperature Field Measurements (Degrees Centrigrade, ºC)

Date (Sample time)	Sample Location							
	Site 1		Site 2		Site 3		Site 4	
	Depth (ft)	Temp (ºC)	Depth (ft)	Temp (ºC)	Depth (ft)	Temp (ºC)	Depth (ft)	Temp (ºC)
06/05/03 (10:30)	0.0	20.2	0.0	19.9	0.0	20.4	0.0	15.8
	1.0	20.2	1.0	19.9	1.0	20.4		
	2.0	20.2	2.0	20.5	2.0	21.2		
	3.0	20.7	2.4	20.5	3.0	21.2		
	4.0	22.3			4.0	21.5		
06/26/03 (11:30)	0.0	23.7	0.0	24.6	0.0	25.7	0.0	18.0
	1.0	23.2	1.0	24.6	1.0	24.5		
	2.0	22.7	2.0	24	2.0	24.2		
	3.0	22.5	3.0	23.7	3.0	23.2		
	4.0	22.4						
07/08/03 (am) (08:30)	0.0	22.2	0.0	23.7	0.0	24.0	0.0	15.1
	1.0	22.4	1.0	30.8	1.0	24.0		
	2.0	24.3	2.0	26	2.0	26.5		
	3.0	24.5	2.5	26	2.5	27.0		
	3.5	24.5						
07/08/03 (pm) (16:30)	0.0	29.0	0.0	28.2	0.0	26.7	0.0	19.6
	1.0	28.8	1.0	28.3	1.0	26.8		
	2.0	32.8	2.0	27.8	2.0	27.3		
	3.0	26.9	2.5	27.7	2.5	27.2		
	3.5	26.0						
07/25/03 (11:30)	0.0	22.6	0.0	22.4	0.0	23.7	0.0	17.5
	1.0	22.3	1.0	22.3	1.0	23.5		
	2.0	22.1	2.0	22.3	2.0	22.8		
	3.0	22.1						
08/12/03 (9:30)	0.0	22.9	0.0	23.4	0.0	22.3	0.0	15.7
	1.0	22.9	1.0	23.4	1.0	22.3		
	2.0	22.9	2.0	23.3				
	2.5	22.9						
09/11/03 (3:30)	0.0	23.5	0.0	27.8	0.0	26.7	0.0	19.8
	1.0	23.1	1.0	26.1				
	2.0	22.4	1.9	23.7				
09/30/03 (9:30)	0.0	19.30	0.0	17.10	0.0	18.80	0.0	15.2
	1.0	19.6	1.0	19.50				
	2.0	19.60	1.5	22.20				
10/28/03 (11:30)	0.0	18.80	0.0	22.20	0.0	21.80	0.0	15.7
	1.0	17.0	1.0	18.10				
	2.0	18.10	1.5	17.30				
10/31/03 (6:45am)	0.0	10.20	0.0	10.30	0.0	10.70	0.0	10.4
	1.0	10.4	1.0	10.40	1.2	10.40		
	1.5	11.10	2.0	11.50				
			3.0	12.5				

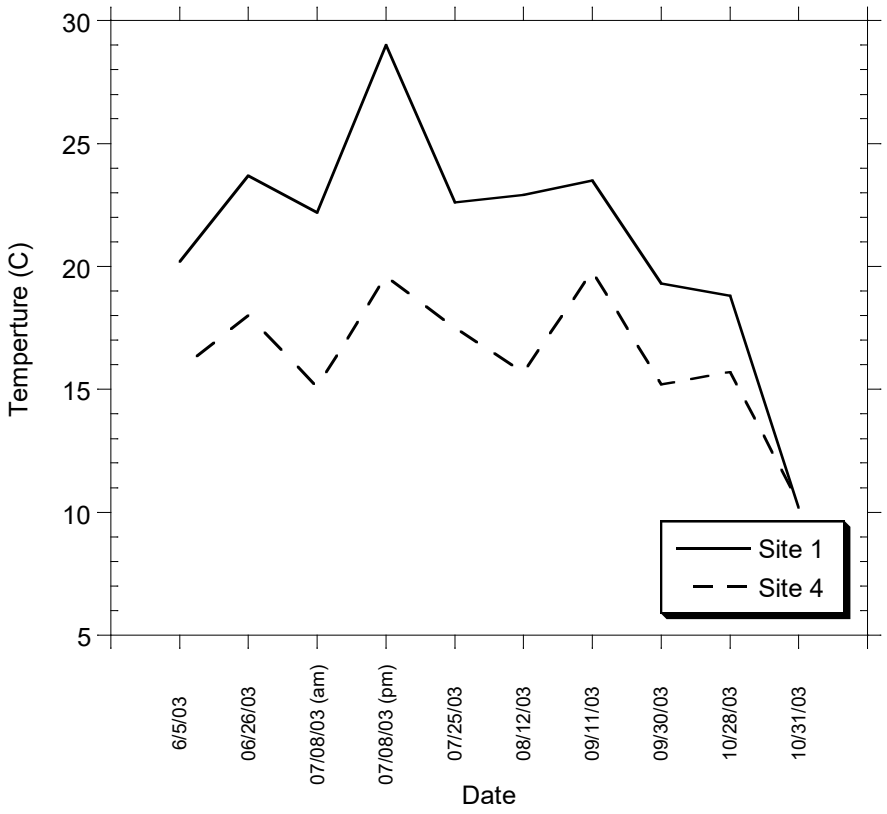


Figure 4.6. Water Temperature (Degrees ºC) Measured at Sites 1 and Site 4

Nutrients

Water samples were collected and analyzed by the Santa Cruz County Environmental Health Water Quality Laboratory for soluble nutrients including: organic-, ammonia- and nitrate-nitrogen, and total phosphorus.

Nitrogen and phosphorus at low levels are important nutrients in aquatic ecosystems. However, at elevated levels these constituents can result in excessive, invasive and some times noxious characteristics that lead to euthrophic and anoxic conditions in a lagoon system. Sources of nitrogen and phosphorus include storm water runoff, organic matter, lawn fertilizers, leaking sewer pipes and/or domestic animals. Natural nutrient sources include the decomposition of organic debris delivered to surface water bodies during storm events.

Over the course of the study, nutrients were measured on five separate monitoring events at each of the four sampling locations. The results are presented in Table 4.4.

Table 4.4. Nutrient (Nitrogen and Phosphorus) Measurements (in mg/L)

Sample Location	Date	Nitrate-N (mg/L)	Ammonia-N (mg/L)	Organic-N (mg/L)	Total Phosphorus (mg/L)
1	06/05/03	<0.01	0.54	5.44	<0.05
	07/08/03	<0.01	0.04	0.86	<0.05
	08/12/03	<0.01	0.09	1.6	<0.05
	10/28/03	<0.01	< 0.04	3.9	5
	10/31/03	1.7	0.72	8.8	0.9
2	06/05/03	<0.01	0.06	1.35	<0.05
	07/08/03	<0.01	0.05	0.85	<0.05
	08/12/03	<0.01	0.13	1.7	<0.05
	10/28/03	<0.01	< 0.04	3.7	<0.05
	10/31/03	1.5	0.74	6.4	0.7
3	06/05/03	<0.01	0.04	1.83	<0.05
	07/08/03	<0.01	0.07	0.83	<0.05
	08/12/03	<0.01	0.14	2	<0.05
	10/28/03	<0.01	0.07	4.2	<0.05
	10/31/03	1.2	0.44	5.2	0.5
4	06/05/03	1.10	0.07	0.82	<0.05
	07/08/03	0.50	< 0.04	0.68	<0.05
	08/12/03	0.26	0.11	1.3	<0.05
	10/28/03	0.09	0.06	0.8	0.09
	10/31/03	0.9	0.72	4.4	0.3

Nitrate-N (NO_3^-) concentrations at the four sampling locations ranged from less than the reporting limit, 0.01 mg/L, to 1.7 mg/L. Ammonia-N (NH_3) concentrations at the four sampling locations ranged from less than the reporting limit, 0.04 mg/L, to 0.74 mg/L. Organic-N concentrations at the four sampling locations ranged from 0.68 mg/L to 8.8 mg/L. Total phosphorus concentrations at the four sampling locations ranged from less than the reporting limit, 0.05 mg/L, to 0.9 mg/L.

The highest concentrations of total phosphorus, nitrate-N (NO_3^-), ammonia-N (NH_3), and organic-N were measured during the first flush sampling event on October 31, 2003. The concentrations are significantly higher than those measured on October 28, 2003, just three days before the first significant rainfall event of the season, as shown at Site 2 in Figure 4.7. The increased concentrations are likely a result of urban pollutants, such as waste products and lawn fertilizers, which were transported into the lagoon by storm water runoff.

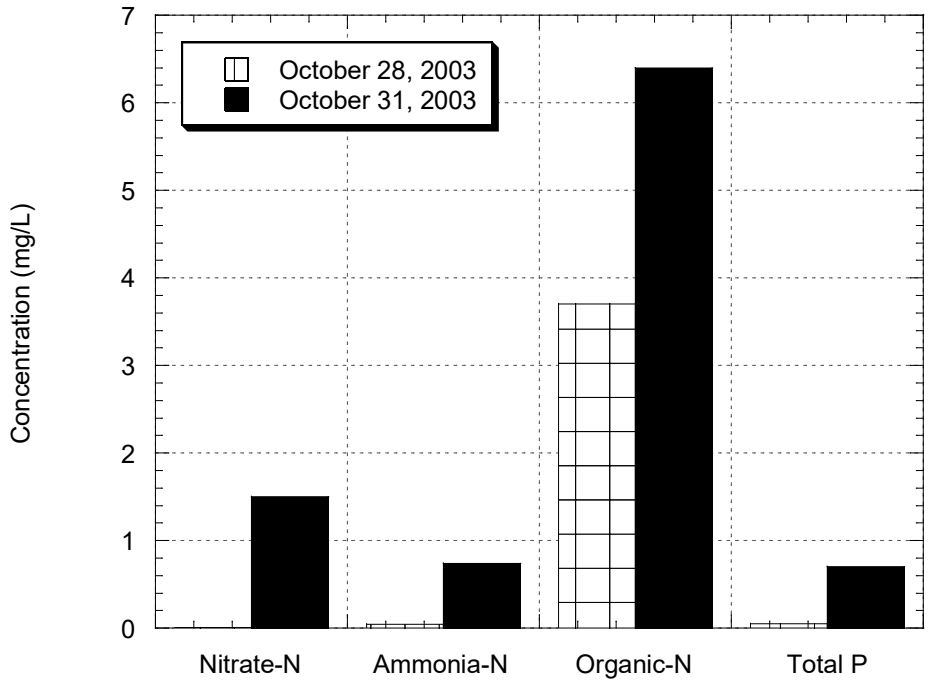


Figure 4.7. Nutrient Concentrations at Site 2 on October 28 and October 31, 2003

Total and Fecal Coliform Bacteria

Water samples were collected from each monitoring site and analyzed for total and fecal coliform bacteria. Total and fecal coliform bacteria are indicator organisms routinely used to test the quality of surface and drinking water sources. Testing for these organisms are relatively easy, inexpensive and provide a good indication of the level of pollution that may occur in a water body.

The total coliform bacteria group includes a large group of bacteria that can occur naturally in soils and water or in wastes from animals. Fecal coliform is a subgroup of bacteria that live in the intestines and waste material, or feces, excreted from warm-blooded animals. When fecal coliform bacteria are present in high numbers (greater than 200 colonies/100 milliliters of water sample) it means the water may contain fecal matter from a wide variety of animals including waterfowl, domestic and wild animals and humans, and may be unsafe for direct contact. Although coliform bacteria may not be pathogenic, the presence of these organisms may indicate the potential presence of other disease carrying organisms.

In an urban setting sources of fecal coliform are many, including storm runoff carrying waste from domestic and wild animals, decaying vegetation, organic sediment, leaking sanitary sewers, and water fowl that may reside in the stream or lagoon.

The Santa Cruz County Environmental Health Lab analyzed water samples for total and fecal coliform bacteria. Samples were taken at each of the four sampling locations and are reported in units of colony forming units per 100 milliliters of water sample (CFUs).

Total coliform counts ranged from 4 CFUs to 'too numerous to count', and fecal coliform counts ranged from less than 1 to 11,470 CFUs.

Table 4.5. Total and Fecal Coliform Measurements

Date	Membrane Filtration Tests (Colony Forming Units per 100 millimeters)							
	Site 1		Site 2		Site 3		Site 4	
	TC	FC	TC	FC	TC	FC	TC	FC
6/5/03	40	20	20	20	70	50	570	1350
7/8/03	16	<1	4	4	<1	<1	TNTC	56
8/12/03	12	4	4	16	16	880	240	5720
10/31/03	75,640	11,470	56,933	9,150	50,427	9,550	34,770	8,850
Water Quality Objectives								
Water Contact Recreation		200*		200*		200*		200*
Non-Water Contact Recreation		2000**		2000**		2000**		2000**

Notes:

TC- Total Coliform

FC - Fecal Coliform

TNTC - Too numerous to count

* - This is a benchmark objective only, the enforceable water quality objective is based on a minimum of not less than five samples for any 30-day period (ref. Water Quality Control Plan, CCRWQCB, 2001)

** - This is a benchmark objective only, the enforceable water quality objective is based on a minimum of not less than five samples for any 30-day period (ref. Water Quality Control Plan, CCRWQCB, 2001)

The highest total and fecal coliform counts were recorded during the first flush sampling event on October 31, 2003, and the highest values on that day were recorded at Site 1, as shown in Figure 4.8. Site 1 receives storm water runoff from Moran Creek as well as from a storm drain outlet under East Cliff Drive, which likely contributed to the increased fecal coliform counts at this location. The highest counts prior to October 31, 2003, sampling events, were recorded at Site 4 in Moran Creek, as shown in Figure 4.8 for samples collected on August 12, 2003.

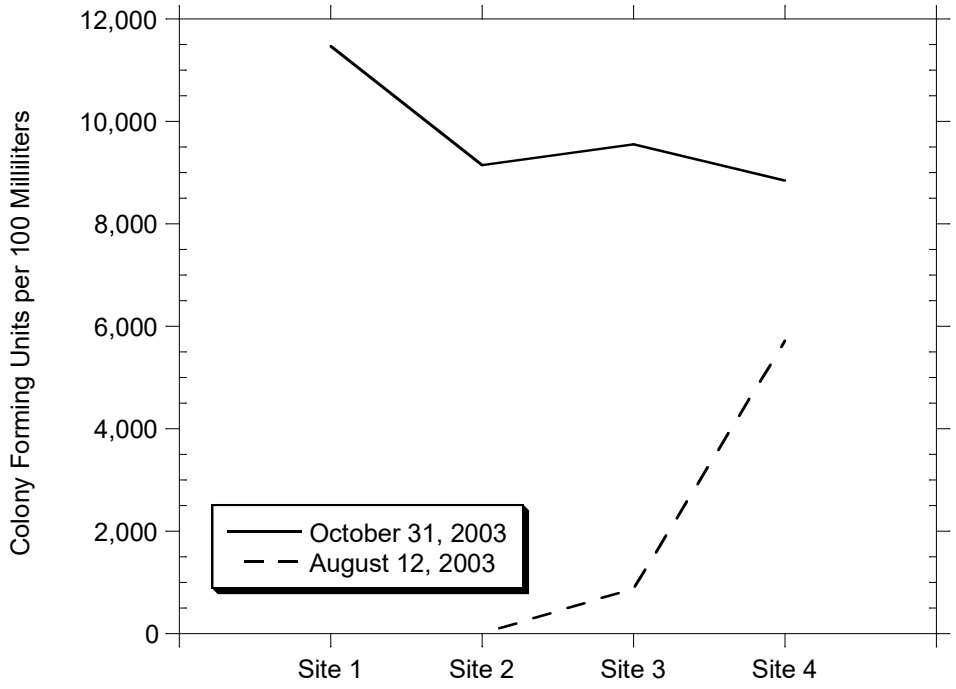


Figure 4.8. Results of Fecal Coliform Counts on August 12 and October 31, 2003

Total Suspended Solids and Turbidity

Total Suspended Solids

Water samples were also analyzed for total suspended solids (TSS), which is the concentration of solids suspended in water. These solids can be either mineral or organic (e.g. soil or algae) matter. A high concentration of TSS can adversely impact water quality by blocking light transmittance through water and adversely affecting photosynthesis and primary production in a lake, and can result in direct impacts to aquatic life by clogging or injury to fish gills and smothering benthic organisms on the lagoon bottom. Suspended solids can also transport attached pollutants, including metals and hydrocarbons in runoff, potentially increasing concentrations of these components within a water system.

TSS values can increase as a result of high-energy runoff that has eroded soil and transported soil and other debris into a water system. TSS also increases as a result of seasonal algae growth, which can be caused by warm temperatures or a release of nutrients from the decomposition of organic material.

The Santa Cruz County Environmental Health Lab analyzed three water samples collected at each sampling site for total suspended solids. Two samples were collected during the summer months when the lagoon was closed and a third sample was collected

during the first flush event in late October. Turbidity results are presented in Table 4.6. The measured concentrations of total suspended solids ranged from 2.0 mg/L to 92.0 mg/L.

Table 4.6. Turbidity (in NTU) and Total Suspended Solids (in mg/L) Measurements

	Sample Location							
	Site 1		Site 2		Site 3		Site 4	
Date	Turbidity (NTU)	Total Suspended Solids (mg/L)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Turbidity (NTU)	Total Suspended Solids (mg/L)
06/05/03	3.1	32.0	3.2	17.2	6.3	11.2	5.3	2.0
06/26/03	5.6	--	6.6	--	9.1	--	7.5	--
07/08/03 (am)	4.6	--	5.2	--	6.9	--	4.0	--
07/08/03 (pm)	4.9	16.8	5.2	24.8	7.3	19.2	4.8	2.4
07/25/03	0.2	--	3.4	--	7.2	--	0.3	--
08/12/03	0.79	--	2.8	--	8.28	--	1.42	--
09/11/03	1.46	--	5.8	--	8.40	--	1.93	--
09/30/03	0.84	--	5.1	--	4.45	--	1.33	--
10/28/03	2.06	--	14.3	--	12.19	--	14.60	--
10/31/03	43.10	84.4	35.3	59.3	35.50	67.7	25.50	92.0

Samples collected during the summer months, June and July, represent conditions during which the majority of TSS is algae floating in the water column. During this period the TSS concentrations ranged from approximately 5 mg/L to 35 mg/L. Samples collected in October during the first flush event had substantially higher TSS concentration ranging from 60 to 92 mg/L. The higher TSS concentrations are attributed to storm water runoff entering the lagoon from Moran Creek, local drainage and East Cliff Drive. Figure 4.9 shows the results of three representative sampling events collected from the four sampling sites within Moran Lake and analyzed for TSS.

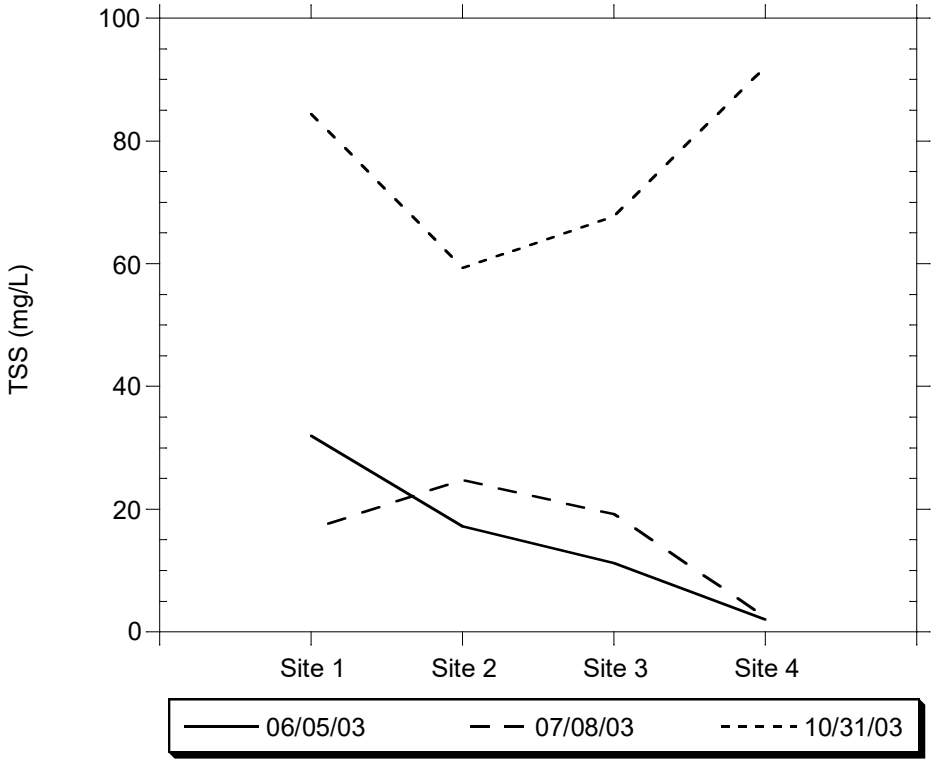


Figure 4.9. Total Suspended Solids Concentrations

Turbidity

Turbidity is an indirect measurement of suspended matter in water. The turbidity test measures the amount of light scattered through a sample of water. The presence of suspended matter or clay particles will tend to scatter focused light beam that is directed through a given thickness of water. A light sensor detects the amount of scatter and converts this intensity to a unit of transmittance, which is roughly approximated to the amount of suspended matter in the water. Generally, a high turbidity value indicates a high concentration of total suspended solids (however, in some instances there may be no direct correlation particularly if there is a high concentration of organic acids that may absorb the light in the water resulting in a low reading). Typically a high concentration of suspended solids increases the scatter of light and increases the turbidity value, and a low concentration of solids allows the light to pass through the water with little scatter.

At Moran Lake, turbidity measurements were taken from samples collected at each of the four sampling locations on ten sampling occasions. Turbidity was measured in the field and reported in Nephelometric Turbidity Units (NTU), and the results are presented in Table 4.6. The recorded turbidity measurements at the four sampling locations for the ten sampling events ranged from 0.2 to 43.1 NTU.

Turbidity measurements across the four sampling sites did not vary significantly, though overall Site 3 appeared to have higher readings than the other two locations. Site 3, in the

upper lagoon, could have higher turbidity measurements due to the accumulation of organic debris at this location as well as the proximity to a storm drain outfall. The highest turbidity measurement at each sampling location was recorded during the first flush sampling event. The high readings occurred because of high energy storm water flows that introduced suspended sediments into the lagoon and also re-suspended sediment and organic debris from the lagoon bottom. Figure 4.10 shows the results of turbidity measurements collected from the four sampling locations on August 12, 2003, which depicts the increased readings at Site 3 during the summer months, and the increased turbidity measurements observed during the first flush on October 31, 2003.

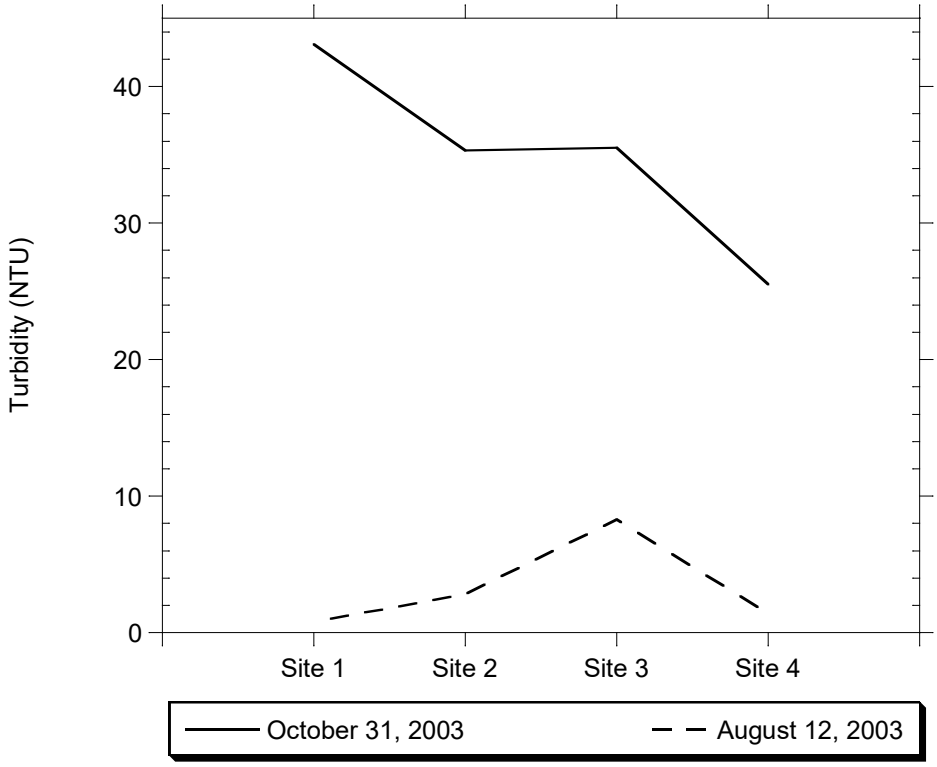


Figure 4.10. Turbidity Measurements taken on August 12th and October 31st 2003

Salinity and Conductivity

Salinity

Salinity measures the concentration of salt in water, and is generally reported in parts per thousand (ppt). Ocean water has a salinity of approximately 35 parts per thousand. Water with salinity levels in excess of ocean water is referred to as hyperhaline or hypersaline, depending upon if the salts are ocean or land derived.[1] Water with

[1] **Hyperhaline.** Term used to characterize waters with salinity greater than 40 ppt (parts per thousand) due to ocean-derived salts. **Hypersaline.** Term used to characterize waters with salinity greater than 40 ppt due to land-derived salts (Cowardin et al. 1979).

concentrations greater than ocean water is generally observed within enclosed water bodies where the effects of evaporation increase salt concentration as water evaporates and salts accumulate.

When salinity levels in Moran Lake exceed ocean water, the system can be characterized as hyperhaline as the salts in Moran Lake are ocean derived. Hyperhaline conditions in Moran Lake limit biological diversity and impact aquatic biota within the lagoon as salts accumulate and salinity levels increase above tolerable limits.

Salinity measurements were taken at each of the four sampling locations, from the water surface to the lake bottom in one-foot increments. Salinity measurements were taken on ten sampling events, as shown in Table 4.7. The recorded salinity measurements at the four sampling locations ranged from 0.3 to 36.5 parts per thousand (ppt).

Salinity in the lagoon increased from June to October, when the lagoon opening was closed and evaporation increased salt concentrations in the lagoon. The highest salinity measurements were recorded in August and September, and were in excess of 35 ppt, approaching hyperhaline conditions. Figure 4.11 shows increasing salinity measurements taken on the surface of the lagoon at Site 1. Salinity decreased rapidly during the first flush, when high freshwater flows entered the lagoon from Moran Creek. The decreased salinity on this date was recorded due to the freshwater lens formed on the surface of Moran Lake from Moran Creek and other surface water drainages adjacent to the lagoon that contribute storm water runoff.

Salinity measurements taken at the surface were generally less than measurements taken at depth within the lagoon. This phenomenon indicates that a warm wedge of saltier water forms in the deeper water in the lagoon. At the beginning of the sampling, in June, salinity measurements were generally uniform across the entire lagoon. Beginning in August and continuing into October, the salinity measurements generally decreased from the lagoon inlet towards the upper lagoon. All salinity measurements taken at Site 4 were less than or equal to 0.5 ppt, indicating the site was measuring freshwater flows from Moran Creek and is above any salinity influences from the lagoon. Figure 4.12 shows surface water salinity measurements collected during three sampling events within the lagoon at Sites 1, 2, and 3, showing the trend towards decreasing salinity in the upper lagoon during late summer.

Table 4.7. Salinity Field Measures (in parts per thousand, ppt)

Date (Sample time)	Sample Location							
	Site 1		Site 2		Site 3		Site 4	
	Depth (ft)	Salinity (ppt)	Depth (ft)	Salinity (ppt)	Depth (ft)	Salinity (ppt)	Depth (ft)	Salinity (ppt)
06/05/03 (10:30)	0.0	29.4	0.0	28.7	0.0	28.7	0.0	0.3
	1.0	29.4	1.0	28.8	1.0	28.7		
	2.0	29.3	2.0	29.1	2.0	29.2		
	3.0	29.4	2.4	29.1	3.0	29.4		
	4.0	30.7			4.0	29.8		
06/26/03 (11:30)	0.0	33.1	0.0	33.2	0.0	32.9	0.0	0.3
	1.0	33.1	1.0	33.1	1.0	33.2		
	2.0	33.1	2.0	33.3	2.0	33.3		
	3.0	33.1	3.0	33.2	3.0	33.0		
	4.0	33.1						
07/08/03 (am) (08:30)	0.0	30.9	0.0	30.5	0.0	30.4	0.0	0.5
	1.0	30.8	1.0	24.2	1.0	30.5		
	2.0	32.4	2.0	33.1	2.0	33.2		
	3.0	33.0	2.5	33.1	2.5	33.4		
	3.5	33.0						
07/08/03 (pm) (16:30)	0.0	32.6	0.0	31.0	0.0	31.0	0.0	0.4
	1.0	32.6	1.0	30.9	1.0	30.9		
	2.0	28.5	2.0	31.8	2.0	31.8		
	3.0	32.9	2.5	32.4	2.5	32.4		
	3.5	32.9						
07/25/03 (11:30)	0.0	34.4	0.0	34.1	0.0	33.3	0.0	0.3
	1.0	34.5	1.0	34.1	1.0	34.0		
	2.0	34.5	2.0	34.1	2.0	34.0		
	3.0	34.6						
08/12/03 (9:30)	0.0	36.0	0.0	35.4	0.0	34.8	0.0	0.4
	1.0	36.0	1.0	35.4	1.0	34.7		
	2.0	36.0	2.0	35.3				
	2.5	36.0						
09/11/03 (3:30)	0.0	36.3	0.0	36.0	0.0	34.3	0.0	0.4
	1.0	36.5	1.0	35.8				
	2.0	36.5	1.9	35.7				
09/30/03 (9:30)	0.0	35.8	0.0	30.0	0.0	27.1	0.0	0.4
	1.0	36.2	1.0	31.3				
	2.0	36.3	1.5	35.1				
10/28/03 (11:30)	0.0	31.9	0.0	31.6	0.0	31.0	0.0	0.3
	1.0	31.7	1.0	30.7				
	2.0	32.2	1.5	31.8				
10/31/03 (6:45am)	0.0	1.2	3.0	0.7	0.0	0.3	0.0	0.1
	1.0	1.4	2.0	0.9	1.2	0.3		
	1.5	10.4	1.0	11.4				
			0.0	29.6				

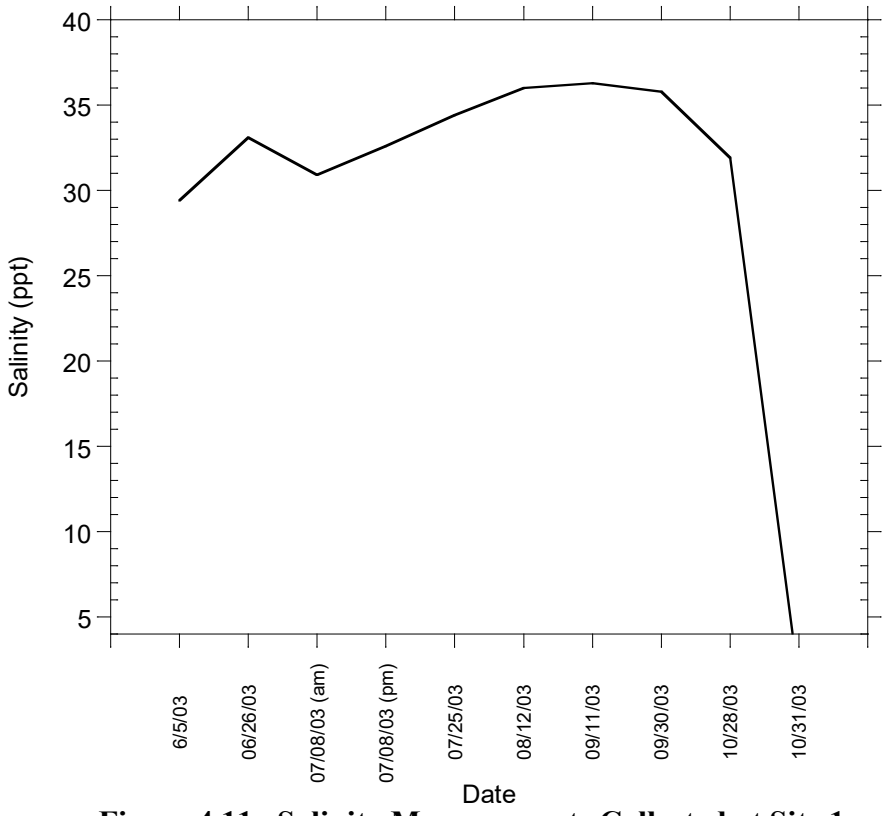


Figure 4.11. Salinity Measurements Collected at Site 1

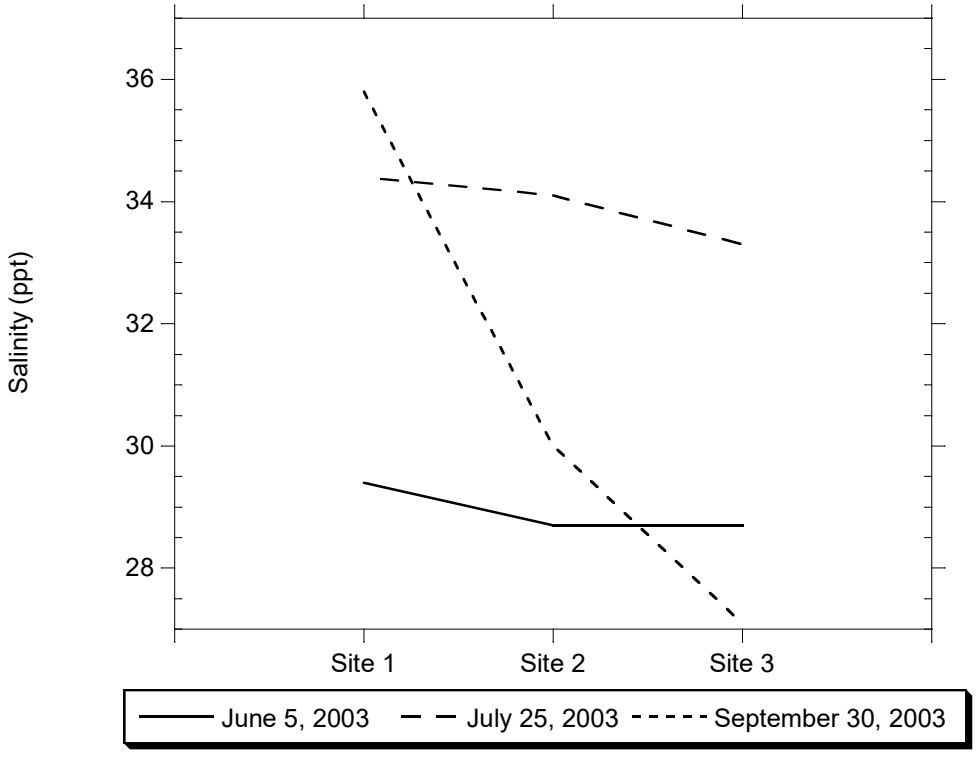


Figure 4.12. Salinity Measurements on June 5th, July 25th , September 30th , 2003

Electrical Conductivity

Electrical conductivity is the measure of a water samples ability to conduct an electrical current, and is reported in units of micromhos or microsiemens (□S). The electrical conductivity of water increases as the concentration of ions (charged particles) increases. For example pure water has a very low electrical conductivity, whereas ocean water with high sodium and chloride concentrations has a high electrical conductivity. The complexity of natural waters very rarely provides direct estimates of ion concentrations from electrical conductivity measurements.

At Moran Lake, electrical conductivity measurements were taken at each of the four sampling locations, from the water surface to the lagoon bottom in one-foot increments. The results are presented in Table 4.8. The recorded salinity measurements at the four sampling locations ranged from 0.105 to 53.5 □S.

The lowest electrical conductivity measurements were recorded at Site 4, in the freshwater of Moran Creek. The highest measurements were recorded during August and September at Site 1, where near-hyperhaline conditions were observed. Very little variation in electrical conductivity measurements between each of the three sampling locations within the lagoon was observed. Electrical conductivity measurements did generally increase with depth at each of the sampling locations within the lagoon, another indication of the warm lens of saltier water on the lagoon bottom. Figure 4.13 shows the transition of salinity and conductivity measurements with depth collected from Site 2 on October 31, 2003.

Table 4.8. Conductivity Field Measurements (in micron siemens, mS)

Date (Sample time)	Sample Location							
	Site 1		Site 2		Site 3		Site 4	
	Depth (ft)	Conductivity (mS)	Depth (ft)	Conductivity (mS)	Depth (ft)	Conductivity (mS)	Depth (ft)	Conductivity (mS)
06/05/03 (10:30)	0.0	41.2	0.0	40.2	0.0	40.4	0.0	0.468
	1.0	41.1	1.0	40.2	1.0	40.5		
	2.0	41.0	2.0	41.1	2.0	41.8		
	3.0	41.3	2.4	41.0	3.0	42.0		
	4.0	47.4			4.0	42.8		
06/26/03 (11:30)	0.0	49.0	0.0	50.2	0.0	50.6	0.0	0.504
	1.0	48.8	1.0	50.5	1.0	50.4		
	2.0	48.2	2.0	49.7	2.0	49.9		
	3.0	48.1	3.0	49.5	3.0	48.8		
	4.0	48.0						
07/08/03 (am) (08:30)	0.0	44.8	0.0	45.8	0.0	45.9	0.0	0.555
	1.0	44.9	1.0	46.7	1.0	46.1		
	2.0	48.1	2.0	51.6	2.0	52.3		
	3.0	49.8	2.5	51.6	2.5	53.0		
	3.5	49.9						
07/08/03 (pm) (16:30)	0.0	49.9	0.0	51.2	0.0	48.9	0.0	0.637
	1.0	53.5	1.0	51.2	1.0	49.1		
	2.0	53.4	2.0	52.6	2.0	51.0		
	3.0	52.1	2.5	53.0	2.5	51.7		
	3.5	51.3						
07/25/03 (11:30)	0.0	49.8	0.0	49.1	0.0	49.8	0.0	0.552
	1.0	49.6	1.0	49.1	1.0	50.2		
	2.0	49.4	2.0	49.1	2.0	49.4		
	3.0	49.4						
08/12/03 (9:30)	0.0	52.1	0.0	51.9	0.0	49.9	0.0	0.598
	1.0	52.3	1.0	51.8	1.0	49.9		
	2.0	52.3	2.0	51.8				
	2.5	52.2						
09/11/03 (3:30)	0.0	53.3	0.0	57.5	0.0	53.3	0.0	0.664
	1.0	52.9	1.0	55.1				
	2.0	52.4	1.9	52.6				
09/30/03 (9:30)	0.0	48.0	0.0	39.4	0.0	36.5	0.0	0.614
	1.0	48.9	1.0	40.2				
	2.0	49.1	1.5	50.3				
10/28/03 (11:30)	0.0	43.3	0.0	45.9	0.0	41.7	0.0	0.578
	1.0	41.5	1.0	41.5				
	2.0	43.1	1.5	41.4				
10/31/03 (6:45am)	0.0	1.6	0.0	0.960	0.0	0.434	1.8	0.105
	1.0	2.0	1.0	1.786	1.2	0.447		
	1.5	11.5	2.0	13.9				
			3.0	35.6				

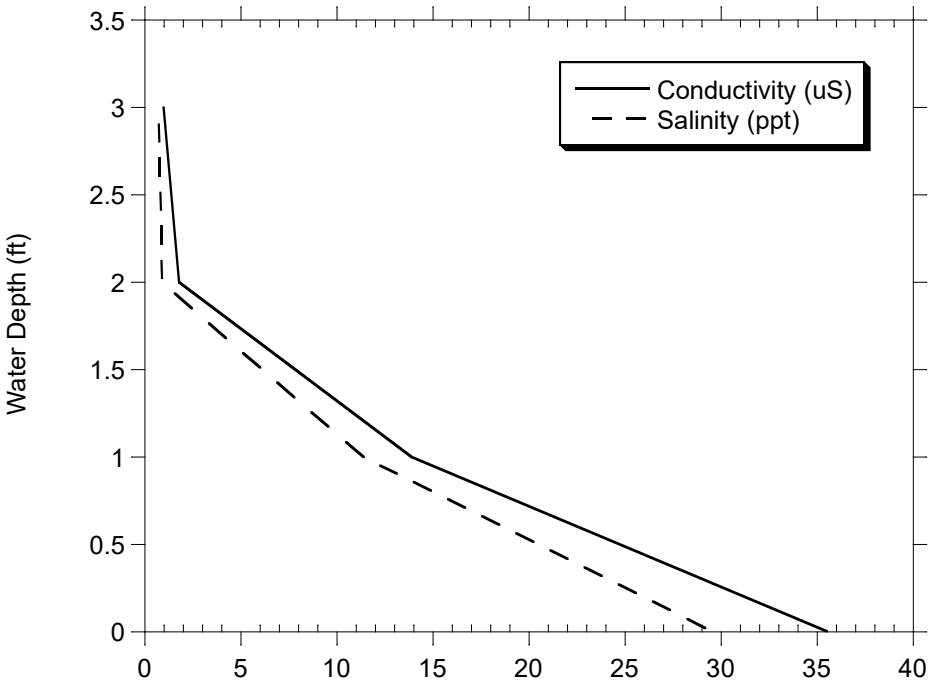


Figure 4.13. Salinity and Conductivity Measurements at Site 2 on October 31st 2003.

General Minerals

General mineral analyses were completed on four rounds of testing conducted in June, July and October, as shown in Table 4.9. The first three rounds of testing were completed when the lagoon was closed and the last sample was collected during the first flush event at the end of October 2003. The results clearly indicate that during the summer months the lagoon is filled primarily with salt water and the major ions in solution include chloride and sodium. During the first flush event that occurred on October 31, 2003, the water quality in the lagoon shifted significantly to represent freshwater conditions.

Table 4.9. General Mineral Analysis

Sample Location	Date	Chloride	Nitrate-N	Sulfate	Sodium	Potassium	Magnesium	Calcium	Bicarbonate
		(all in units mg/L)							
1	06/05/03	14991	<0.01	2118	8018	363	1065	357	114.4
	07/08/03	17118	<0.01	2320	9545	377	1123	399	124.2
	10/28/03	17475	<0.01	2319	9932	429	1308	839	248.5
	10/31/03	457	1.7	101	310	21	42	32	24.0
2	06/05/03	14968	<0.01	2097	8228	371	1051	349	117.4
	07/08/03	17251	<0.01	2317	9663	383	1193	410	126.3
	10/28/03	16702	<0.01	<0.05	2270	9664	409	1291	412.0
	10/31/03	331	1.5	61	187	15	25	22	19.3
3	06/05/03	12099	<0.01	1803	6483	293	915	303	121.4
	07/08/03	17448	<0.01	2313	9468	384	1188	410	128.0
	10/28/03	16524	<0.01	2230	9533	414	1258	426	249.3
	10/31/03	140	1.2	40	83	10	13	17	18.4
4	06/05/03	49	1.10	70	40	5	16	42	117.9
	07/08/03	61	0.50	110	45	7	20	65	125.9
	10/28/03	63.8	0.09	108	49.7	10.3	18.4	70.7	143.1
	10/31/03	17.1	0.9	16.4	11.2	5.8	3.6	12.1	18

Total Metal Concentrations

On three occasions during the study period water samples were collected and analyzed for lead, copper and zinc. The results are presented in Table 4.10. The concentration levels for trace metals were very low for all three metals tested for during June and July. The highest concentrations were routinely detected in the samples collected from Moran Creek, which receives dry weather runoff from urbanized areas. Dry weather runoff includes runoff resulting from street and driveway, and constructed related washing activities, residents washing cars, over spray from landscape irrigation systems. From these sources, dust laden with trace metals typically from tire wear and atmospheric deposition is washed into drainage ways, such as Moran Creek. The last sample was collected in late October during the first significant rainfall event (>0.5 inches of rain) or commonly referred to as the "first flush" event.

During the summer months the total metals concentrations was very low in the two rounds of testing conducted. The highest concentrations measured over the course of the study occurred in Moran Creek, which is attributed to urban runoff. Samples collected during the first flush event were also significantly higher than samples collected during the summer or dry period.

The test results have been compared to several water quality criteria to determine if the concentrations pose a threat to fresh and marine aquatic life. The State of California and the U.S. Environmental Protection Agency (EPA) have set different criteria for total metals concentrations, which are summarized below. In addition, the toxicity of copper, lead and zinc is also a function of the water hardness: in hard water the metal is less biologically available or toxic to aquatic life, and in softer water the metals may be more toxic at lower concentrations. Table 4.11 presents water quality criteria set forth in the *California Toxics Rule* (CTR), prepared by EPA. Different concentration values are a function of the water hardness calculated for the different water samples tested.

Table 4.10. Total Copper, Lead and Zinc Concentrations
(all in units ug/L)

Sample Location	Date	Copper µg/L	Lead µg/L	Zinc µg/L
1	06/05/03	1.3	<1	2.2
	07/08/03	2.6	<0.5	1.4
	10/31/03	34	6.9	400
2	06/05/03	1.2	<1	2
	07/08/03	0.8	<0.5	1.5
	10/31/03	27	4.5	350
3	06/05/03	1.5	1.3	1.2
	07/08/03	0.6	<0.5	1.6
	10/31/03	30	6.2	300
4	06/05/03	2.1	1.7	4
	07/08/03	4.5	0.6	4.7
	10/31/03	30	5.5	350

Table 4.11. California Toxics Rule (US EPA Water Quality Criteria) for the Protection of Freshwater and Saltwater Aquatic Life

Date	Total Hardness (in mg/L as $CaCO_3$)	California Toxics Rule and USEPA Criteria for Fresh and Saltwater Aquatic life Protection					
		Copper Criteria		Lead Criteria		Zinc Criteria	
		1-hr Average Total Recoverable (in ug/L)	4-day Average Total Recoverable (in ug/L)	1-hr Average Total Recoverable (in ug/L)	4-day Average Total Recoverable (in ug/L)	1-hr Average Total Recoverable (in ug/L)	4-day Average Total Recoverable (in ug/L)
Site 1							
06/05/03	>400	52	30	480	19	390	390
07/08/03	>400						
10/28/03	>400						
10/31/03	253	34	21	270	12.5	270	270
Site 2							
06/05/03	>400	52	30	480	19	390	390
07/08/03	>400						
10/28/03	>400						
10/31/03	158	22	14	150	5	175	175
Site 3							
06/05/03	>400	52	30	480	19	390	390
07/08/03	>400						
10/28/03	>400						
10/31/03	96	13	9	75	3	120	120
Site 4							
06/05/03	171	23	15	165	5	180	185
07/08/03	244	32	20	270	12	260	260
10/28/03	252	33	21	270	12.5	262	260
10/31/03	45	6.5	4.5	30	3	60	60

Table 4.12 presents water quality objectives established in the California Regional Water Quality Control Board's Water Quality Control Plan (Basin Plan) for the Central Coast

Region. The Basin Plan objectives include ambient water quality objectives to protect both fresh and marine life. The Basin Plan also encompasses water quality objectives established by the State's Ocean Plan.

Comparing the test results to the different criteria indicate that during the first flush event, all three metals were measured at concentrations that exceed several criteria. Total copper concentrations were measured in Moran Creek and at two locations in the lagoon at levels that exceeded both acute toxicity (1-hr average) and chronic toxicity (4-day average) criteria established by the CTR and Basin Plan objectives established to protect both fresh and saltwater aquatic life. Total lead concentrations were measured during this event at levels that exceeded the CTR chronic criteria. Total zinc concentrations measured during the first flush event exceeded both acute and chronic toxicity levels at all sample locations in the creek and lagoon. The test results indicate that runoff from urbanized areas in the watershed discharge significant and potentially toxic levels of copper and zinc to Moran Lagoon.

The total concentration of zinc is typically what has been found in runoff collected in other urban areas throughout the United States. Table 4.13 compares the total concentration of copper, lead and zinc to test results Copper concentrations were also comparable to average concentrations encountered in National Urban Runoff Pollution studies undertaken by the U.S. Environmental Protection Agency in the 1980's. Lead concentrations are substantially lower than what has been measured in other earlier studies in the Lagoon and nationwide, suggesting either the increased use of unleaded fuels has reduce the concentration of lead in runoff or runoff entering the creek and lagoon are substantially diluted. Based on the concentration of zinc and copper detected, the results suggest that runoff is not well diluted in the creek or lagoon and that the water in the lagoon is primarily urban runoff.

Table 4.12. Water Quality Objectives from the Central Coast Region Water Quality Control Plan

				CCRWQCB Water Quality Control Plan - Water Quality Objectives		
		California Ocean Plan - Marine Aquatic life Protection			Water Quality Objectives to Protect Freshwater Life	
					Hard	Soft
Metal	**Unit**	Instantaneous Maximum	Daily Maximum	Water Quality Objectives to Protect Marine Life	(>100 mg/L CaCO3)	(<100 mg/L CaCO3)
Copper	ug/L	30	12	10	30	10
Lead	ug/L	20	8	10	30	30
Zinc	ug/L	200	80	20	200	4

Table 4.13. Comparison of Moran Creek and Lagoon Water Quality to Urban Runoff Water Quality in Other Areas

Metal	Older Urban Area (Baltimore)[1]	National NURP Study Average[1]	Moran Lake - October 31, 2003			
			Site 1	Site 2	Site 3	Site 4
Zinc	397	176	400	350	300	350
Copper	105	47	34	27	30	30
lead	389	180	6.9	4.5	6.2	5.5

1. Source: Schueler, T.R., 1987, *Controlling Urban Runoff: A practical Manual for Planning and Designing Urban BMPs*

Sediment Quality

Four sediment samples were collected at three locations within Moran Lake on November 25, 2003, and analyzed for a combination of metals, polynuclear aromatic hydrocarbons, organochlorine pesticides, organophosphorus pesticides, polychlorinated biphenyls (PCBs), total ammonia as nitrogen, total sulfides, and oil and grease. Three samples were collected at the surface of the bottom of the lagoon and a fourth sample was collected approximately six (6) inches below the bottom of the lagoon bottom. The test results are summarized in Table 4.14.

General Parameters. All four samples were analyzed for total ammonia and sulfide. One sample was analyzed for oil and grease. The test results indicate that all four samples were in a reduced and anaerobic condition with high concentrations of total ammonia and sulfide. The results also indicate that the sample collected closest to the confluence of Moran Creek and the lagoon contained a relatively high concentration of oil and grease, which is attributed to the discharge of polluted urban runoff entering the lagoon.

Metals. All four sediment samples were analyzed for total concentration of chromium, copper, lead, mercury and zinc. The severity of contamination with heavy metals can be evaluated by comparisons to sediment quality benchmarks that indicate which concentrations are expected to pose a potential threat to the ecosystem. Table 4.14 shows the Moran Lake concentrations alongside several sediment quality benchmarks. The benchmarks are considered guidelines for evaluation of potential risk, rather than levels that require action. These benchmarks include the following:

- National Oceanic and Atmospheric Administration (NOAA) Effects Range low (ERL) and Effects Range Median (ERM). ERL: concentrations above which adverse biological effects may be expected 10% of the time. ERM: concentrations above which adverse biological effects may be expected 50% of the time.

- Ontario sediment quality guidelines (established by the Ontario Ministry of Environment and Energy) including lowest effect levels (LEL), levels that could

affect the most sensitive 5% of the species, and severe effects levels (SEL) in which 95% of the species could be effected.

The concentration of the all metals tested in near surface sediments from Moran Lake are well below the reported Sediment Quality Benchmark values shown in Table 4.14. The data indicates that the metal concentrations in the surface sediments are at levels that are not potentially toxic to benthic organisms.

Table 4.15 compares the recent metals data with historical sediment data collected from Moran Lake in 1976 and 1980. Additional sediment data is also provided for comparison from the Crandall Creek Demonstration Urban Stormwater Treatment (DUST) Marsh in Alameda County and several San Francisco Bay Area streams, flood control channels, and natural wetlands. These data are also presented in Table 4.15. Comparing the 2003 sediment data to the earlier test results indicate that chromium concentrations appear to have increased, but the concentration is relatively low compared to other urbanized watersheds in the Bay Area. Lead concentrations measured in 2003 appear to be slightly lower than those measured in 1980, which was lower than concentrations measured in 1976. Mercury concentrations appear to have increased in 2003, as compared to results tested in 1976; however, the higher concentration may be attributed to better analytical methods and levels of detection. Metal concentrations detected in Moran Lake samples are relatively lower than sediment collected from other streams and wetlands in the San Francisco Bay.

Polycyclic Aromatic Hydrocarbons (PAHs). Two composite sediment samples were analyzed for polycyclic aromatic hydrocarbons (PAHs). The results of the test detected the presence of several PAHs, which are shown in Table 4.14. PAHs are formed during the burning of oil, gas, wood, and other organic substances. They are also present in coal tars, and petroleum products, such as creosote and asphalt. PAHs are ubiquitous environmental contaminants, and one particular PAH, benzo(a)pyrene, is considered an indicator of such contamination because it usually occurs in mixtures of PAHs (WWF, 1997). The likely sources of PAHs in the Moran Lake watershed are from roads, parking lots and vehicle service areas.

Many PAHs, such as benzo(a)anthracene, benzo(a)pyrene and chrysene, are carcinogenic, causing tumors in fish and other animals, and are acutely toxic to some organisms. Noncarcinogenic PAHs, such as fluoranthene, phenathrene, and pyene, are also toxic to some organisms (MacCoy and Black, 1998). Concern about PAHs initially focused on their ability to cause cancer, but more recently concern has turned to their interference with hormone systems and their potential effects on reproduction, as well as their ability to depress immune function (WWF, 1997). A particular concern is the effects of PAHs on egg production in fish, and their potential effects on the early life stages of many aquatic organisms that reside in the surface microlayer of the bottom of many wetlands and lagoons, where PAHs can become concentrated. .

Comparing the PAH concentrations with different sediment quality benchmarks indicate that the phenanthrene, chrysene, benzo(a)anthracene and benzo(a)pyrene exceed criteria

established by the British Columbia Ministry of Water, Land and Air Protection for protection of freshwater organisms, as shown in Table 4.14. The total concentration of PAHs is elevated, but is below the low and median effects levels established by the National Oceanic and Atmospheric Agency (NOAA). Based on the more conservative and contaminant specific criteria established by British Columbia, the levels of PAHs detected in the sediment may cause impairment to benthic organisms in the lagoon.

Organochlorine Pesticides. Two sediment samples were tested for organochlorine (OC) pesticides. The test results detected chlordane. The presence of chlordane in Moran Lagoon sediments after being banned since 1980 appears to reflect either the slow movement of this persistent pesticide through groundwater to the lagoon, or the erosion of contaminated soils. Chlordane is still found in groundwater and storm water samples in most environments where it has been tested for, albeit at low levels (Scheuler, T.S and H. K, Holland, 2000). Chlordane was widely used as a residential fumigant in the 1960's and 1970s.

Most OC pesticides have been banned or restricted because of potential human and wildlife health effects, tendency to bioaccumulate, and ability to persist in the environment (Wong, Capel and Nowell, 2000). In general, OC pesticides have moderate to high chronic toxicity, and are associated with development and/or reproductive effects in animal studies. OC compounds are also very toxic to aquatic organisms.

The sediment test results detected total chlordane levels well above the probable and threshold effects levels established by several agencies, as shown in Table 4.14. The results indicate that the residual and persistent chlordane levels in lagoon sediments may impair aquatic life in the lagoon

PCBs, DDT derivatives, and other organic chemicals were not detected in the samples tested.

Table 4.14. Sediment Quality Test Results - November 25, 2003

Parameter	Unit	Sample Location				Sediment Quality Benchmarks								
						NOAA		OME		FDEC		CISQG		BCMWLA
		1	2 @ Surface	2 @ 6" Depth	3	ERL	ERM	LEL	SEL	TEL	PEL	ISQ	PEL	SC
General Parameters														
Ammonia	mg/kg	<10	52	20	41									
Sulfide	mg/kg	54	887	192	809									
Oil & Grease	mg/lg				2310									
Metals														
Chromium	mg/kg	18.2	13.9	13.8	11.7	81	370	26	110					
Copper	mg/kg	2.73	13.1	8.33	14.0	34	270	16	110					
Lead	mg/kg	1.89	20.6	14.5	20.3	46.7	218	31	250					
Zinc	mg/kg	14.2	95.7	66.6	102	120	270	120	820					
Mercury	mg/kg	<0.0200	0.0408	0.0552	0.0564	0.15	0.71	0.2	2.0					
Polycyclic Aromatic Hydrocarbons (PAHs)														
Phenanthrene	ug/kg		<100		**150**									40
Fluoranthene	ug/kg		190		440									2000
Pyrene	ug/kg		200		480									
Chrysene	ug/kg		150		**320**									200
Benzo(a)anthracene	ug/kg		<100		**230**									200
Benzo (b)fluoranthene	ug/kg		120		240									
Benzo (k)fluoranthene	ug/kg		<100		240									
Benzo(a)pyrene	ug/kg		**130**		**190**									60
Indeno (1,2,3-cd) pyrene	ug/kg		<100		230									
Benzo(g,h,I)perylene	ug/kg		150		250									
Total PAHs	ug/kg		940		2770	4000		4000						
Organochlorine Pesticides														
alpha-Chlordane	ug/kg		19		49									
gamma-Chlordane	ug/kg		15		39									
Total Chlordane	ug/kg		**34**		**88**	0.5	6			22.26	4.79	4.5	8.87	

Notes:

*Organophosphorus compounds and PCBs were not detected in samples.

NOAA Effects Range Low (ERL) and Effects Range Median. ERL - concentrations above which adverse biological effects may be expected 10% of the time. ERL - Concentrations above which adverse biological effects may be expected 50% of the time.

OME - Ontario Ministry of Environment and Energysediment quality guidelines, including lowest effects levels (LEL), levels that could affect the most sensitive 5% of the species, and severe effect levels (SEL) in which 95% of the species could be affected.

FDCE - Florida Department of Environmental Conservation, including: Threshold Effect Level (TEL), and Probable Effect Level (PEL)

CISQG - Canadian interim sediment quality guidelines (1998) for freshwater sediment, including: interim sediment-quality guideline (ISQC) and probable effect level (PEL).

BCMWLA - British Columbia Ministry of Water, Land and Air Protection Water Qualty Guidelines (Criteria) for sediment criteria for Polycyclic Aromatic Hydrocarbons (PAHs)

Table 4.15. Comparison of Moran Lake Sediment Quality to Other Areas

Metal	Moran Lake Sediment Testing Data (all reported in mg/kg)			Regional Sediment Concentrations, mg/kg dry weight, Mean and (Range)		
	11/26/03	02/05/1980[1]	08/76[2]	Crandal Creek DUST Marsh System[3]	Alameda County[4]	USACOE Marsh Study[5]
Chromium	14.4 (13.9-18.2)	5.3	9.5	113 (58-140)	55 (29-104)	181 (110-224)
Copper	9.5 (2.7-14.0)	NA	NA	53 (12-410)	76 (13-1500)	63.8 (24.2-90.6)
Lead	14.3 (1.9-20.6)	22.84	50	72 (4-673)	113 (5.8-640)	35.4 (13.7-85.6)
Zinc	69.6 (14.2-102)	NA	NA	164 (50-769)	246 (49-2600)	143.3 (88.5-166.1)
Mercury	0.0508 (<0.0200-0.0564)	NA	0.007	0.25 (0.18-0.40)	0.23 (<0.03-0.98)	0.33 (0.059-0.515)

NA - Not Analyzed

References:

1. Stern, G. and P. Courter. 1980. *Report on Environmental Baseline Study for the Moran Lake Enhancement Plan, Santa Cruz, California*
2. Singer, S. and R. Aston. 1976. *A Staff Report on Moran Lake: Its Problems and Solutions* . County of Santa Cruz, California
3. Woodward-Clyde. 1998. *Demonstration Urban Stormwater Treatment (DUST) Marsh Long Term Evaluation.* Alameda Countywide Clean Water Program
4. Alemada County Clean Water program. 1998. Sediment sample results from 10 creeks and flood control channels
5. Lee, et al.. 1992. US Army Corps of Engineers, analysis of sediment data from natural wetlands in San Francisco Bay Area

4.4. Summary of Findings

1. Eutrophic and hyperhaline conditions in Moran Lake have been well documented since the mid 1970's. Several factors are contributing to this including poor circulation and flushing during the summer months and nutrient rich runoff entering the lagoon from urbanized lands.

2. Historical and recent testing continue to detect high concentrations of fecal coliform bacteria indicating the lagoon is receiving contaminated runoff from the surrounding urbanized areas. Although historic testing may have indicated sewage overflows from the treatment plant that once existed at Lode Street, it is likely that present coliform contamination comes from multiple sources, including domestic animals, leaking sewers, and wildlife (most notably water fowl) residing in the lagoon or riparian corridor.

3. A reduction in lagoon surface area and volume has diminished the ability of Moran Lake to dilute and treat contaminants.

4. In general the pH of the lagoon tended to increase as the lake became more eutrophic and saline. When the lagoon sand bar breached the pH dropped dramatically when the lagoon was primarily freshwater.

5. Eutrophic or highly enriched watercourses, such as Moran Lake show highly varying levels of dissolved oxygen (DO). During early morning periods DO is suppressed with low concentrations, while in the late afternoon DO may be very high due to algae and other aquatic vegetation releasing DO into the water column. Urban pollution and storm water runoff act to decrease dissolved oxygen concentrations in lake water. Polluted runoff containing degradable organic matter introduced to a water body such as Moran Lake, exert an oxygen demand during the assimilation and decomposition of these waste products. This oxygen demand can deplete DO concentrations, creating unsuitable conditions for aquatic organisms.

6. Water temperatures were relatively uniform throughout the lagoon and were generally higher (between five to ten degrees) than surface water entering the lagoon from Moran Creek. Due to the shallow conditions in the lagoon water temperatures did not vary significantly from the surface to the bottom of the lagoon, which would normally occur in a natural and unfilled coastal lagoon. The increased temperature results from the high heat capacity of the lagoon resulting from the thick biomass in the water column, combined with shallow water depths.

7. The highest concentrations of total phosphorus, nitrate-N (NO_3^-), ammonia-N (NH_3), and organic-N were measured during the first flush sampling event on October 31, 2003. These nutrient concentrations are significantly higher than those measured on other occasions. The increased concentrations are a result of urban pollutants, such as waste products and lawn fertilizers, which were transported into the lagoon by storm water runoff.

8. Total suspended solids measurements completed during the summer and early fall shows how the character of the lagoon water quality is distinct in these two periods. Samples collected during the summer months of June and July represent conditions during which the majority of TSS is algae floating in the water column. During this period the TSS concentrations ranged from approximately 5 mg/L to 35 mg/L. Samples collected in October during the first flush event had substantially higher TSS concentration ranging from 60 to 92 mg/L, which was composed primarily of fine inorganic suspended solids, which are attributed to storm water runoff entering the lagoon from Moran Creek and local Lake drainage sources.

9. Salinity in the lagoon increases from June to October, when the lagoon tidal inlet closes and evaporation increases salt concentrations. The highest salinity measurements were measured in August and September, and were in excess of 35 ppt, approaching hyperhaline conditions. Salinity levels in the lagoon decreased rapidly during the first flush, when high freshwater flows entered the lagoon from Moran Creek, further demonstrating that the volume and dilution capacity of the lagoon is very small relative to the watershed drainage area.

10. General mineral analyses conducted in June, July and October clearly indicate that during the summer months the lagoon is filled primarily with salt water and the major ions in solution include chloride and sodium. During the first flush event, the water quality in the lagoon shifted rapidly to represent freshwater conditions.

11. The concentration of trace metals varied significantly both spatially and seasonally. During the summer months the trace metals concentration was very low for all three metals tested (copper, lead and zinc) in the lagoon and Moran Creek. However, the highest concentrations during this period were routinely detected in the samples collected from Moran Creek which receives dry weather runoff from urbanized areas. Dry weather runoff includes runoff from streets and driveways, construction- related washing activities, car washing, and over spray from landscape irrigation systems. A sample collected in late October during the first significant rainfall event ("first flush" event) contained significantly higher concentrations of these metals, which could adversely affect aquatic organisms.

12. Comparing the test results to the different water quality criteria indicate that during the first flush event, all three metals were measured at concentrations that exceed several criteria. Total copper concentrations were measured in Moran Creek and at two locations in the lagoon at levels that exceeded both acute toxicity (1-hr average) and chronic toxicity (4-day average) criteria established by the California Toxic Rules (CTR) and Water Quality Control Plan for the Central Coast Region, established to protect both fresh and saltwater aquatic life. Total lead concentrations were measured during this event at levels that exceeded the CTR chronic criteria. Total zinc concentrations measured during the first flush event exceeded both acute and chronic toxicity levels at all sample locations in the creek and lagoon. The test results indicate that runoff from urbanized areas in the watershed discharge significant and potentially toxic levels of copper and zinc to Moran Lagoon.

13. The total concentration of zinc is typically what has been found in runoff collected other urban areas throughout the United States. Copper concentrations were also comparable to average concentrations encountered in National Urban Runoff Pollution studies undertaken by the U.S. Environmental protection Agency in the 1980's. Lead concentrations are substantially lower than what has been measured in other earlier studies in the Lagoon and nationwide, suggesting either the increased use of unleaded fuels has reduced the concentration of lead in runoff or runoff entering the creek and lagoon are substantially diluted. The concentration of zinc and copper suggests that runoff is not well diluted in the creek or lagoon and that the water in the lagoon is primarily urban runoff.

14. The concentration of the all metals tested in near surface sediments from Moran Lake are below reported Sediment Quality Benchmark values indicating that the metal concentrations in the surface sediments are at levels that are not potentially toxic to benthic organisms.

15. Comparing the 2003 sediment data to the earlier test results indicate that chromium concentrations appear to have increased, but the concentration is relatively low compared to other urbanized watersheds in the San Francisco Bay Area. Lead concentrations measured in 2003 appear to be slightly lower than those measured in 1980, which was lower than concentrations measured in 1976. Mercury concentrations appear to have increased in 2003, as compared to results tested in 1976; however, the higher concentration may be attributed to better analytical methods and levels of detection.

16. Metal concentrations detected in Moran Lake sediment samples are relatively lower than sediment collected from other streams and wetlands in the San Francisco Bay Area.

17. Sediment samples detected the presence of several PAHs. Principal source of PAHs is from roads, parking lots and vehicle service areas. Several of the PAH compounds detected are carcinogenic compounds and other compounds are potentially toxic to aquatic life. Comparing the PAH concentrations with different sediment quality benchmarks indicate that the phenanthrene, chrysene, benzo(a)anthracene and benzo(a)pyrene exceed criteria established by the British Columbia Ministry of Water, Land and Air Protection for protection of freshwater organisms. The total concentration of PAHs is elevated, but is below the low and median effects levels established by the National Oceanic and Atmospheric Agency (NOAA). Based on the more conservative and contaminant specific criteria established by British Columbia, the levels of PAHs detected in the sediment may be impairing benthic and other aquatic life in the lagoon.

18. Sediment test results detected total chlordane levels well above the probable and threshold effects levels established by several agencies. The results indicate that the residual and persistent chlordane levels in lagoon sediments may adversely affect aquatic life in the lagoon.

5. RESTORATION OPTIONS

Restoration opportunities exist in the Moran Lake watershed to improve water quality and habitat conditions in the lagoon. Many opportunities are present in the immediate vicinity of the lagoon, while other projects and actions can be taken in the upper watershed area.

Restoration options presented below include a broad spectrum of activities, including physical restoration projects, storm water management and treatment, recommendations for environmental education, site planning and design standards with the objective of reducing impervious cover in the watershed.

5.1. Lagoon Restoration and Education Opportunities

This section identifies restoration and environmental education projects that could be implemented in the immediate vicinity of the lagoon.

5.1.1 Improve Lagoon Water Circulation

Historical and ongoing water quality testing clearly indicates that lack of circulation and infrequent flushing of the lagoon with fresh and/or salt water is impairing water quality and aquatic life in the lagoon. As previously discussed many factors affect circulation, mixing and the occurrence of freshwater and tidal flushing in the lagoon. In review, these factors include the freshwater inflows, lagoon volume, frequency (how often) and duration (how long) the lagoon remains open or closed. Many of these factors are random or commonly referred to as stochastic variables that can vary both seasonally and annually depending on many conditions.

To improve circulation in the lagoon several different approaches could potentially be taken, such as, modifying the inlet to attempt to increase tidal and stream flushing, enlarging and deepening the lagoon to near its original size, actively managing the lagoon entrance (breaching the sand bar and removing sediments in culvert), installing an aeration system to increase biological decomposition of detritus and maintain higher levels of dissolved oxygen in the water column, and possibly augmenting stream flow with highly treated reclaimed wastewater. In all cases a more detailed technical and economic analysis would be required to assess the overall technical feasibility and benefit derived from the various alternatives. The following sections provide a brief summary of potential merits or constraints related to each alternative.

Modify Lagoon Inlet

As previously discussed a significant concern is that the lagoon inlet may limit the opening and closing of the inlet, and reduce circulation and tidal flushing of the lagoon resulting in degraded water quality and aquatic habitat conditions. The existing box culvert, an engineered structure, fixes the position, cross-sectional area, and depth or grade of the inlet channel. In a natural lagoon system the inlet is in a state of dynamic

equilibrium, meaning that the inlet configuration (location, cross-sectional area and depth) responds primarily to seasonal variations in the water flow, water levels, littoral drift, and wave action. The culvert and roadbed have "stabilized" the lagoon inlet preventing the natural migration of the inlet channel in response to wave and storm events. Maintaining a stable inlet is also important to protect public infrastructure and private properties surrounding the lagoon from flooding.

Research efforts to understand and predict a "stable" or equilibrium flow area of a tidal inlet indicate that the cross-sectional area of an inlet is primarily a function of the tidal peak discharge, the mean tidal range in the sea, and the annual littoral drift. A review of beach profiling data indicates that the annual opening and closing of the lagoon may not be limited by the cross-sectional area of the inlet channel. However, if the opening were broader, it is likely that the lagoon may expand southerly beyond East Cliff Drive and onto the beach (as occurs at Corcoran Lagoon, see Figure 5.2). Similarly, if the opening of the lagoon was modified with a clear span bridge or arched bottomless culvert the lagoon would be able to equilibrate to a more "natural state". How that would influence the frequency of opening and closing is difficult to predict without detailed hydrologic modeling. Historical studies of the San Dieguito Lagoon in Del Mar, California indicated that the opening and closing of the lagoon is principally a function of flood flows.

As previously described the lagoon inlet is a box culvert with a fixed bottom as shown in Figure 5.1. The culvert also fixes the depth of the lagoon inlet to -1 foot below mean sea level (msl). This elevation is most likely higher than would naturally occur if the inlet channel was not fixed or the bed of the channel was moveable. If the inlet channel were to be modified as a moveable bed, the depth of the inlet would change both seasonally and annually depending on storm flows and wave action affecting littoral drift and ephemeral bar formation. It is expected that the "equilibrium" elevation of the new channel would be deeper than the current elevation.



Figure 5.1. Moran Lake Outlet (September, 2002)



Figure 5.2. Corcoran Lagoon (September 2002)

The potential benefits of modifications to the lagoon inlet include increasing the frequency of lagoon flushing, increasing lagoon volume, and improving water quality within the lagoon.

Replacing the box culvert with an arched bottomless culvert or clear span bridge would not impede the lagoon inlet to a fixed depth, which may increase tidal flushing and the frequency of lagoon opening and closing. Figure 5.3 presents examples of a bottomless arched culvert used to restore stream and lagoon functions in sensitive habitat areas. However, limited beach profiling information collected during the period of study suggest that the inlet configuration at Moran Lake may function similar to an unimpaired lagoon system, with seasonal fluctuations of the ephemeral bar on the Moran Lake beach controlling the connection of the lagoon with the ocean.



Figure 5.3. Examples of Bottomless Arched Culvert Crossings

Replacing the box culvert with a new culvert or clear span bridge could modify the lagoon substantially. During wet years, flood flows could cause the lagoon inlet channel to scour and lower, and/or storm surges and wave action combined with high flows could

result in more extensive bank erosion, as compared to what has been experienced in recent years. This change could result in further bank instability and erosion and possible damage to public and private properties. A change in the culvert size or invert elevation could also increase lagoon salinity affecting sensitive species such as tidewater goby and monarch butterfly. Further analysis would be required to more thoroughly assess the potential benefits and impacts associated with a modification of the existing culvert.

Enlarge and Deepen the Lagoon

Enlarging and deepening the lagoon to the original size and configuration is not considered feasible at this time due to the extent of surrounding development and existence of sensitive species' habitat. Reshaping and enlarging the lagoon would require dredging and be a major undertaking. The water quality benefits achieved are unknown at this time. Federal, state and local permits would be required, and proper disposal of potentially contaminated dredge spoils must also be considered.

Manage the Lagoon Entrance (Breach the Sand Bar)

A common practice previously implemented at several large lagoons in the Monterey Bay region, included the active breaching of sand bars. This practice was routinely conducted for flood control, primarily to protect private properties in close proximity to a lagoon from becoming inundated when the lagoon water levels rose in winter or late summer. However, in most instances this practice has been curtailed in response to sensitive species issues. Artifically removing sand from the culvert and excavating a drainage channel between the culvert and ocean is a related technique with similar consequences. Actively managing the sand bar would require a thorough, costly and possibly lengthy environmental review process to obtain and maintain permits to undertake the activities. Artificial breaching could lead to greater ocean- lagoon water exchange, however, the water quality benefit achieved by this action is unknown at this time.

Install an Aeration System

Similar to a wastewater treatment system, an aeration system could be installed in the lagoon to improve water quality. The aeration system would be designed to maintain high dissolved oxygen levels and improve mixing throughout the lagoon and water column. This management option may have some water quality and biologic benefits, but a more detailed water quality evaluation and design analysis would be required to determine the size and the capital, operation and maintenance costs of an aeration system for the lagoon.

Stream Flow Augmentation with Highly Treated Reclaimed Wastewater

Presently, freshwater flows to the lagoon are intermittent, with high flows during the winter months and very low or no flows during the summer. Stream flow augmentation using highly treated reclaimed wastewater, if it were to become available from the County Sanitation District, could be a method to maintain higher water quality in the

lagoon. A small satellite wastewater treatment system could be constructed at the Lode Street facility (R. Lather, personal communication 2004). Introducing higher freshwater flows during the dry period would lower the salinity and increase the water level in the lagoon. However, at this time public sentiment may not support this project, and proceeding with this option would require a thorough, lengthy environmental, permitting, public review and education process.

5.1.2 Create Wetlands in Upper Lagoon

Historical fill practices have significantly impacted Moran Lake by diminishing over forty percent of the surface area of the lagoon. This has reduced the volume and depth of the lagoon, which has affected the lagoons ability to assimilate or dilute pollutants entering the lagoon during winter runoff events. Expanding the effective surface area of the lagoon would be beneficial. However, increasing the lagoon area is constrained by development, competing land uses and sensitive species protection (monarch butterfly habitat).

A potential opportunity to create an expanded wetland on public lands within the upper lagoon has been identified. Wetlands have been shown to be effective filters of urban stormwater pollutants, and could reduce the concentration of nutrients, solids, metals and other constituents entering Moran Lake. Figure 5.4 shows County owned land that may be suitable for development of a wetland.



Figure 5.4. Public Land in Upper Lagoon Identified for Possible Wetland

A wetland in the upper lagoon could potentially improve water quality and improve wildlife foraging and nesting habitat within the lagoon. Construction of a wetland would also develop more natural hydrologic conditions within the lagoon by restoring a wetland area where it likely existed historically. Figures 5.5 and 5.6 present a conceptual layout and cross section of how a wetland in the upper lagoon could be constructed. The wetland could incorporate walking trails for public access, as well as multiple pools with varying depths to maximize pollutant removal and habitat diversity.

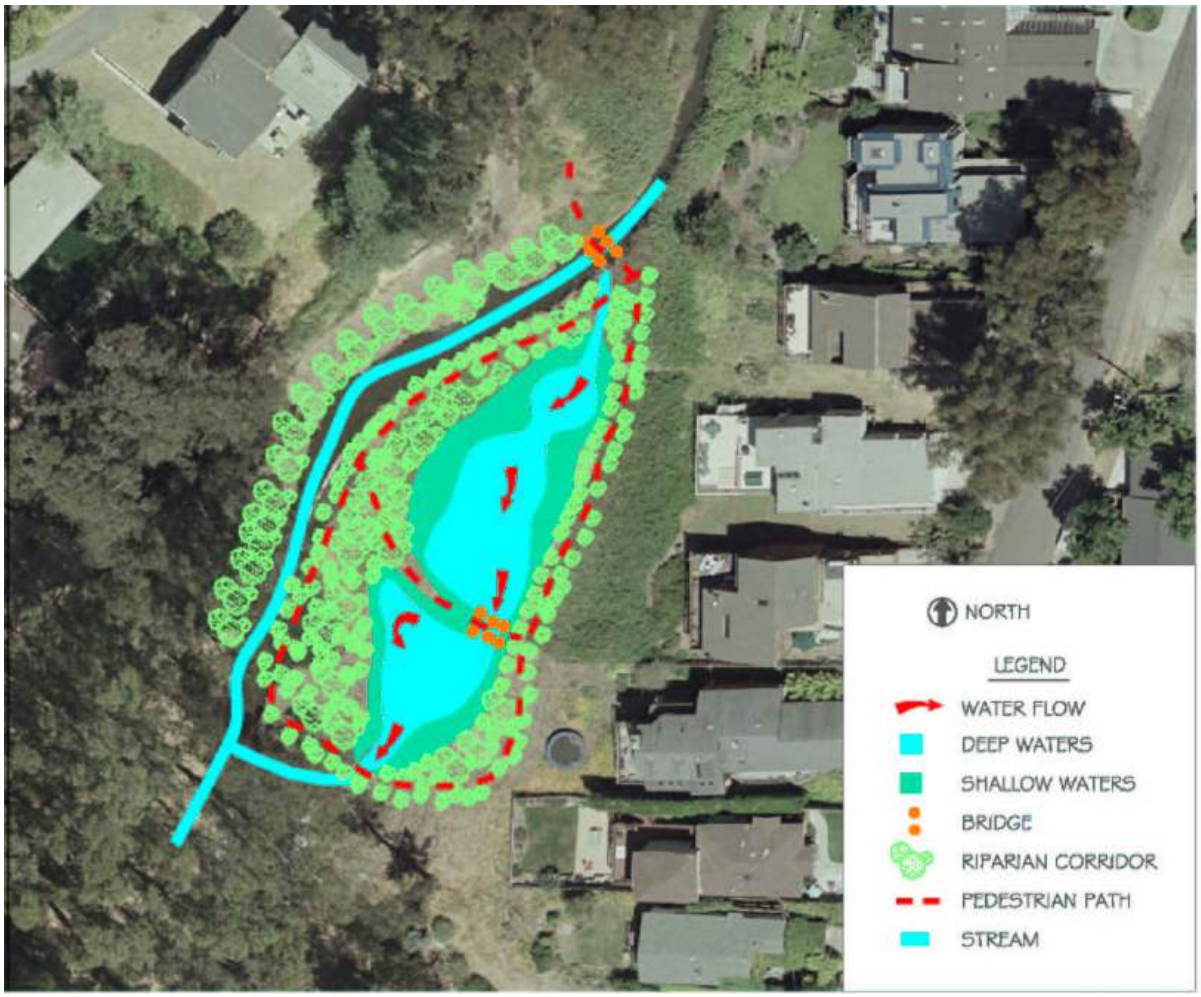


Figure 5.5. Conceptual Layout of Proposed Wetland in the Upper Lagoon Area of Moran Lake

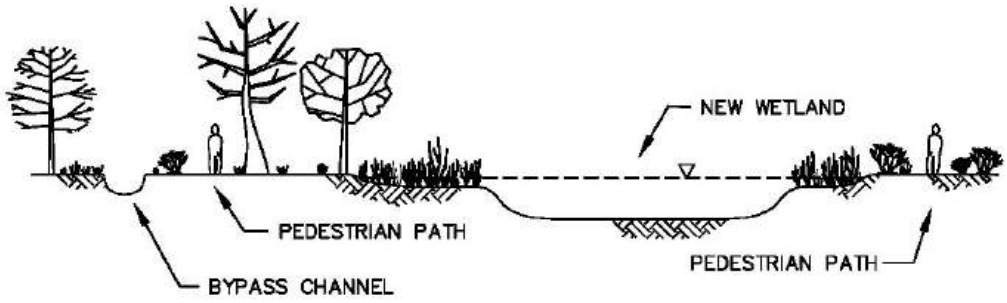


Figure 5.6. Cross-Section of Restored Wetland Area

The appropriate wetland depths, configuration, mix of wetland plant species, inlet and outlet structures need to be considered in final design of this facility. Future investigation into the creation of wetlands in the upper lagoon should consider the issue of mosquito abatement, particularly the public health issues associated with West Nile Virus, and the proper management of the wetland during high and low flow periods. This alternative would also require a significant environmental and public review process.

5.1.3 Reshape Bank Slopes and Restore Lagoon Fringe Wetlands

Due to urban development adjacent to the lake wetlands that once likely existed along the edges of Moran Lake have been destroyed. Concurrent with the removal or alteration of fringe wetlands, diminished vegetation and increased flows from a mostly impervious watershed have resulted in failing banks at some locations along the shore of the lagoon. The most notable failure has occurred on the lower east lagoon bankslope. Figure 5.7 shows the failing bank and its proximity to a frequently accessed bike trail. (A portion of the slope near the lagoon outlet has been reinforced with riprap.)



Figure 5.7. Eroding Bank on the Eastern Shore of Moran Lake (Photos taken on September 11, 2003 (lower) and February 2, 2004)

Undertaking a bank stabilization project is important to protect the bicycle path and to reduce further erosion. A bank stabilization project that employs a biotechnical solution, incorporating a combination of vegetation and structural elements, is desirable to restore the bank to a more natural configuration and to restore habitat value to the disturbed area.

A conceptual bank stabilization project is proposed utilizing a biotechnical approach to stabilize the bank to protect the bicycle path and improve wetland habitat along the fringe of the lagoon. The conceptual plan would regrade the existing steep bank to a 2.5:1 to 3:1 slope from the crown of the slope and incorporate a low terrace or bench at the toe that can be planted with native brackish wetland species. The upper bank could be planted with salt tolerant upland herb and shrub species with the upland flat planted with scattered trees, herbs, and grasses. This design would have the benefits of creating additional wildlife habitat while reducing or eliminating the current rate of bank erosion. In order to protect the bicycle path and adjacent upland, the restored bank may need to be

rebuilt in a westerly direction recapturing the bank lost to erosion. Figure 5.8 is a cross section showing a conceptual design of the restored bank.

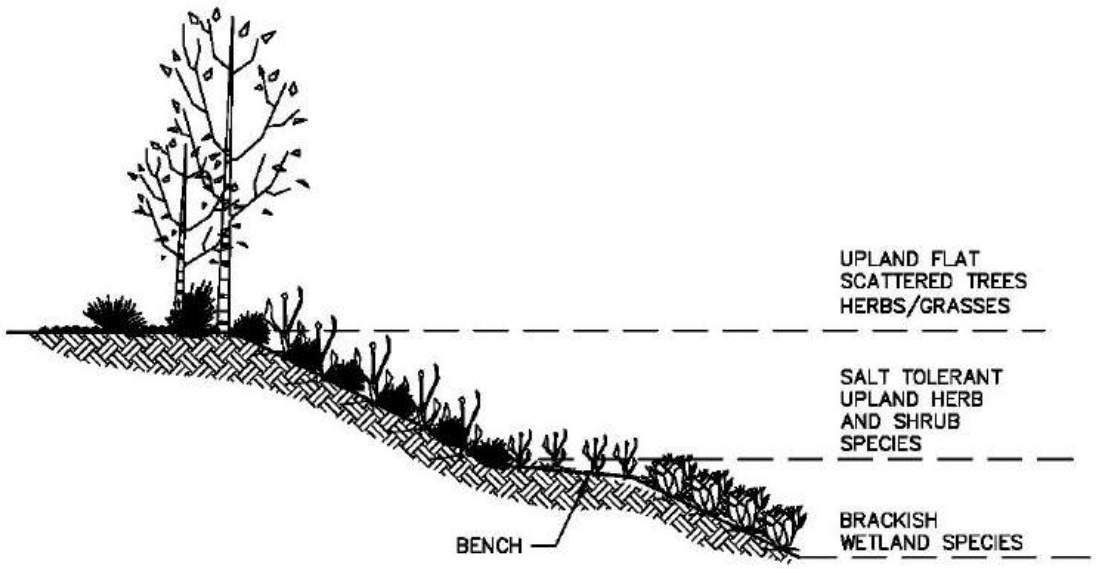


Figure 5.8. Cross-Section showing the Conceptual Layout of Restored Bank on Eastern Shore of Moran Lake

Further engineering analysis of this project may indicate the need to incorporate some additional structural protection (such as a crib type wall to reduce the slope of the bank) or hardscape (such as riprap at the toe of the bank to protect the toe of the bank from excessive scour) combined with the vegetative treatment.

5.1.4 Remove Non-Native Plants and Restore with Native Wetland and Upland Species

Many of the native plants that once lined the banks, shores and upland areas adjacent to Moran Lake have been removed, disturbed, or replaced with non-native species. The highly invasive exotics are of the most concern. To restore the lagoon and upland habitats to a more natural condition, removal of non-native plants and replacement with native wetland and upland species is recommended. Removal of non-native species along Moran Lake would eliminate aggressive species that can rapidly spread into adjacent natural areas. Complete elimination of the ice plant, French broom and Himalayan blackberry is recommended. Replacement with natives should follow a detailed revegetation plan that indicates species composition, planting guidelines, irrigation and other maintenance requirements, and a monitoring protocol. Figure 5.9 is one example of an area covered with iceplant (*Mesembryanthemum* spp.) which could be removed and revegetated with wetland and upland plants that would also provide slope protection. Exotics removal and revegetation should be handled in phases and coupled with erosion control to prevent slope destabilization during implementation. The hands on work of

exotics removal and native plant installation would also provide an opportunity to involve volunteers from the Moran Lake community.



Figure 5.9. Possible Location for Revegetation with Native Plant Species (Area presently covered almost exclusively with non-native ice plant)

The eucalyptus groves within Moran Lake County Park provide critical Monarch butterfly habitat. Therefore elimination of eucalyptus (also somewhat invasive) is not recommended, but management of trees in these areas should follow guidelines contained in the Monarch Management Plan (Janecki et.al. 2002). English ivy and Cape ivy are highly invasive exotics that are growing beneath and up eucalyptus trees. As these species are one of few nectar sources for butterflies during fall and winter months, it is recommended they be retained and controlled only in high density butterfly areas. They should be selectively removed in other locations where they are spreading, and replaced with compatible native or non-invasive ornamental nectar plants.

5.1.5 Interpretive Trail and Signing

The existing trails within the Moran Lake County Park are well used and present an opportunity to develop an interpretive trail and signing. The unique lagoon ecosystem and monarch habitat provide educational themes for community members, visitors, and students. Possible signing themes include: lagoon wetland functions in maintaining/enhancing water quality; wildlife species information, including habitat and species' life cycles; monarch butterfly habitat, migration, winter roosting, and importance of specific microclimate conditions; and native plant species' identification and

recognition. An example of the type of visual and factual information an interpretative sign could include is shown in Figure 5.10.

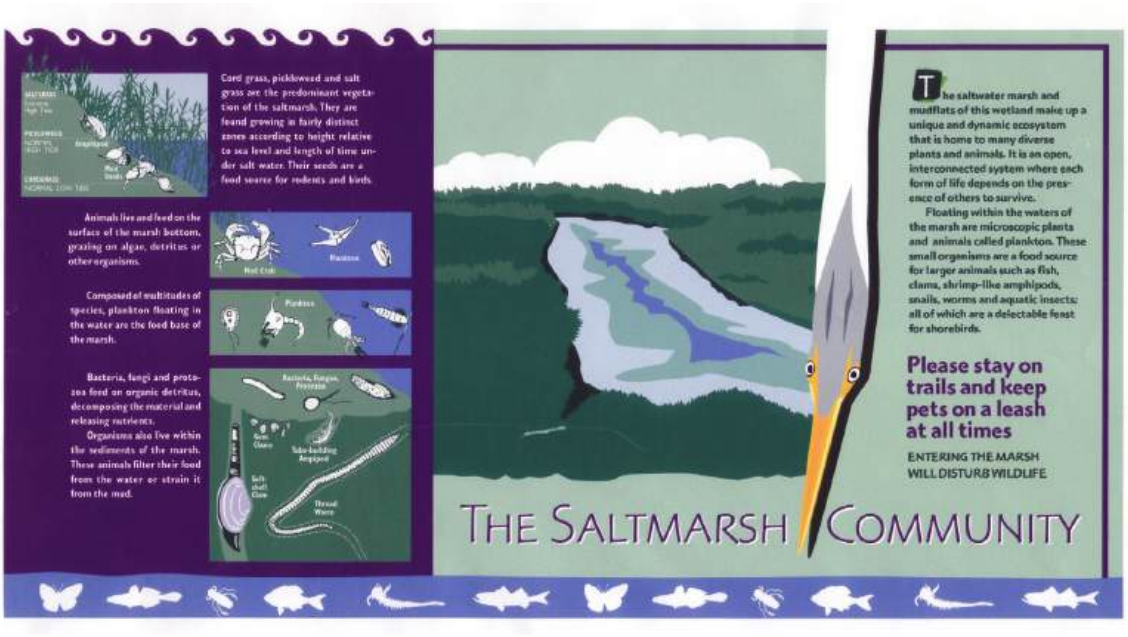


Figure 5.10. Example of Interpretive Sign (S. Erspalmer, Design Science, 2001)

The Monterey Bay Marine Sanctuary has recently placed a sign near the parking lot at Moran Lake County Park, and any future development of interpretive signs in the area should be consistent and compliment this existing sign. In developing the interpretive signs, careful consideration should also be given to protection against vandalism.

5.2. Watershed Restoration

This section presents a series of potential restoration opportunities that may be undertaken in the upper watershed of the lagoon. The primary goals of these projects are to establish better storm water treatment/ filtration systems, restore stream and riparian habitats, create better groundwater recharge, and reduce the need for costly flood control engineering measures.

5.2.1 Water Treatment Wetland at 38th Ave. Detention Basin

The existing storm water detention basin located at 38th could potentially be modified to function as a storm water treatment wetland during low flow events. The existing detention basin could be reconfigured to divert runoff through the wetland during low flow periods. During high flow events the wetland would be temporarily inundated, allowing it to capture nutrients, bacteria and heavy metals contained in urban runoff. The wetland could improve surface water quality entering the lower reaches of Moran Creek and ultimately the lagoon. The wetland could also be designed to provide wildlife

habitat. A conceptual layout of how the 38th Avenue detention basin could be reconfigured to a low flow stormwater wetland is presented in Figure 5.11.



Figure 5.11. Conceptual Layout of 38th Avenue Detention Basin Modified to Include a Stormwater Wetland

Additional engineering and hydrologic analyses are required to develop a detailed conceptual and/or preliminary design of a stormwater wetland in the detention basin. It will be important that the new facility be able to provide an equivalent level of flood control currently provided by the detention basin. Further analysis will also be necessary to evaluate the actual water quality benefits to downstream watercourses provided by a modified basin.

5.2.2. Restore Moran Creek Riparian Corridor

Development in the Moran Lake watershed has significantly reduced the Moran Creek riparian corridor and floodplain. At many locations the Moran Creek channel has been placed in underground culverts. In other areas development has encroached into the riparian corridor eliminating the low flood terrace and riparian vegetation that plays an

important role in natural stream function. It would benefit the overall condition of Moran Lake to restore the floodplain and riparian corridor to a more natural function to the extent practicable. Any opportunity to restore undeveloped or redeveloped lands to increase the stream corridor and daylight the stream would be a significant benefit to the watershed.

In areas where a narrow above-ground channel exists, widening of the stream corridor to provide for a functional riparian corridor buffer should be considered. High density development and urbanization severely limit restoration opportunities, and any possible stream restoration will be tied to new land use projects. Figure 5.12 presents a conceptual layout and cross section of an above-ground portion of Moran Creek that could be considered for restoration as land use in the area changes. The restoration concept plan suggestswidening and reshaping the stream channel to a more natural meandering flow path.

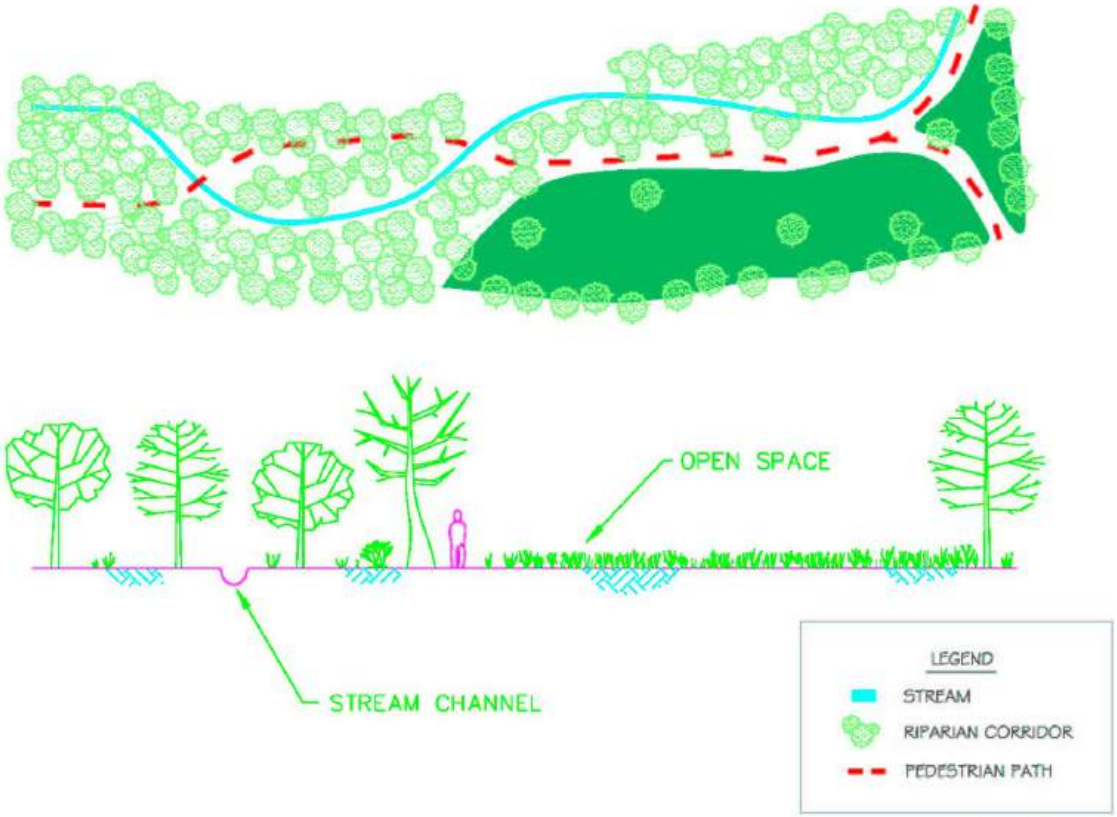


Figure 5.12. Conceptual Layout of Moran Creek Stream Restoration

5.3. Storm Water Management and Treatment

Adopting new storm water control measures are an important step towards reducing the amount of pollutants from urbanized areas in the watershed in order to protect the lagoon and Monterey Bay. Presently, a substantial number of source control and treatment best management practices (BMPs) are available to reduce pollutants (see Appendicies B&C). The following section presents a summary of the available BMPs that can meet a variety of treatment and site restoration goals. Several of the BMPs are landscaped-based techniques, such as bioretention and vegetated swales and constructed wetlands. These types of BMPs can achieve a high level of contaminant reduction, provide for ecologic restoration, and are considered integral to the restoration of water quality in the lagoon.

This section of the report provides a general overview of the type and use of BMPs. The information provided is not intended to be used for design purposes; several other technical resources area available for the site-specific design of BMPs. A list of technical resources is presented in Appendix C.

5.3.1. Innovative Site Design

Considering that many of the future projects in the urbanized areas will require substantial new site development, the opportunity exists to address storm water management at the onset of a project through the site planning and design process. Adopting innovative planning and design approaches that can minimize the volume, speed and quantity of pollutants released from the site will in turn reduce the size of structural BMPs required.

Several factors contribute to storm water degradation in a conventional development. Large paved roads and parking surfaces create and collect runoff. Building sites may be graded substantially, altering runoff patterns and removing natural vegetation that absorbs runoff. The curbs, gutters, and catch basins collect runoff and carry it rapidly, proving little opportunity for treatment or infiltration. Consequently large quantities of runoff may be carried to a conveyance storm water system, discharging sediments and other pollutants directly to the creek, lagoon and Monterey Bay.

Innovative approaches to site design can be incorporated into the planning and development process to reduce the volume and improve the quality of runoff leaving these sites. Innovative site design techniques employ a variety of methods to reduce total paved area, distribute and diffuse storm water, and conserve natural or landscaped areas. The approach seeks to accomplish three goals at every development site: to reduce the amount of impervious cover, to increase landscaped areas or natural areas set aside for conservation and recreation, and to use pervious areas for more effective storm water treatment. To meet these goals designers and planners must scrutinize every aspect of a site plan – its streets, sidewalks, driveways, and parking spaces, to determine if these elements can be incorporated. At the same time creative grading and drainage techniques should be employed to reduce the volume of storm water runoff and direct runoff to natural landscaped areas maximizing site infiltration and passive treatment of pollutants.

5.3.2. Storm Water Control and Treatment BMPs

A variety of storm water control and treatment BMPs can be selected for a site, including source control measures, and structural and non-structural treatment BMPs. Source control measures include a variety of hazardous materials management systems, such as enclosed fuel and hazardous material storage areas, secondary containment measures for fuel, waste oil and other hazardous wastes, street sweeping, and diversion of washwater and other process flows to the County's sanitary sewer system. Typical structural BMPs include various types of in-line filters and cyclonic separation technology. Non-structural BMPs typically include landscape based natural treatment systems, including bioretention areas, grass swales, constructed wetlands and other passive treatment systems. Appendix B includes an overview of storm water control practices, including source control measures, filtration control measures, and detention type storm water treatment systems.

5.3.3. Performance Standards for Storm Water Management

The greatest opportunity to protect water quality and reduce storm water runoff can occur during site planning and the design phase of any project. Therefore, adopting performance standards or criteria addressing site design standards is a critical element of any storm water management program. Early planning efforts afford the designer the opportunity to identify multi-site conjunctive uses including storm water control measures. Additionally, establishing performance standards for storm water best management practices clarifies the planning, selection and design of the specific BMPs appropriate for the site and related land use activities. New development opportunities in the Moran Lake watershed could provide the County and City of Capitola with an opportunity to adopt alternative site design standards that can reduce impervious surfaces and storm water runoff from these areas. Appendix C outlines typical site design performance standards and design standards for storm water management and treatment best management practices.

5.4. Public Education and Outreach

Development of public education and outreach projects within the Moran Lake watershed would ultimately benefit the lagoon by increasing awareness about lagoon functioning and proper watershed practices. Possible outreach could include informational brochures to community members, interpretive signs, and community activities focused on the stream or lagoon awareness, education and restoration. Simple brochures could be prepared addressing the importance of stream stewardship. For example, maintaining good water quality practices means not using the creek, drainage inlets or lagoon as an urban waste dump. The adverse effects of toxic chemicals on long-term habitat quality and public health should also be emphasized.

Possible community actions include formation of a watershed group through the California Coordinated Resource Management and Planning (CRMP) process, or developing a volunteer water quality monitoring effort through the Coastal Watershed Council (CWC). Outreach could also be accomplished through organization of

community members to volunteer for stream cleanup and exotic plant species' removal. Public and educational workshops about Moran Lake would also help to strengthen a commitment from residents within the Moran Lake watershed to protect and restore the lagoon. Special attention should be given to upper watershed land uses especially commercial uses along 41st Avenue and Portola Drive, and the numerous mobile home parks within watershed.

6. IMPLEMENTATION

A series of restoration projects and programmatic activities have been presented in the previous section. In this section a general review of planning and implementation options is outlined for restoration, public education, and programmatic activities. Preliminary cost information is also presented for the projects. A preliminary constraint analysis that reviews the potential benefits and constraints associated with each project is also presented to rank and prioritize the projects.

6.1. Planning and Implementation

Several tasks are required to plan and implement the various restoration and programmatic activities outlined in this plan. In order to carry out many of the restoration projects, additional technical studies, engineering analysis and design, and environmental review and permitting will be required. Public resources of both staff time and funding would be required to implement several of the programmatic activities.

6.1.1. Funding

Because County funding sources are limited, other sources should be reviewed for partial or full funding of projects listed below. Current possibilities include the California Coastal Conservancy (grants and loans for coastal access and wetland enhancement), US Environmental Protection Agency and California State Water Resources Control Board (water quality grant funding) and the Monterey Bay National Marine Sanctuary.

6.1.2. Restoration Project Implementation

Planning and implementing a restoration project normally involves several phases of work, including:

1. Planning and technical analysis;
2. Environmental review and permitting;
3. Engineering and preparation of construction documents; and
4. Project implementation or construction.

Planning and Technical Analysis. At the initial phase of a project, additional data gathering, such as a topographic survey and completion of technical studies, including hydrologic, biotic and archaeological studies may be necessary to evaluate the feasibility and/or design and permit a project.

Environmental Review and Permitting. Once a project is considered feasible and supporting technical studies have been completed, the project will undergo an environmental review process to comply with the California Environmental Quality Act (CEQA). At this stage of project an environmental site assessment study may be conducted to determine the potential for adverse environmental effects that may require mitigation or alteration of the project design. Relevant CEQA documents would be

prepared and subject to a public review process. Once the environmental review process is conducted, local, state and/or federal permits may need to be obtained in order to execute a project.

Preparation of Construction Documents. Once a project has been approved and permitted, construction documents are prepared. These documents typically include engineering design plans and specifications, an engineering cost estimate for the project, and construction bid and contract documents.

Project Implementation. Project implementation or construction typically involves pre-project, construction and post construction activities. Pre-project activities for many restoration projects occurring in stream and wetland settings can involve pre-project biotic monitoring, installing temporary dewatering or stream diversion systems, construction surveying and establishing a construction staging area. Once the pre-project activities are completed the project is constructed. After completion post-construction activities are commonly required to clean up the construction zones, and monitor and maintain the project, usually for a three to five year period.

Section 6.2 presents preliminary cost estimates to plan and construct seven proposed restoration and education projects identified in Section 5.

6.1.3. Public Education and Programmatic Activities

In Section 5 public education and programmatic activities have been identified. These include:

- Interpretative trail and signing around Moran Lake;
- Public education and outreach; and
- Storm water management activities.

Interpretative Trail and Signing. As previously discussed the existing trails within the Moran Lake County Park are well used and present an opportunity to develop an educational and interpretive signs. The unique lagoon ecosystem and monarch habitat provide educational themes for community members, visitors, and students. To develop and implement an interpretative trail and signing project the following activities are suggested:

1. Establish a voluntary oversight committee to raise funds and oversee the development and installation of interpretative displays;
2. Begin to acquire funds to plan, develop, and install interpretative displays;
3. Retain an individual or graphics design firm to prepare a plan for the interpretative trail and signing and to prepare the signs.
4. Install (or improve) trails and install signs.

Public Education and Outreach. Several public education and outreach activities have been mentioned in Section 5. In summary the main activities discussed include:

- Formation of a watershed group through the California Coordinated Resource Management and Planning (CRMP) process;
- Organized community activities and informational forums focused on the water quality issues, natural history, restoration of streams and coastal lagoons, and storm water management strategies;
- Storm water and water quality workshops for small commercial and industrial businesses in the Live Oak area;
- Preparation and distribution of informational brochures to community members; and
- Volunteer days for stream cleanup and exotic plant species' removal.

Through the watershed planning activities of the Santa Cruz County Resource Conservation District the community may be able to obtain technical assistance to start a watershed group. Once the watershed group is formed than the group might seek additional funds to hire a part-time coordinator to help organize watershed group activities, and to conduct fundraising activities for broader outreach efforts.

Storm Water Management Activities. Adopting new storm water control measures are an important step towards reducing the amount of pollutants from urbanized areas in the watershed to protect the lagoon and Monterey Bay. Various storm water management and treatment practices are available to reduce pollutants. In Section 5 three major areas of storm water management are outlined:

- Innovative site design;
- Use of storm water control and treatment best management practices (BMPs); and
- Establishing performance standards for site design and storm water control and treatment BMPs.

These activities would be implemented on a county-wide basis under the auspices of the County of Santa Cruz's Storm Water Management Program currently underway. The County Program should consider the recommendations contained in this plan as their activities relate to the Moran Lake watershed area. Additional implementation efforts beyond the County's program are not recommended at this time.

6.2. Project Cost Analysis

Preliminary costs have been prepared for several restoration and public education projects outlined in the plan. Eight separate projects were analyzed:

1. Replacing of the box culvert on East Cliff Drive with an arched and bottomless culvert;
2. Construction of a wetland in the upper arm of Moran Lake;
3. Reshaping and stabilizing the eroded bank on the east side of Moran Lake;

4. Removal of invasive and non-native plants and revegetation with native plantings;
5. Modifying the 38th Avenue Detention Basin to include a storm water wetland on the bottom of the existing basin;
6. Restoring portions of Moran Creek and riparian corridor;
7. Installing interpretative signs around the lagoon.

Costs for forming a watershed group, and conducting public education and outreach activities have not been included, although they are expected to be nominal.

6.2.1. Replacement of the East Cliff Drive Box Culvert with a Arched, Bottomless Culvert

Although limited benefits are expected to be achieved, an arched and bottomless culvert could replace the existing box culvert to restore the lagoon inlet to a more natural configuration. Using an arched culvert to provide a clear span across the lagoon inlet would be a least cost method, as compared to a clear span or trestle style bridge. Preliminary cost estimates for this project are presented in Table 6.1 below.

Table 6.1. Preliminary Cost Estimate for Arched Bottomless Culvert
For East Cliff Drive Crossing

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Topograpic Survey & Mapping	15,000.00
1.2. Hydraulic Analysis	50,000.00
1.3. Preliminary Engineering Analysis and Design	30,000.00
1.4. Preliminary Engineering Costs Analysis	5,000.00
Sub-total	100,000.00
2. Environmental Review and Permitting	
2.1. Phase 1 & 11 Envionmental Site Assessment	10,000.00
2.2. CEQA Review	25,000.00
2.3. Permitting & Fees	20,000.00
Sub-total	55,000.00
3. Preparation of Construction Documents	
3.1. Engineering Design Plans and Specifications	50,000.00
3.2. Contract Documents	10,000.00
Sub-total	60,000.00
4. Project Implementation	
4.1. Site Work (Excavation/Grading, Drainage and Erosion Control)	75,000.00
4.2. Install abutments and wingwalls	100,000.00
4.3. Install arched culvert	250,000.00
4.4. Replace Utilities in Roadway	100,000.00
4.5. Finish Grading and Paving of Roadway	75,000.00
Sub-total	600,000.00
Total Project Sub-total	815,000.00
Contingency (15%)	122,250.00
Total Project Cost =	**$ 937,250.00**

6.2.2. Upper Lagoon Wetland

A wetland in the upper lagoon would improve lower lagoon water quality and create wildlife foraging and nesting habitat. Construction of a wetland would also restore more natural hydrologic conditions within the lagoon by recreating a wetland area where it probably existed historically. Table 6.2 presents a preliminary cost estimate to construct a wetland in the upper arm of the lagoon. The preliminary costs include trails and two small foot bridges to provide for recreational access around the wetland.

Table 6.2. Preliminary Cost Estimate for Wetland in Upper Lagoon

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Topographic Survey	7,500.00
1.2. Hydrologic and Hydraulic Analysis	25,000.00
1.3. Preliminary Engineering Analysis and Design	10,000.00
1.4. Preliminary Engineering Costs Analysis	5,000.00
Sub-total	47,500.00
2. Environmental Review and Permitting	
2.1. Phase 1 & 11 Enviromental Site Assessment	15,000.00
2.2. CEQA Environmental Review	20,000.00
2.3. Permitting & Fees	15,000.00
Sub-total	50,000.00
3. Preparation of Construction Documents	
3.1. Engineering Design Plans and Specifications	30,000.00
3.2. Contract Documents	10,000.00
Sub-total	40,000.00
4. Project Implementation	
4.1. Site Work (Excavation/Grading)	250,000.00
4.2. Install Hydraulic Control Structures	100,000.00
4.3. Revegetation and Erosion Control	50,000.00
Sub-total	400,000.00
Total Project Sub-total	537,500.00
Contingency (15%)	80,625.00
Total Project Cost =	**618,125.00**

6.2.3. Reshape and Stabilize Lagoon Bank

Undertaking a bank stabilization project on the east side of the lagoon is important to protect the pedestrian/bicycle path and to reduce the likelihood of further erosion. A bank stabilization project that employs a biotechnical solution, incorporating a combination of vegetation and structural elements is desirable to restore the bank to a more natural configuration and to restore habitat value to the disturbed area. Access in this area is an important link to the surrounding neighborhood to the east. Table 6.3 presents a preliminary cost estimate for the project.

Table 6.3. Preliminary Cost Estimate for Bank Stabilization Project on east side of Lagoon

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Topographic Survey	5,000.00
1.2. Preliminary Engineering Analysis and Design	10,000.00
1.3. Preliminary Engineering Costs Analysis	5,000.00
Sub-total	20,000.00
2. Environmental Review and Permitting	
2.1. Phase 1 & 11 Environmental Site Assessment	8,000.00
2.2. CEQA Environmental Review	20,000.00
2.3. Permitting & Fees	15,000.00
Sub-total	43,000.00
3. Preparation of Construction Documents	
3.1. Engineering Design Plans and Specifications	30,000.00
3.2. Contract Documents	10,000.00
Sub-total	40,000.00
4. Project Implementation	
4.1. Reshape Eroded Bank (~200 LF)	175,000.00
4.2. Revegetation and Erosion Control	50,000.00
Sub-total	225,000.00
Total Project Sub-total	328,000.00
Contingency (15%)	49,200.00
Total Project Cost =	**$ 377,200.00**

6.2.4. Modify 38th Avenue Detention Basin with a Low-Flow Wetland

The existing storm water detention basin located at 38th could be modified to function as a storm water treatment wetland during low flow events. The existing detention basin would need to be reconfigured to divert runoff through the wetland during low flow periods allowing it to capture nutrient, bacteria and heavy metals contained in urban runoff. During high flow events the wetland would be temporarily inundated, also providing some pollutant retention. The wetland could also be designed to provide some wildlife habitat value. Table 6.4 presents preliminary cost estimates to retrofit the detention basin.

Table 6.4. Preliminary Cost Estimate to Modify 38th Avenue Detention Basin with a Low-Flow Wetland

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Topographic Survey	7,500.00
1.2. Preliminary Engineering Analysis and Design	30,000.00
1.3. Preliminary Engineering Costs Analysis	5,000.00
Sub-total	42,500.00
2. Environmental Review and Permitting	
2.1. Phase 1 & 11 Environmental Site Assessment	10,000.00
2.2. CEQA Environmental Review	15,000.00
2.3. Permitting & Fees	10,000.00
Sub-total	35,000.00
3. Preparation of Construction Documents	
3.1. Engineering Design Plans and Specifications	40,000.00
3.2. Contract Documents	5,000.00
Sub-total	45,000.00
4. Project Implementation	
4.1. Modify Flow Control Structures and Spillways	250,000.00
4.2. Reshape Pond and Soil Disposal	50,000.00
4.3. Revegetation and Erosion Control	50,000.00
Sub-total	350,000.00
Total Project Sub-total	472,500.00
Contingency (15%)	70,875.00
Total Project Cost =	**543,375.00**

6.2.5. Restore Moran Creek Corridor

Development in the Moran Lake watershed has significantly reduced the Moran Creek riparian corridor and floodplain. To enhance the condition of Moran Creek any opportunity to restore undeveloped or redeveloped lands to increase the stream corridor and daylight the stream would be a significant benefit to the watershed. In areas where a narrow above-ground channel exists, widening of the stream corridor to provide for a functional riparian corridor buffer should be considered. For planning purposes, preliminary cost estimates have been prepared to restore approximately 1,000 lineal feet of stream channel in the watershed. These costs, as presented in Table 6.5, do not include any property acquisition costs.

Table 6.5. Preliminary Cost Estimate for 1000 feet of Channel Restoration

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Topographic Survey	10,000.00
1.2. Preliminary Engineering Analysis and Design	25,000.00
1.3. Preliminary Engineering Costs Analysis	5,000.00
Sub-total	40,000.00
2. Environmental Review and Permitting	
2.1. Phase 1 & 11 Environmental Site Assessment	20,000.00
2.2. Environmental Review	15,000.00
2.3. Permitting & Fees	10,000.00
Sub-total	45,000.00
3. Preparation of Construction Documents	
3.1. Engineering Design Plans and Specifications	40,000.00
3.2. Contract Documents	5,000.00
Sub-total	45,000.00
4. Project Implementation	
4.1. Restore 1,000 LF of Stream Channel	500,000.00
4.2. Revegetation and Erosion Control	100,000.00
Sub-total	600,000.00
Total Project Sub-total	730,000.00
Contingency (15%)	109,500.00
Total Project Cost =	839,500.00

6.2.6. Removal of Non-Native Invasive Plants and Revegetation with Natives

Table 6.6. Cost Estimate for Non-Native Plant Removal and Revegetation

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Topographic Survey & Detailed Vegetation Mapping	4,000
1.2. Prepare Exotics Removal and Revegetation Plan	3,000
Sub-total	7,000
2. Project Implementation[1]	
2.1. Exotics removal[2]	15,000
2.2. Nursery Plant Propagation	30,000
2.3. Vegetation[2]	50,000
2.4. Maintenance and irrigation	10,000
Sub-total	105,000
Total Project Sub-total	112,000
Contingency (15%)	16,800
Total Project Cost =	**$ 128,800**

1. Project phased over a 10 to 15 year period

2. Assumes volunteer labor force supervised by restoration specialist

6.2.7. Interpretative Signs

Table 6.7. Costs for Interpretative Signs and Trails

Description	Total Cost
1. Planning and Technical Analysis	
1.1. Prepare Trail and Interpretative Sign Plan	3,000
Sub-total	3,000
2. Project Implementation	
2.1. Prepare signs (three (3) signs)	8,000
2.2. Install (modify) trails and install signs	6,000
Sub-total	14,000
Total Project Sub-total	17,000
Contingency (15%)	2,550
Total Project Cost =	**$ 19,550**

6.3. Constraint Analysis

A preliminary constraint analysis has been prepared to identify and rank potential benefits and constraints that would either be achieved or may impede the successful completion any of the projects. The results of the analysis are summarized in Table 6.8. Since the overall goal is to improve water quality and habitat conditions in Moran Lake, the potential benefits include basic water quality and habitat enhancement. Several potential constraints have been identified including:

1. Permit Complexity - The project could require numerous permits and a complex permit approval process

2. Technical Feasibility – Evaluates whether the project directly improves water quality or habitat conditions

3. Property Acquisition – The project may require purchasing private property or securing easements. Costs of this have not been considered

4. Environmental Remediation – The project may require environmental remediation of toxic materials, including environmental testing and remedial corrective action (eg. soil excavation and disposal)

5. Sensitive Species Mitigation - The project may have sensitive species present and would require mitigation of potential impacts or loss of habitat

6. Cost – Program costs are ranked based on cost estimates above

7. Maintenance and Monitoring – Project may require on-going maintenance or periodic monitoring to achieve stated goals

Table 6.8. Benefits and Constraints Analysis

Project	Benefits			Constraint							
	Water Quality Improvement	Habitat Enhancement	Public Awareness and Education	Permit Complexity	Technical Feasibility	Property Acquisition	Environmental Remediation	Sensitive Species Mitigation	Costs	Maintenance Requirements	Monitoring Requirements
A. East Cliff Drive Arched Culvert	7	3	0	4	7	6	7	4	4	6	5
B. Upper Lagoon Wetland	1	2	2	4	5	6	7	6	4	5	5
C. Reshape Bank and Erosion Control	3	1	3	4	6	6	6	6	5	5	5
D. Removal of Non-Native Plants	5	1	1	6	0	0	0	0	6	5	5
E. 38th Avenue Detention Basin	1	3	3	6	6	6	5	6	5	5	5
F. Restore Moran Creek	2	1	2	4	7	4	4	7	4	5	5
G. Interpretive Trail and Signing	3	0	1	0	0	0	0	0	6	6	0
H. Public Education and Outreach	2	2	1	0	0	0	0	0	6	0	0

0 Not Applicable
1 High Potential Success
2 Moderate Success
3 Low Potential Success
4 Significant Constraint
5 Moderate Constraint
6 Low Constraint
7 Unknown

To summarize: 1) The cost-efficient projects, d. non-native plant removal, g. trails/ signing and h. public education will have moderate to major benefits without significant constraints. 2) The moderate and higher cost projects—e. modification of 38th Avenue detention basin, c. erosion control on Moran Lake east bankslope, and b.the upper lagoon wetland also appear to have moderate to significant benefits without major constraints. The County should prioritize these projects and pursue funding from outside sources as needed. 3) Project f., restoration of selected reaches of Moran Creek above the lagoon could be very costly if land acquisition is necessary, but may be less expensive and provide water quality and habitat benefits if restoration occurred as part of the design for new development projects. Coordination with the Planning Department would be necessary to implement this recommendation. 4) Project a., replacement of the East Cliff box culvert with a bridge or arched culvert is also an expensive project that would require further hydrologic and environmental analyses to determine if benefits outweigh constraints.

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Appendix A

Overview of Stormwater Control Practices, Site Design, and Stormwater BMP Performance Standards

Appendix A – Overview of Stormwater Control Practices, Site Design and Stormwater BMP Performance Standards

A.1. STORMWATER CONTROL PRACTICES

A.1.1. Source Control Measures

Source controls are management techniques that reduce the amount of pollutants and volumes of water entering the storm water drainage system. Reducing the volume of pollution entering the storm water system can often be the most effective and least expensive means of control. The following presents a brief description of the common source controls that are applicable to Moran Lake watershed.

Covering. Areas that are potential sources of chronic loading or acute releases of pollutants to the environment (such as fuel dispensing facilities, hazardous materials/waste storage areas, solid waste storage areas, and vehicle maintenance areas) should be covered with a permanent canopy, roof, or awning. Rainfall should not come in contact with materials and activities in these areas. Areas that are covered should be paved beneath the cover and hydraulically isolated through grading, berms, or drains to prevent uncontaminated storm water from running onto the area and carrying pollutants away. Drainage from the hydraulically isolated area is directed to an approved on-site industrial wastewater treatment facility, or other approved on-site temporary storage facility or containment device/structure.

Pavement. Areas used to store potentially reactive materials should be paved with Portland cement concrete and the pavement should be epoxy coated. Gasoline and other materials can react with asphalt pavement, causing the release of toxic oils from the pavement. If the area is already paved with asphalt, an asphalt sealant can be applied to the pavement surface.

Alternative Paving. There are two categories of alternative paving: porous pavement and concrete grid or modular paving. (This method of pavement is only applicable in areas where the sub-soils have adequate infiltration rates, which should be determined prior to final design.) Porous pavement is an open-graded aggregate laid on top of a permeable soil layer. Modular pavements are formed using concrete blocks with open spaces that are filled with sand and vegetation. Alternative paving is used to reduce the amount of impervious cover and to maximize infiltration of rainfall at a site. Alternative paving systems also provide passive treatment of storm water through adsorption and biodegradation of pollutants entering these systems. The use of alternative paving materials is appropriate in low-trafficked areas, such as employee parking lots and emergency access roads or driveways. Modular paving is generally more expensive than porous paving, however porous paving is subject to clogging.

Street Sweeping. Street sweepers remove debris and particulate from paved surfaces using rotating brushes, water jets, and/or vacuums. They are a good method of pollution reduction for urban areas that are hard to retrofit with physical structures or biological areas. Optimal frequencies of street sweeping are usually between weekly and monthly.

Revegetation. Revegetation is the conversion of paved areas to vegetated areas. This technique not only helps to reduce the volume of runoff from these areas, but runoff directed to these areas will infiltrate through the soil and passively reduce pollution levels. There are also secondary benefits associated with revegetation, such open space and soil stabilization.

A.1.2. Filtration Control Measures

Filtration controls are either structural or non-structural (landscape based) treatment systems that are normally installed or integrated as a part of a storm drain system. They usually take up less surface area than downstream controls and can be integrated into the site design as landscaped areas. Inline controls are often located underground.

Bioretention filter. Bioretention filters utilize landscaped areas to reduce pollutants in storm water runoff. In this system, the site is graded so that storm water runoff is directed over a curtain drain and buffer strip to a vegetated bioretention area. The bioretention area is composed of several layers including woody and herbaceous plants, mulch, soil, and a sand bed. As runoff percolates through the system, pollutants are transformed, sequestered, or filtered out by the plant and soil system. Bioretention areas are generally designed in a manner that allows water to pond on the surface for brief periods of time. Bioretention is typically used as a storm water management BMP in road medians and parking lot islands. An example of typical bioretention filter is presented in Figure A.1 actual dimensions of an installed bioretention filter will vary depending on actual site conditions and volume of runoff to be treated.

Typical maintenance for bioretention filters might include mowing grass and removing grass clippings, occasional removal of sediment especially at inlets, revegetation as necessary, and the removal of debris that has blown onto the filter.

Vegetated Channels. Vegetated channels refer to ditches, grass channels, vegetated dry and wet swales. These are vegetated channels with a slope that is similar to that of a standard storm drain, but is wider and shallower to minimize velocity and maximize infiltration and adsorption of pollutants. Often vegetated channels are used in road medians like bioretention filters, but unlike bioretention, they emphasize flow along the surface rather than infiltration and subsurface flow. An example of a dry swale is shown in Figure A.2. The actual dimensions of the swale, including depth, width and length will depend on site conditions, such a depth to shallow groundwater and volume of water conveyed in the swale system.

Sand filter. Sand filter units are located either in open units or in vaults. In a sand filter, storm water filters through a sand layer and into an underdrain. They are convenient for urban areas because they can be located underground. However, they can only treat a relatively small area and storm water must be pretreated to remove large solids. These systems have been shown effective at removing a range of pollutants, but they can require a high level of maintenance.

Filter traps. There are a variety of commercially available catch-basin type filter traps. These systems are typically designed with baffles and/or cartridge type filters that trap sediment, oil and grease. Many are designed to capture and treat the 'first flush' or rainfall events of one inch or less, and are designed to bypass peak storm events in excess of the one-inch event. These events are the most frequent events and often generate the highest pollution loads over the course of a rainy season. Routine cleaning, often after every storm, is critical to maintain the effectiveness of the traps. These units are designed to remove trash, sediment, oil and grease and some systems are designed specifically to remove hydrocarbons from storm water. Performance of these systems is highly variable and generally dependent on the design of the system and maintenance frequency. Filters are not worth using and should not be used unless they can be inspected and maintained on a very frequent basis.

Centrifugal Units. There are a variety of specially designed systems for storm water treatment that use vortex or adjustable weirs to route low flows to a water quality treatment unit to remove solids, oil and grease. Higher flows from more intense storms are restricted by low-flow orifices and directed over the adjustable weir, bypassing the water quality facility and preventing the resuspension of sediments. They can also be used in conjunction with other storm water treatment BMPs to provide higher levels of treatment. These systems are appropriate to pretreat runoff from areas with high concentration of solids and oil and grease, such as truck tire washing areas, processing plant yards and material storage areas. A conceptual drawing of this system is presented in Figure A.3.

Pre-Engineered Stormwater Treatment System. The Storm water Management's StormFilter™ is typical of a more advanced inline treatment system that is designed to remove solids, oil and grease and soluble metals. The StormFilter uses filter cartridges housed in concrete vaults creating a self-contained storm water filtering system that is inline with storm drains. The filter media traps particulate and adsorbs materials such as dissolved metals and hydrocarbons. A conceptual drawing of a typical StormFilter system is presented in Figure A.4.

Infiltration. Infiltration can be achieved using trenches and basins. They reduce pollution loading by infiltrating storm water into the ground. Media such as coarse gravel and sand are used to allow for rapid percolation into the soil. The life expectancy of infiltration system can be short if the permeable bed becomes clogged. Infiltration of polluted storm water into the underlying ground water can also be a concern.

A.1.3. Detention Type Stormwater Treatment Systems

Detention type storm water treatment systems are generally located at the outlet of the conveyance system just before storm water runoff enters receiving waters or exits a site. Detention type controls are typically larger then filtration systems because they usually handle a larger volume of water. They typically have higher construction costs than other types of treatments, but their cost per volume of water treated and pounds of pollution removed can be competitive or less than other treatment schemes.

Dry Ponds. Dry ponds are conventional extended ponds that are normally dry between storm events. They detain water over a course of days to allow particulates to settle out of the runoff. Pollutant removal efficiency is variable with dry ponds. Heavier pollutants that settle out of runoff can be partially removed; however, negligible removal of soluble pollutants is achieved.

Wet Ponds. Wet ponds have a permanent pool of water for treating incoming storm water runoff. Pollutants are removed via settling, plant uptake, and bacterial decomposition. The degree of pollutant removal is a function of the pool size in relationship to the drained area. Maintenance is often low and is partially a function of aesthetic value required.

Constructed Wetlands. Wetlands operate in a similar manner to ponds and can provide very effective storm water treatment. They are generally shallow, allowing vegetation to grow, but they are less tolerant to fluctuations in water depth. They provide more habitat value than ponds; however, they can require a lot of space. An example of a multiple pond storm water wetland is shown in Figure A.5.

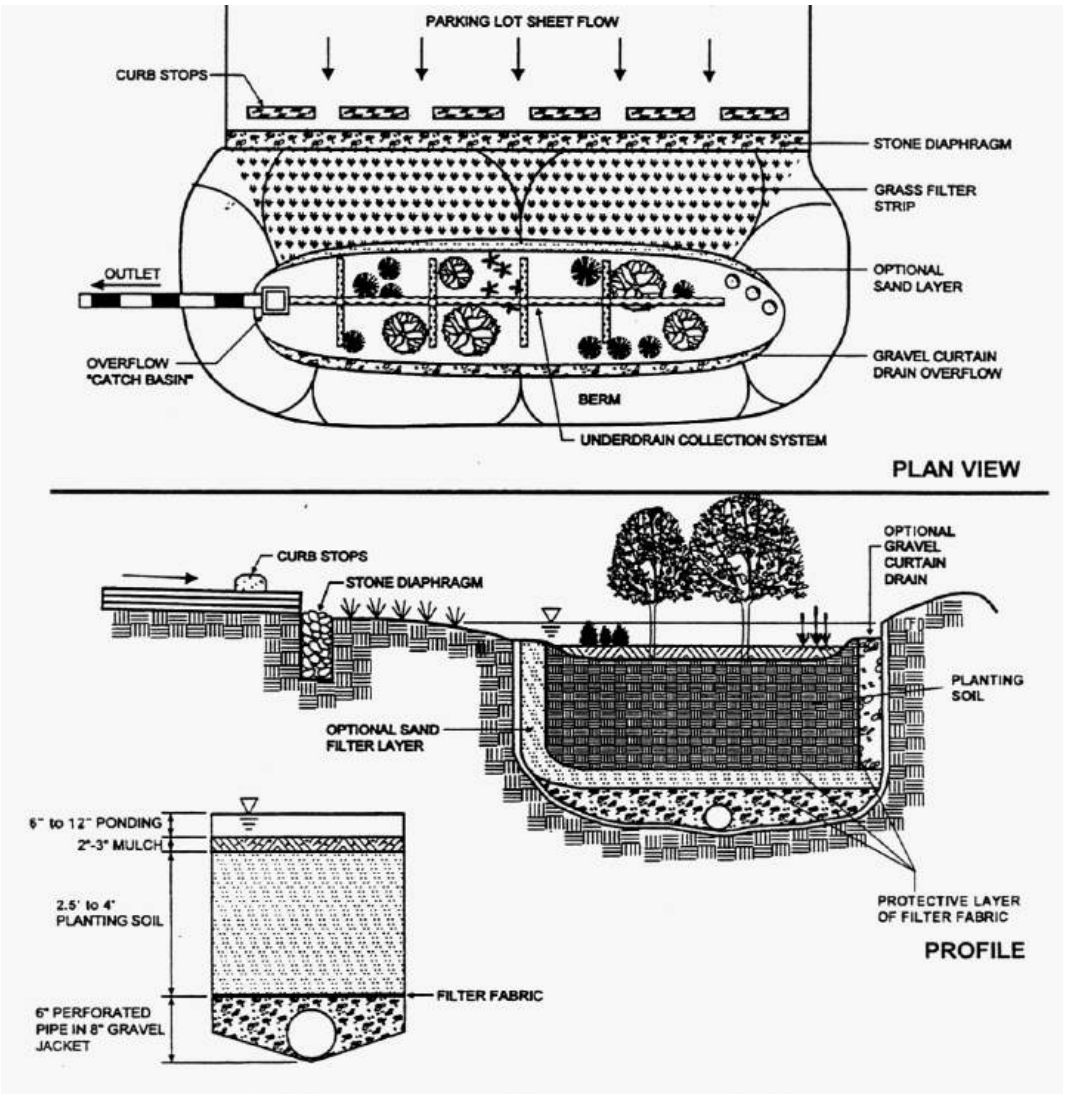


Figure A.1. Typical Bioretention Filter (MDE, 2000)

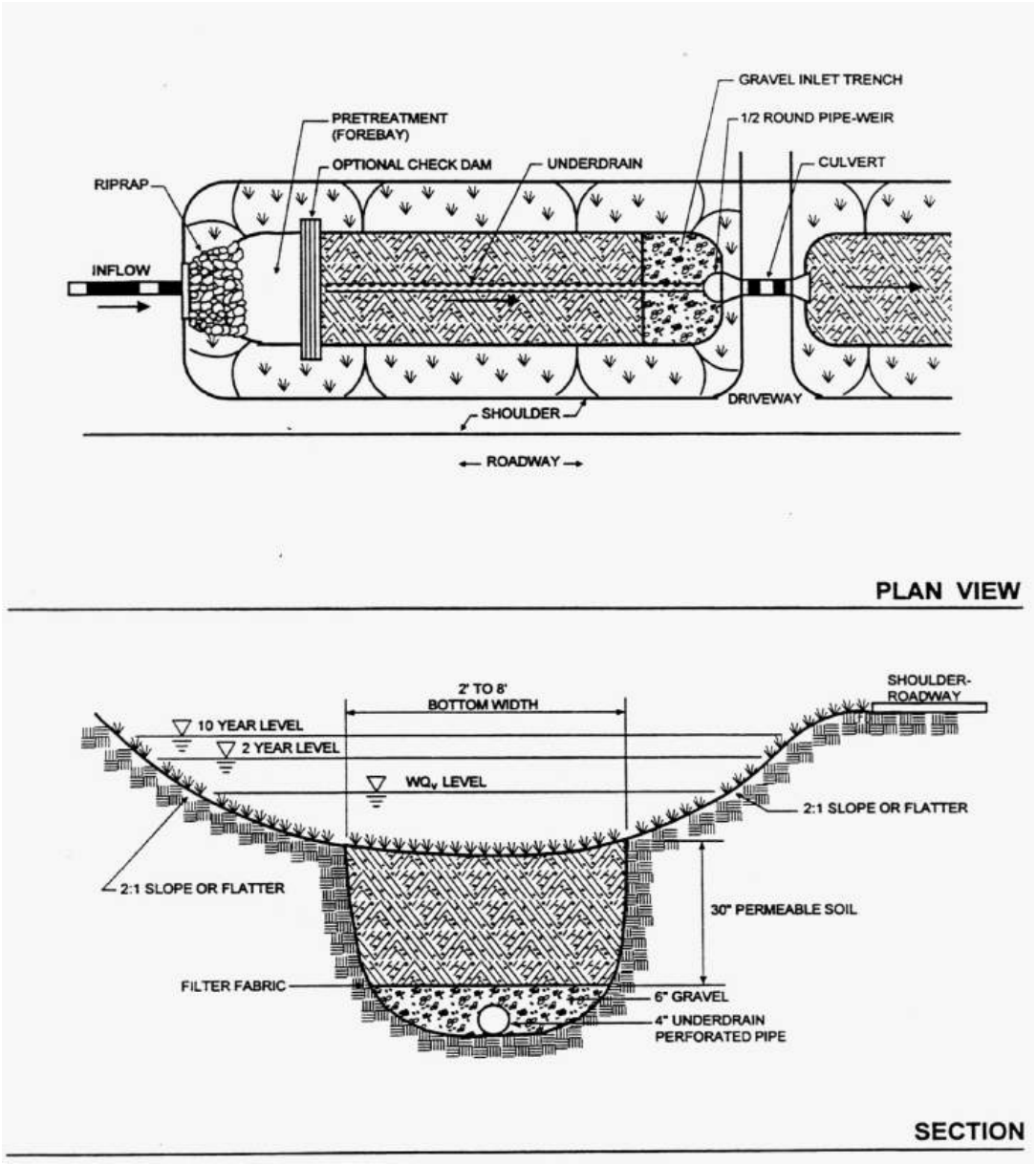


Figure A.2. Typical Dry Swale

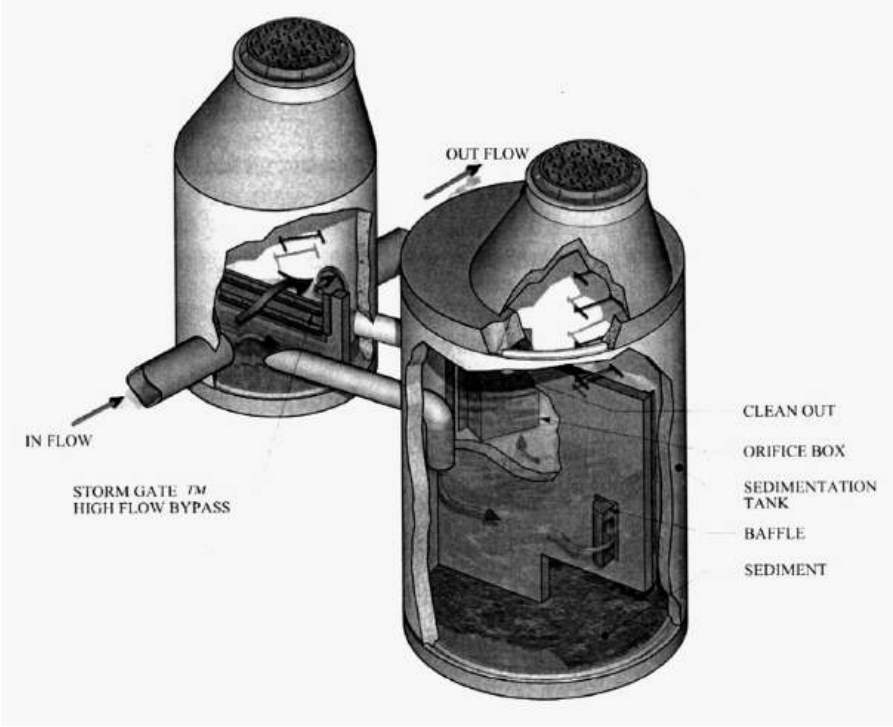


Figure A.3. Common Filter Trap Type System

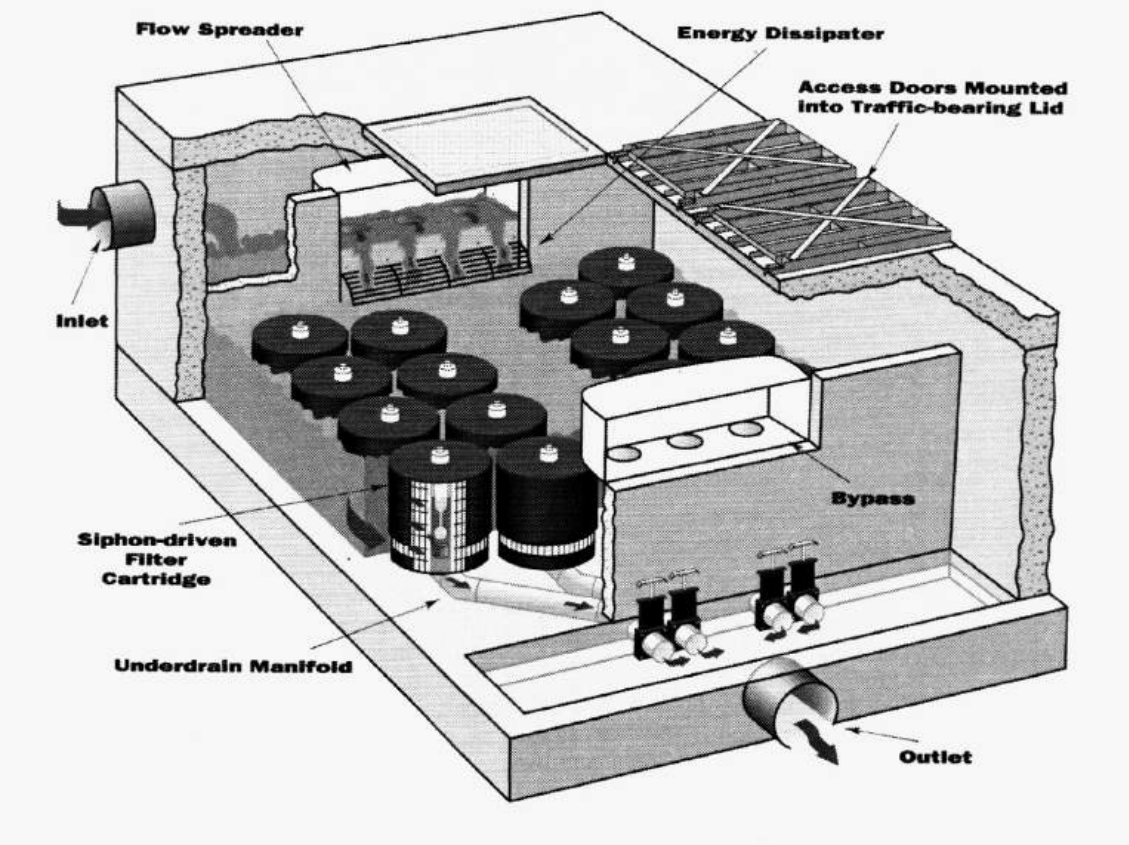


Figure A.4. Advance Storm Water Treatment System

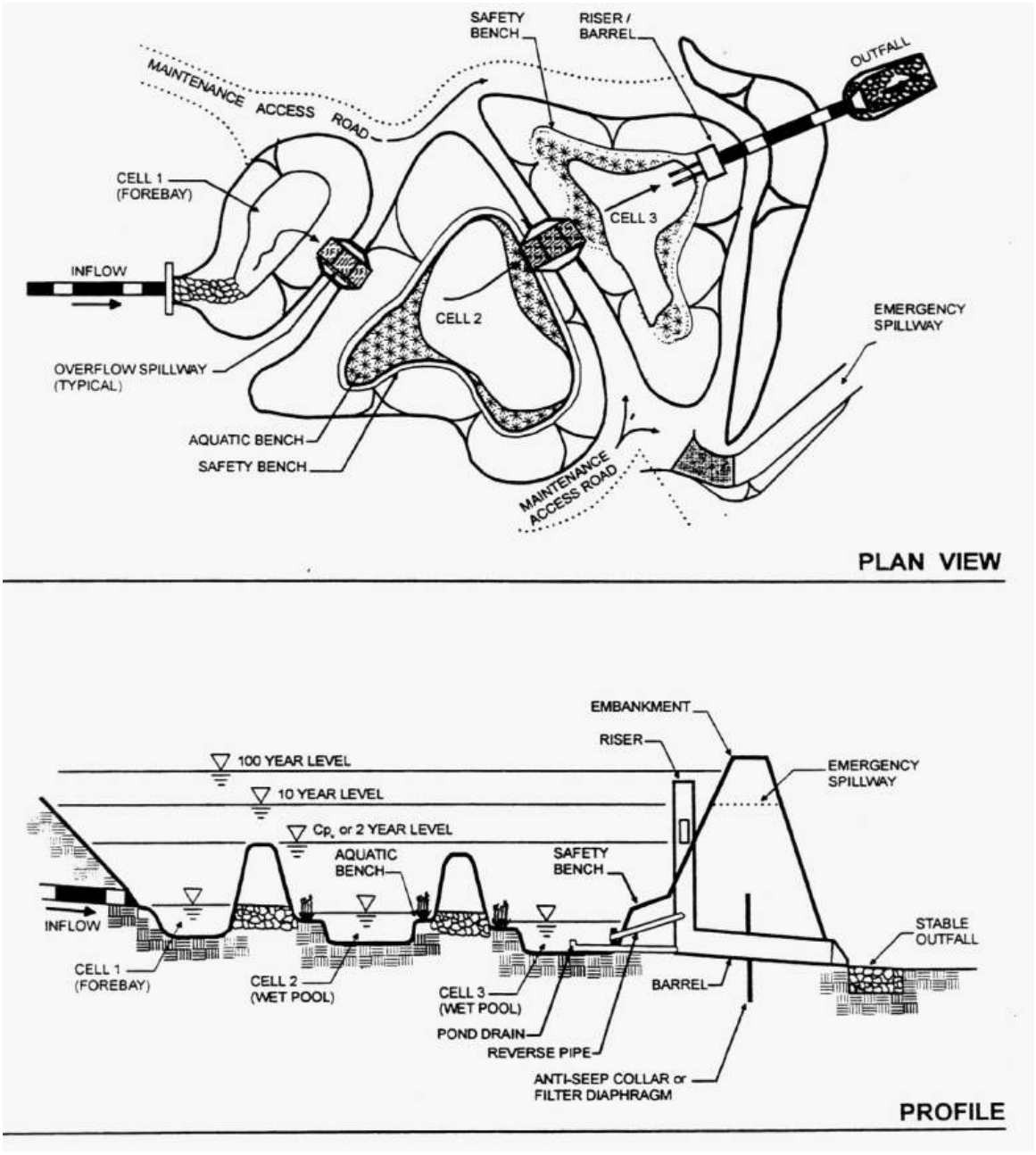


Figure A.5. Typical Multiple Pond Storm Water Wetland

Summary of Storm Water Treatment BMP Performance and Planning Information

Table A.1 presents a summary based on performance and planning information for the source control, filtration, and detention type treatment measures described in the previous sections.

Table A.1 Summary of Storm Water BMP Performance and Planning Information

	Runoff Reduction		Contaminant Reduction Capability						Comparative Cost		Maintenance & Longevity		Environmental/Community Benefits			
Management Practice	Peak Runoff	Volume Reduction	TSS	TPH	PAH	Metals	O&G	Nutrients	Capital Cost	O&M	Maintenance Requirements	Longevity (years)	Recreation	Natural/Open Space	Bay Access	Environmental Education
Source Controls																
Covering	NA	NA	M	H	H	M	H	NA	L	L	L	20+	NA	NA	NA	NA
Drainage Controls	M	L	M	M	M	M	M	M	L	L	L	20+	NA	NA	NA	NA
Alternative Roofing	NA	NA	L	NA	NA	H	NA	NA	L	L	L	15+	NA	NA	NA	NA
Permeable Pavement	H	M	M	M	M	M	M	M	M	M	M	5+	NA	NA	NA	M
Street Sweeping	NA	NA	H	L	L	M	L	L	M	L	M	NA	NA	NA	NA	NA
Revegetation	H	M	H	H	H	H	H	M	L	L	M	10+	NA	NA	NA	NA
Inline Controls																
Bioretention	H	M	H	H	H	H	H	M	L	L	M	20+	L	M	L	M
Vegetative Channels	M	L	M	M	M	L	M	L	L	L	M	20+	M	M	M	M
Sand Filters	M	L	H	H	H	M	H	L	H	H	H	15+	L	L	L	L
Filter Traps	L	L	L-M	L-M	L-M	L	M	L	M	M	M-H	20+	L	L	L	L
Stormwater Filters	L	L	H	H	H	H	H	M	H	M	M	20+	L	L	L	L
Infiltration	H	H	H	H	H	H	H	M	H	H	H	5+	L	L	L	L
Downstream Controls																
Dry Ponds	H	H	H	H	H	M	H	M	M	M	M	20+	M	M	H	M
Wet ponds	H	H	H	H	H	M	H	M	M-H	M	M	20+	M	M	H	M
Constructed Wetlands	H	H	H	H	H	H	H	M	M-H	M	M	20+	H	H	H	H

Rating Criteria: L = Low; M = Moderate; H = High; NA = Not Applicable

A.2. Site Design Performance Standards

Adopting site design performance standards provides the opportunity for economically viable, yet environmentally sensitive development. In general, proper site design reduces the amount of impervious cover and reduces the amount of storm water runoff generated at a site. Therefore, reductions in impervious cover result in smaller required storage volumes and, consequently, lower BMP construction costs. Economic benefits can be derived directly by the developer from the reduced construction costs associated with narrower roads, smaller parking areas, use of landscaped based treatment BMPs, and other alternative development strategies designed to minimize impervious cover. In summary, the documented benefits of site design performance standards include (CWP, 1998):

- Minimize the generation of storm water runoff
- Reduced soil erosion during construction
- Reduced development construction costs
- More pedestrian friendly areas and more space for recreation
- Protection and enhancement of creek and lagoon habitat
- A more aesthetically pleasing and naturally attractive landscape
- More sensible locations for storm water facilities
- Easier compliance with stream and wetland and other resource protection regulations
- Neighborhood designs that provide a sense of community
- Urban wildlife habitat through natural area preservation

The County of Santa Cruz can seek opportunities for open space development that incorporate site design strategies to minimize total impervious cover, reduce the total construction costs, preserve and/or enhance natural areas, provide community open space, and promote watershed protection. These strategies are consistent with the County's long-term land use plans for the Live Oak area.

The following are examples of site design performance standards that can be applied to new development sites in the watershed to minimize the generation of storm water.

1. Site designs should minimize the generation of storm water and maximize pervious area for storm water treatment. Several municipal agencies have established impervious surface reduction rules for new and redevelopment projects. For example, the City of Santa Monica requires that any new or redevelopment project must reduce the amount of existing impervious cover by 20 percent. Similarly, in the City of Olympia, the reduction requirement for new and redevelopment projects are 15 percent.

2. Site designers can attempt to minimize the creation of impervious cover in new and redeveloped sites by:

    - Specifying narrow road sections

- Smaller turnarounds and cul-de-sac radii
- Permeable spill-over parking areas
- Smaller parking demand ratios
- Smaller parking stalls
- Angled one way parking
- Preservation or increased landscaped areas
- Shared parking and driveways
- Narrow sidewalks

3. New streets and driveways can be designed for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access. These widths should be based on traffic volume and other issues as well.

4. Wherever possible, street right-of-away widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains can be located within the pavement section of the right-of-way, wherever feasible.

5. Where topography, soils, and slope permit, vegetated open channels can be used in the street right-of-way to convey and treat storm water runoff.

6. Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.

7. Reducing overall lot imperviousness can be accomplished by using alternative driveway surfaces and shared driveways that connect two or more lots together.

8. Wherever possible, storm water treatment for parking lot runoff can be achieved using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaped areas and traffic islands.

9. Rooftop runoff can be rerouted to pervious areas such as landscaped areas and avoid routing rooftop runoff to the roadway and the storm water conveyance system.

10. Storm water discharges from land uses or activities with higher potential for pollutant loadings (fueling facility, etc.) may require the use of specific structural BMPs and pollution prevention practices. In addition, storm water from these areas should not be infiltrated without proper pretreatment.

A.3. Performance Standards for Storm Water Management and Treatment BMPs

Performance standards for storm water management and treatment BMPs have been recently established and adopted in different regions of the State for new and redevelopment projects. The overall goal of these standards is to reduce pollutant discharges and changes in runoff flows where they can cause damage to downstream

water bodies to the maximum extent practicable. The standards are established to prevent exceedance of receiving water quality standards over the life of the project, through implementation of control measures. The following are example standards that reflect an approach to address provisions of the Phase II Municipal Storm Water Permit to be issued by the California Regional Water Quality Control Board in the near future.

1. All new or redeveloped projects, that create one acre (43,560 square feet) or more of impervious cover, including roof area, streets, parking, driveways, material storage areas and sidewalks, are required to install treatment Best Management Practices (BMPs). The treatment BMPs should be sized according to either a volume hydraulic design basis or a flow hydraulic design basis, as follows:

   a. Volume Hydraulic Design Basis

   Treatment BMPs whose primary mode of action depends on volume capacity, such as detention/retention units or infiltration structures, should be designed to treat storm water runoff equal to:

   - The maximized storm water quality capture volume for the area, based on historical rainfall records, determined using the formula and volume capture coefficients set forth in *Urban Runoff Quality Management*, *WEF Manual of Practice No. 23/ ASCE Manual of Practice No. 87,* (1998), pages 175-178 (e.g., 85 (%) percent of the average annual 24-hour rainfall event, equivalent to approximately 1 inch of precipitation (in the Live Oak area); or

   - The volume of annual runoff required to achieve 80 percent or more capture determined in accordance with the methodology set forth in Appendix D of the *California Stormwater Best Management Practices Handbook*, (2003), using local rainfall data.

   b. Flow Hydraulic Design Basis

   Treatment BMPs whose primary mode of action depends on flow capacity, such as swales, sand filters, or wetlands, should be sized to treat:

   - 10 (%) percent of the 50-year design flow rate, or

   - the flow of runoff produced by a rain event equal to at least two times the 85^{th} percentile hourly rainfall intensity for the applicable area, based on historical records of hourly rainfall depths; or
   - the flow of runoff resulting from a rain event equal to at least 0.2 inches per hour intensity.

2. To be considered an effective BMP for stand alone treatment of the water quality volume or flow conditions, a design should be capable of:

- Capturing and treating the required water quality volume or flow;
- Removing 80% of the TSS; and
- Having an acceptable longevity rate in the field (15 to 25 years).

3. A storm water management system should be designed to not adversely affect existing storm water conveyance capabilities. It is presumed that a system meets this criteria if one of the following are met:

    - The existing hydraulic conveyance is maintained; and
    - The applicant demonstrates that the storm water BMP will reduce the peak discharge to less than pre-project levels.

4. New or redeveloped projects should not discharge untreated storm water directly to a jurisdictional wetland or local water body without adequate treatment.

5. All storm water BMPs should be designed in a manner to minimize the need for maintenance, and reduce the chances of failure.

6. Storm water BMPs should be designed to accommodate maintenance equipment access and to facilitate regular operational maintenance (such as underdrain replacement, unclogging filters, sediment removal, mowing and vegetation control). Operational maintenance and operation easements shall be provided when necessary to facilitate equipment access.

7. In order to protect groundwater from pollutants that may be present in storm water runoff, the following conditions should be satisfied if infiltration treatment measures (such as infiltration trenches and infiltration basins) are considered as a treatment BMP:

    a. Pollution prevention and source control BMPs should be implemented at a level appropriate to protect groundwater quality at sites where infiltration devices are to be used.
    b. Use of infiltration devices should not cause or contribute to an exceedance of groundwater water quality objectives.
    c. The vertical distance from the base of any infiltration device to the seasonal high groundwater mark should be at least 10 feet.
    d. Unless storm water is first pretreated, infiltration devices are not be recommended for areas of industrial or light industrial activity; areas subject to high vehicular traffic; automotive repair shops; fleet storage areas (bus, truck, etc.); and other high threat to water quality land uses and activities.

A.4. Technical Resources

The following list provides information on readily available technical resources that can be consulted for the selection and design of source control, appropriate site design and treatment BMPs. The information provided pertains to technical literature and professional organizations, but does not include information for equipment manufacturers.

Site Planning and Design

1. *Start at the Source: Design Guidance Manual for Stormwater Quality Protection*. 1999. Bay Area Stormwater Management Agencies Association (BASMAA)
2. *Better Site Design: A Handbook for Changing Development Rules in Your Community*. 1998. Center for Watershed Protection (CWP)
3. *Site Planning for Urban Stream Protection*. 1995. CWP

Best Management Practice Performance

1. *Guide for Best Management Practice (BMP) Selection in Urban Developed Areas*. 2001. ASCE
2. *National Stormwater Best Management Practices (BMP) Database*. 1999. American Society of Civil Engineers (ASCE)
3. *National Pollutant Removal Performance Database for Stormwater Treatment Practices, 2nd Edition*. 2000. U.S. Environmental Protection Agency and CWP
4. *The Practice of Watershed Protection*: *Techniques for protection our nation's streams, lakes, rivers and estuaries*. 2000. CWP

Storm Water Treatment Design

1. *California Storm Water Best Management Practice Handbooks, Volumes 1 – 3, Municipal, Commercial/Industrial, and Construction BMP Handbooks*. 2003. Storm Water Quality Task Force
2. *Guidance Manual for On-Site Stormwater Quality Control Measures*. 2000. Sacramento Stormwater Management Program, City of Sacramento Department of Utilities, County of Sacramento Water Resources Division
3. *Design and Construction of Urban Stormwater Management Systems*. 1992. ASCE Manuals and Reports of Engineering Practice No. 77, Water Environment Federation (WEF) Manual of Practice FD-20
4. *Design of Stormwater Wetland Systems*: *Guidelines for Creative Diverse and Effective Stormwater Wetland Systems in the Mid-Atlantic Region*. 1992. Metropolitan Washington Council of Governments
5. *Stormwater Design Manual, Volumes I &II*. 2000. State of Maryland, Maryland Department of the Environment
6. *Surface Water Design Manual*. 1998. King County, Washington
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Appendix E

2010 Draft Moran Lake Monarch Butterfly Habitat Management Plan

DRAFT

MORAN LAKE

MONARCH BUTTERFLY HABITAT MANAGEMENT PLAN

August 9, 2010



Prepared for:
The Santa Cruz County Parks, Open Space & Cultural Services

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report integrates previous habitat reports and studies of the monarch butterfly wintering habitats at Moran Lake in Santa Cruz County, California. The primary objective of this report is to approach the restoration and preservation of the wintering habitats under one integrated management plan for the County of Santa Cruz Parks, Open Space & Cultural Services (County Parks Department). The previous reports incorporated here include:

- Management Plan for the Monarch Habitat at Moran County Lake Park (November 2004, Joni L. Janecki & Associates)
- Management Plan for the Monarch Habitat at the D. A. Porath Sanitation Facility of the Santa Cruz County Sanitation District (February 2006, Joni L. Janecki & Associates, Inc.)

And portions of the:

- Moran Lake Water Quality Study & Conceptual Restoration Plan prepared for the Santa Cruz County Redevelopment Agency (February 2005, John Gilchrist & Associates and Fall Creek Engineering).

A Memorandum of Understanding (MOU) between the Santa Cruz County Parks Department and the Santa Cruz County Sanitation District establishes that the County Parks Department will manage the preservation and restoration of the overwintering habitats surrounding Moran Lake, including Moran Lake County Park and the Sanitation District's D. A. Porath Sanitation Facility. Accordingly, this report includes an overview of the existing conditions impacting the butterfly habitat, recommendations for short and long-term actions necessary to preserve, restore and enhance the habitat, recommended actions for improving public safety, and recommendations for on-going periodic evaluations to assess tree health and potential hazards. Recommended actions to address other issues such as restoration of the lagoon and creek corridor at Moran Lake are incorporated as they address the overall health of the monarch butterfly wintering habitat. Finally, public access improvements are integrated as an element of the overall vision for County Parks Department's implementation of this management plan.

The following page summarizes the General Recommendations and Specific Recommendations that, when implemented, will afford the County and community an opportunity to stabilize, rehabilitate and preserve this unique monarch butterfly habitat.

EXECUTIVE SUMMARY

SUMMARY OF GENERAL RECOMMENDATIONS

1. Approach the preservation and management of the Moran Lake wintering habitat as a whole, including the private properties surrounding publicly owned properties. In addition to the direct habitat care of the trees and nectar understory, the dynamic relationship of the lagoon, riparian corridor, ocean and developed lands should be integrated into habitat management efforts.

2. Establish guidelines for monitoring the status of the monarch butterflies.

3. Stabilize and protect the existing trees, groves and windscreens by:

    - Elective pruning and trimming of the trees to maintain public safety and the integrity and biological functionality of the groves
    - Selective tree removal
    - Management of the understory vegetation
    - Improve drainage and eliminate ponding of water around tree roots
    - Planting new habitat-specific trees

4. Manage non-native plants that provide nectar, remove invasive non-native plants, and restore with wetland and upland species in select locations.

5. Incorporate interpretive signage to educate the public about the dynamic ecosystems, habitats, and species of the Moran Lake area.

6. Manage storm water runoff to protect the water quality of Moran Lake riparian corridor and Monterey Bay National Marine Sanctuary.

7. Develop public education and community volunteer effort to foster long term stewardship and restoration of the Moran Lake area.

SUMMARY OF SPECIFIC RECOMMENDATIONS

A diagrammatic Habitat Management & Park Improvement map of the Moran Lake Wintering Habitat illustrates where specific recommendations are to be implemented (Figure 38).

The recommendations numbered on the plan correspond to actions to be taken at the specific areas including park improvements, windrows, nectar source vegetation, and roosting areas. Diagrammatic photos with planting recommendations are provided as well as storm water management improvements and bank stabilization at the lake margins. Finally, the plan includes park upgrades such as:

- Improved access
- Trail stabilization and boardwalk installation
- Interpretive signage
- New ADA-compliant restroom
- ADA-compliant picnic areas and overlooks
- Reconfigured parking areas
- New plantings to enhance the monarch butterfly wintering habitat and improve drainage areas

Integrating improvements to the park and overall habitat enhancement into this management plan strengthens the awareness of the connection between human activities and monarch butterfly wintering habitat of the Moran Lake area.

1.1 SCOPE OF THIS STUDY

PURPOSE:

This plan is intended to serve as a tool to guide park managers in balancing the often-conflicting goals of public safety and management of park lands with the habitat needs of the wintering monarch butterflies (*Danaus plexippus*). In addition, this plan provides background information and guidance for the restoration and enhancement of the traditional lakeside roost areas within the park and Sanitation Department's lands.

This plan comes at a critical time for maintaining a viable wintering habitat for the monarch butterfly at Moran Lake. Over the past twenty years much of the traditional monarch butterfly wintering habitat at Moran Lake has been significantly impacted due to several factors including: tree loss due to natural causes, permitted and non-permitted tree removal, improper tree maintenance and tree loss due to poor drainage. These factors, combined with the absence of a cooperative management plan that coordinates the activities of county agencies and local property owners, place the monarch butterfly wintering habitat at Moran Lake in jeopardy.

The monarch butterfly is not bound by property lines or jurisdictional boundaries and relies on the entire habitat area for its winter survival. Individual trees, windscreens and understory vegetation play critical roles in maintaining the suitability of an area to support monarch butterfly wintering populations. Ultimately, preservation and restoration of Moran Lake and its associated riparian corridor are dependent upon the development and implementation of a comprehensive master plan for the county park, creek corridor and the Santa Cruz Sanitation Facility habitat as a whole.

State and local regulations are in place to provide protection of the monarch butterfly and its wintering habitats. Frequently, property owners are unclear regarding the regulatory framework that their property is bound by. At the state level, the California Environmental Quality Act (CEQA), the Public Resources Code, and the Fish & Game Code all consider wintering habitats for the monarch butterfly as "sensitive habitat." Locally, the Santa Cruz County General Plan and the Local Coastal Plan (LCP) policies apply as well. Public awareness and enforcement of these regulations is essential to maintaining the wintering habitat.

PROCESS:

The MOU between the Santa Cruz County Parks Department and the Santa Cruz County Sanitation District was adopted by the Santa Cruz County Board of Supervisors in March 2006. The Santa Cruz County Parks Department retained Joni L. Janecki & Associates, Inc. to combine the management reports into one document with input from agency stake holders and incorporate the needed public access improvements within Moran Lake County Park.

A workshop was held with multiple stakeholder agencies including: Santa Cruz County Parks Department, the Santa Cruz County Sanitation District, the California Coastal Commission, Santa Cruz County Redevelopment Agency, Santa Cruz County Planning Department, Santa Cruz County Public Works, and California Department of Fish and Game in order to gain consensus on the approach and scope of the project. Decisions reached in the workshop helped to guide the recommendations described in this report. A draft outline was prepared and submitted to the Santa Cruz County Parks Department for review.

A final draft report will be prepared and presented at a County Board of Supervisors public hearing. Upon Board approval of the final draft, the report will be submitted with the permit packages for the park improvement projects for review to ensure compliance with CEQA (California Environmental Quality Act), County Development, and the Coastal Development Permit processes. Implementation of habitat and park improvements can then follow.

1.2 SETTING & SITE OVERVIEW

OVERVIEW OF MORAN LAKE WINTERING HABITAT AREA

The Moran Lake watershed encompasses approximately 620 acres. The watershed extends southward from Soquel Drive in the north to Monterey Bay National Marine Sanctuary in the south and is bounded by Twenty-sixth and Thirtieth Avenues in the west and by Forty-first Avenue in the east. Over the past four decades the watershed has undergone extensive development and urbanization which has led to a significant increase in impervious surface area which has created serious runoff, erosion and pollution problems for Moran Lake. Erosion is present in several locations along the lakeshore and creek, and in some cases has contributed to tree loss.

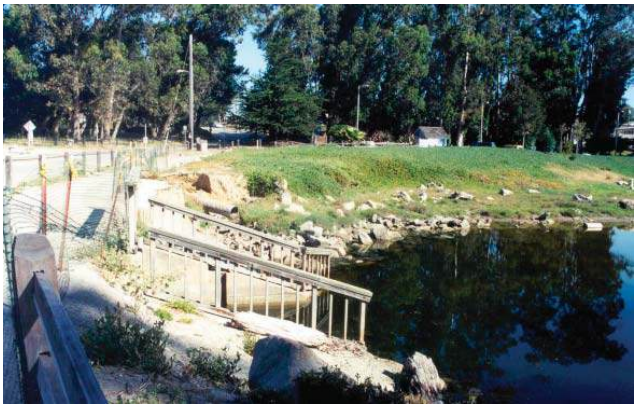
The name Moran Lake was probably taken from a former landowner, Patrick Moran who owned the property in the late 1800's. The lake was originally a coastal lagoon and subjected to tidal saltwater flushing. Today the water body is connected to the ocean by a large concrete culvert (Figure 1).

The 1980 Environmental Baseline Study for the Moran Lake Enhancement Plan, prepared by Stern and Courter, reported that in the 1960's the lagoon was reduced in size by three (3) acres when fill from a harbor dredging and development project was deposited at the south end of the lake. At this time a new drainage culvert was installed about 5 feet above the mean high tide level which cut off the direct connection between the lagoon and the ocean. The harbor fill was comprised of a mix of soil types including clay, silt, sand, and crushed granite.

The land surrounding and including Moran Lake became the property of the Santa Cruz County Department of Parks and Recreation in March 1975 to create a nature park. This land purchase was made possible by funding from the Land and Water Conservation Fund, with matching funds from the County of Santa Cruz, and assistance from the State Coastal Conservancy (Stern and Courter, 1980). The park is approximately 9.2 acres and includes portions of a creek (extending north to Thirtieth Avenue), which provides year-round water flow.

In 1988, a paved parking lot and restrooms were added to improve public access to Moran Lake County Beach (Figure 2). Today, the park includes parking facilities, restrooms, picnic tables, trails, open space, and beach access. The park primarily serves as open space for local residents.

The Moran Lake wintering habitat area also consists of land owned by the Santa Cruz Sanitation Department known as the D. A. Porath Sanitation Facility. This facility is the site for all maintenance on the County sewer system and serves as the primary pumping station between the City of Santa Cruz treatment plant and the sewer system in the eastern portion of the county. The facility is bound on all sides by a blue-gum eucalyptus (*Eucalyptus globulus*) forest that serves as a monarch butterfly wintering site.



Outlet at East Cliff Drive (Figure 1)



Park Restroom and Parking Lot (Figure 2)

1.2 SETTING & SITE OVERVIEW

PUBLIC LANDS, NEIGHBORHOOD LANDS & WINTERING HABITAT AREA

The map below (Figure 3) shows property ownerships within the monarch butterfly wintering habitat area. Moran Lake County Park, together with the County Sanitation Facility at the end of Lode Street and a small parcel owned by the City of Santa Cruz, near 30th Avenue, form a series of publicly held parcels which encompass the majority of the Moran Lake wintering habitat. The remaining lands, including a portion of the upper Moran Lake riparian (creek) area and a portion of the monarch butterfly wintering habitat is private (residential) property.

The fact that a portion of the butterfly habitat is on private land adds complexity to the implementation of this management plan and implies required coordination and cooperation between the public agencies and private landowners. To avoid further impact on the monarch butterfly habitat within the park boundary all portions of the Moran Lake wintering habitat must be cohesively managed.



Project Area and Context (Figure 3)

1.3 MANAGEMENT ISSUES

The Moran Lake area presents a confluence of planning, environmental and land use issues. Land use pressures have impacted the hydrological function of Moran Lake as a coastal lagoon and likewise impacted the quality of the unique habitat required by the monarch butterfly. Public infrastructure, recreational open space, beach access, neighborhood connections, and private property concerns converge at the Moran Lake area.



Monarch Butterfly Roost Cluster (Figure 4)



Entering the Forest (Figure 5)



View of Moran Lake and Main Picnic Area (Figure 6)

1.3 MANAGEMENT ISSUES

HISTORICAL PATTERNS OF THE MONARCH BUTTERFLY WINTERING HABITAT AT MORAN LAKE

Monarch butterflies are present in the Moran Lake wintering habitat from October through February in most years, and small numbers have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as a full-term overwintering habitat.

In the past (1980s), monarchs typically began to congregate along the northwestern shore of Moran Lake during early October, and formed clusters in the North and South Lakeside roost areas. As the population increased during October, clusters also formed in the North and South Creekside roost areas and the lakeside butterflies gradually shifted north into the more sheltered creekside roost areas (Figure 9). Then around mid-November the population shifted its clusters into the Primary Roosting area where they remained until warming temperatures initiated the spring migration sometime in February.

The North Lakeside roost area usually supported clusters of roosting monarchs throughout the month of October, whereas the South Lakeside roost area typically supported clusters only intermittently during the fall. Thus the North Lakeside roost area historically functioned as an autumnal roost area and the South Lakeside roost area functioned as refuge/ bivouac habitat. Tree and limb loss in these habitats has since reduced wind protection and eliminated many of the lower roost limbs that once supported clusters. Currently both roost areas function as refuge/ bivouac habitats.

HABITAT SIGNIFICANCE AT MORAN LAKE

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The monarch butterfly wintering habitat at Moran Lake currently supports the second largest population of wintering monarchs in Santa Cruz County (20% of the county-wide wintering population), and a considerable portion of the state-wide wintering population (5%). Although two to three hundred wintering sites have been identified along the California coastline (from Mendocino County in the north to San Diego County in the south), relatively few of these sites currently support large populations throughout the wintering period. In addition, many of the sites have been destroyed since they were documented. Wintering populations of similar magnitude to Moran Lake occur at only about 25 other sites in California with approximately 5 located in the Monterey Bay region.



Central Coast Overwintering Habitats

1.3 MANAGEMENT ISSUES

CURRENT MONARCH BUTTERFLY WINTERING HABITAT UTILIZATION AT MORAN LAKE

Tree and limb losses in the North Creekside roost area have degraded this habitat over the past ten years resulting in less frequent occupation of the North Creekside roost area and a gradual shift of occupation to the South Creekside roost area. In March/April of 1999, residents on the property adjacent to the South Creekside roost area removed all the eucalyptus trees on their property along the east side of the creek and in that process eliminated all of the eastern windbreak/shade trees that sheltered the South Creekside roost area. During the winter preceding the tree removal (1998-99) the entire wintering population at Moran Lake (approximately 18,000 monarchs) occupied the South Creekside roost area from early October through most of November. During the winter of 1999-2000, no clusters were observed in the South Creekside roost area. Both North and South Creekside roost areas now function only intermittently as refuge/bivouac habitat.

The Primary Roosting area, despite several significant tree removal events, has consistently supported mid-winter monarch populations for at least the past twenty years. With the loss of suitable autumnal habitat in the Lakeside and Creekside roost areas, the Primary Roosting area has now begun to function additionally as autumnal roost habitat. The Primary Roosting area is the only consistently occupied roost area remaining in the Moran Lake monarch wintering habitat.

The grove of eucalyptus at the southeastern end of Moran Lake—the Southeastern Grove, which includes the Moran Way Windrow—in addition to providing critical wind protection for the lake area, functions intermittently as refuge/bivouac habitat and occasionally supports small clusters during periods when monarchs are migrating and winds are relatively calm.

Refer to Figure 9 for the following eight roost areas defined: (A) the Southeast Grove (which includes the Moran Way windrow); (B) the South Lakeside Roost Area; (C) the North Lakeside Roost Area; (D) the South Creekside Roost Area; (E) the North Creekside Roost Area; (F) the Primary Roosting Area (at the north end of the D. A. Porath Sanitation Facility); (G) the Wind Buffer and Field; and (H) the Critical Windbreak.



Existing Conditions North East of North Lakeside Roost Area (Figure 7)



Monarch Butterfly Clusters (Figure 8)

1.3 MANAGEMENT ISSUES



A Southeast Grove & Moran Way Windrow
B South Lakeside
C North Lakeside
D South Creekside
E North Creekside
F Primary Roosting Area
G Wind Buffer & Field
H Critical Windbreak

Monarch Butterfly Roost Areas at Moran Lake Habitat Area (Figure 9)

1.3 MANAGEMENT ISSUES

EUCALYPTUS GROVES & EXISTING VEGETATION

The dominant vegetation of the Moran Lake wintering habitat area is blue-gum eucalyptus (*Eucalyptus globulus*). Most of the blue-gum eucalyptus trees that line Moran Lake today were probably planted as windbreak trees around the turn of the previous century (late 1800's or early 1900's) (Figure 10). The trees were well established by 1929 (based on aerial photos) and were likely planted by the owner of two adjacent wood lots to the north of the lake. The remains of one of these woodlots now surround the Sanitation District's D. A. Porath Sanitation Facility (Figure 11). Such woodlots provided important sources of firewood during the era before petroleum technologies became widespread (around 1920), and thus reduced the need for people to cut down what little remained of accessible native trees.

As petroleum technologies replaced the need for firewood, most of the eucalyptus woodlot enterprises in California became unprofitable and were abandoned. Today the abandoned woodlots and windbreaks provide habitat for wintering monarch butterflies, as well as many native birds and other organisms, that require forest solitude within the increasingly urbanized coastal communities. The tall, densely planted trees that line Moran Lake and the D. A. Porath Sanitation Facility provide essential wind protection which—coupled with proximity to the ocean and other factors—meets the basic habitat requirements for wintering monarchs.



Moran Lake County Park from East Cliff Drive (Figure 10)

WHERE DID THE MONARCH BUTTERFLY ROOST BEFORE THE EUCALYPTUS?

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Prior to urban growth, the coastal canyons and foothills provided woodland canopy and protection for the monarch butterfly. As areas have developed and the Eucalyptus forests have established, the monarch butterfly migrated from the developed areas to the Eucalyptus forest.



D. A. Porath Sanitation Facility Entrance from Lode Street (Figure 11)

1.3 MANAGEMENT ISSUES

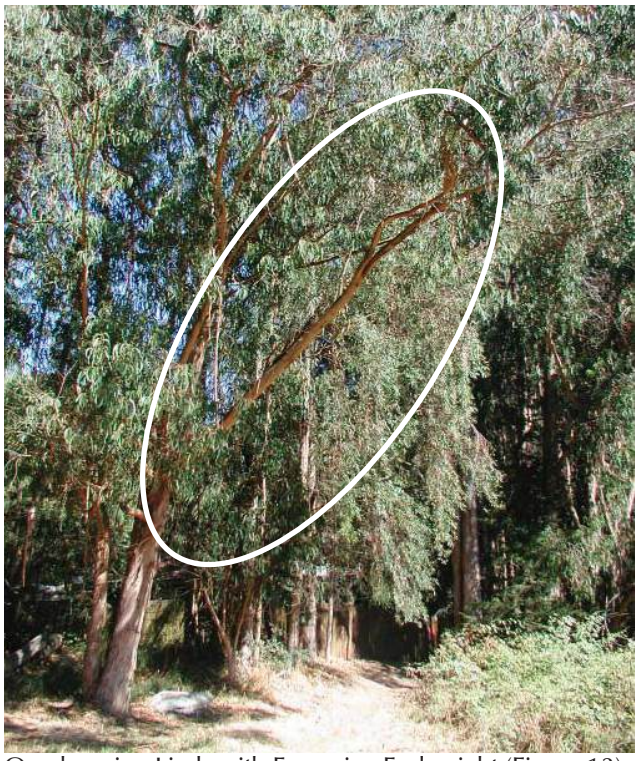
Although the eucalyptus trees in the Moran Lake wintering habitat are in reasonably good health, crowding has created structural problems within the groves. Crowding increases competition for sunlight, water and mineral nutrients among the trees, and also leads to a condition of interdependence, wherein each tree provides (among other things) wind protection for its neighbors. Thus, although thinning a grove may reduce competition among the trees, it also increases vulnerability to wind damage. In addition, many of the trees surrounding the D. A. Porath Sanitation Facility, and a few among the lakeside windbreaks, have coppice sprouted (stump-sprouted) from previous cuts (Figure 12). Trees resulting from coppice sprouting tend to have weaker root systems and exhibit a greater tendency for structural failure from wind.

Competition for light among the densely planted eucalyptus has, in some cases, also resulted in abnormal lengthening of branches (Figure 13). Such branches tend to develop excessive end-weight problems that increase the likelihood of branch failure. Branch failure and tree failure are normal processes in natural forest settings, however, in the setting of an urban park, such failures are also important concerns for human safety.

Trees blown down by wind (wind-throw) along the margin of the lake during the winter of 1997-98, and subsequent tree removals, significantly reduced wind protection for the autumnal roost habitat at the north end of the lake. A mixture of redwood (*Sequoia sempervirens*) and flooded-gum eucalyptus (*Eucalyptus rudis*) was planted as partial mitigation for tree losses in the area adjacent to the autumnal habitat and are now beginning to show good growth rates. However, since this planting, the flooded-gums have become infested by aphid-like insects known as red-gum lerp psyllids (*Glycaspis brimblecombei*) which are reducing the vigor of the trees. Biocontrol agents (tiny host-specific wasps) are presently being reared and released in several locations in the state and may eventually control the state-wide lerp psyllid problem. Blue-gum eucalyptus are not susceptible to the lerp psyllids and although the flooded gum trees had shown positive growth, this particular species is not recommended for re-use.



Coppice Sprouted Tree (Figure 12)



Overhanging Limb with Excessive Endweight (Figure 13)

1.3 MANAGEMENT ISSUES

Mixed among the eucalyptus at Moran Lake are native and non-native trees, shrubs, grasses and herbs including:

- Redwood (*Sequoia sempervirens*)
- Monterey cypress (*Cupressus macrocarpa*)
- Coast live oak (*Quercus agrifolia*)
- Poison oak (*Toxicodendron diversilobum*)
- French broom (*Genista monspressulana*)
- English ivy (*Hedera helix*)
- Cape ivy (*Dalairia odorata*)

English ivy flowers attract monarchs in the fall and provide essential nectar which the monarchs utilize to build-up fat (energy) reserves for the winter. Cape ivy blooms in midwinter (December-February) and is an important source of nectar for monarchs who run low on fat reserves before the spring migration phase. Both English ivy and cape ivy are considered nuisance species because of their propensity to spread through the understory in the semi-shaded confines of tree groves (Figure 14); however, because of their important roles as nectar species for wintering monarchs, their presence in this instance should be tolerated and managed unless it is causing an eminent threat to the life of a tree.



Cape Ivy Growing in the Canopy (Figure 14)



Monterey Cypress (Figure 15)



Himalayan Blackberry (Figure 16)



English Ivy (Figure 17)



French Broom (Figure 18)

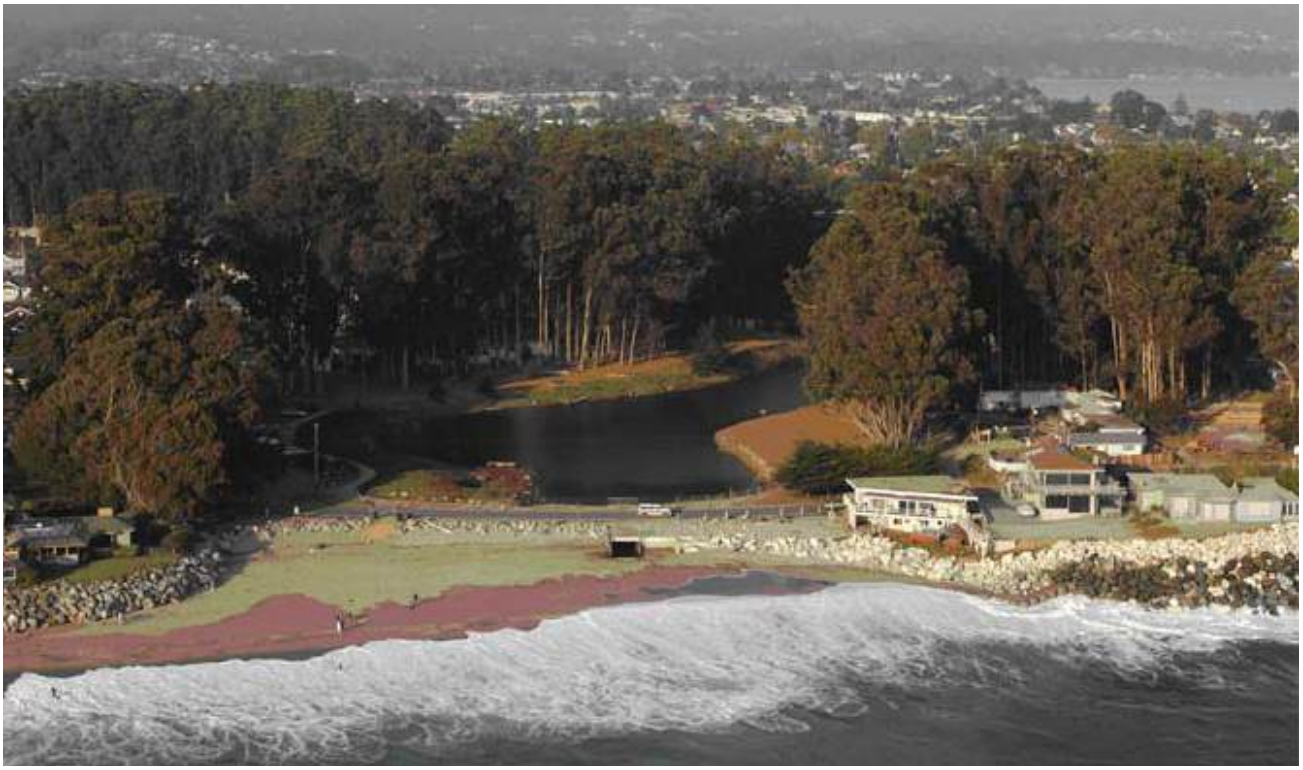
1.3 MANAGEMENT ISSUES

HYDROLOGY

Moran Lake is a coastal lagoon. In general terms a coastal lagoon is a body of brackish, marine or hypersaline water impounded by a sandy barrier and having an inlet connecting with the open ocean. Precipitation in the coastal watershed occurs almost entirely as rainfall. Precipitation rates on the coast range from 24-28 inches per year with approximately 80 percent of precipitation occurring between November and March (Hickey, 1968).

DRAINAGE PATTERNS

Between 1961 and 1963, dredge material removed from Wood's Lagoon for the development of the Santa Cruz Yacht Harbor was deposited in Moran Lake, effectively reducing the surface water area of the lake by three acres. Another significant change in the Moran Lake watershed was the transformation from open grassland and forested coastal terrace, to a rural farming community, and then into high density residential and commercial-industrial land uses. The result of these land use changes greatly increased the impervious surface area in the watershed, altering the hydrologic response, timing, volume, and quality of stormwater entering Moran Lake (John Gilchrist & Associates and Fall Creek Engineering, 2005). The hydrologic response of surface waters in the Moran Lake watershed has been modified as a result of development and land use changes in the area. Historical fill practices have significantly reduced the volume and depth of the lagoon, which has affected the lagoon's ability to assimilate or dilute pollutants entering the lagoon during winter runoff events. Increased development has also increased the impervious surface area which has decreased infiltration capacity and increased the volume of water entering Moran Lake, and its principal tributary Moran Creek. The decreased infiltration capacity has also increased the rate at which water moves through the watershed and enters these water bodies immediately after rainfall events. Impervious surfacing also decreases groundwater storage in the watershed, decreasing natural discharge to water bodies during dry months. Moran Creek and its smaller tributary channels have also been channelized, buried, or the riparian corridor reduced, causing impacts to the watershed hydrology (John Gilchrist & Associates and Fall Creek Engineering, 2005).



Moran Lake Outlet (September 2002) Photo: California Coastal Commission (Figure 19)

1.3 MANAGEMENT ISSUES

During the period when the spoils from the Santa Cruz Yacht Harbor were deposited in the Moran Lake area, a 7-foot diameter culvert was installed at the lake outlet, approximately five feet above the mean high tide level, blocking the lagoon inlet and transforming the coastal lagoon into an inland lake. In 1981 the 7-foot diameter culvert was replaced with the existing box culvert beneath East Cliff Drive. The bottom of the box culvert was set at one foot below mean sea level (Figure 20). In a natural lagoon system the inlet is in a state of dynamic equilibrium, meaning that the inlet configuration (location, cross-sectional area and depth) responds primarily to seasonal variations in the water flow, water levels, littoral drift, and wave action. The culvert and roadbed have "stabilized" the lagoon inlet preventing the natural migration of the inlet channel in response to wave and storm events. Maintaining a stable inlet is also important to protect public infrastructure and private properties surrounding the lagoon from flooding (Figure 21). This engineered structure reduces circulation and tidal flushing of the lagoon resulting in degraded water quality and aquatic habitat conditions (John Gilchrist & Associates and Fall Creek Engineering, 2005) (Figure 22).



Eroding Bank on Eastern Shore of Moran Lake (Figure 21)



Box Culvert at Moran Lake Beach (Photo: FCE) (Figure 20)



Moran Creek (Figure 22)

1.3 MANAGEMENT ISSUES

In 1953 the Santa Cruz County Sanitation Department constructed the D. A. Porath Sanitation Facility at the end of Lode Street (near the north end of Moran Lake). As part of this development, a sewer line was installed along the western margin of the lake. Installation of this sewer line modified drainage patterns along the western lake margin by creating berms and swales that restrict runoff flowing toward the lake. This modification has resulted in saturated soils and water ponding around the root systems of some of the blue-gum eucalyptus trees along the western margin of the lake (Figure 23).

Although blue-gum eucalyptus are somewhat tolerant of saturated soil conditions, the excessive water build-up has in some cases led to a weakening of the soil structure and subsequent loss of trees from wind-throw due to soil and root failure (Figure 24). The problem is compounded by the interdependency of wind protection among the densely planted trees, since with each tree lost, the remaining trees become less protected from wind. Altering this pattern of tree loss is of paramount importance both for public safety reasons and for preservation of the monarch butterfly wintering habitat.



Existing Drainage Channel at D. A. Porath Sanitation Facility (Figure 23)

The primary land use within the watershed is residential. Development in the past forty (40) years has resulted in a dramatic increase in impervious surface area, thereby increasing the amount of urban runoff and non-point source pollution (Figure 25). Visible signs of erosion are present throughout the park. Much of the stream bank above the lake is steep sided with erosion rills and signs of sediment loss.



Saturated Area Causing Tree Failure (Figure 24)



Runoff from Warren Street Towards Park (Figure 25)

1.3 MANAGEMENT ISSUES

PUBLIC PARK USE

Currently, the Moran Lake County Park facilities include parking, a restroom, beach access, nature trail, and wildlife viewing (Figures 26-28). To ensure success of a habitat management plan in a highly urbanized park, human interface and competing land uses need to be integrated as part of the plan.

Residents of the surrounding neighborhoods are the biggest user groups of the Moran Lake County Park. The park provides neighborhood connections to and from the beach while staying off the busy East Cliff corridor. The parking and picnic facilities are used by residents and visitors from Santa Cruz County and beyond. School groups utilize the park facilities as a locale to teach about the monarch butterfly migration and other issues surrounding the coastal lagoon.

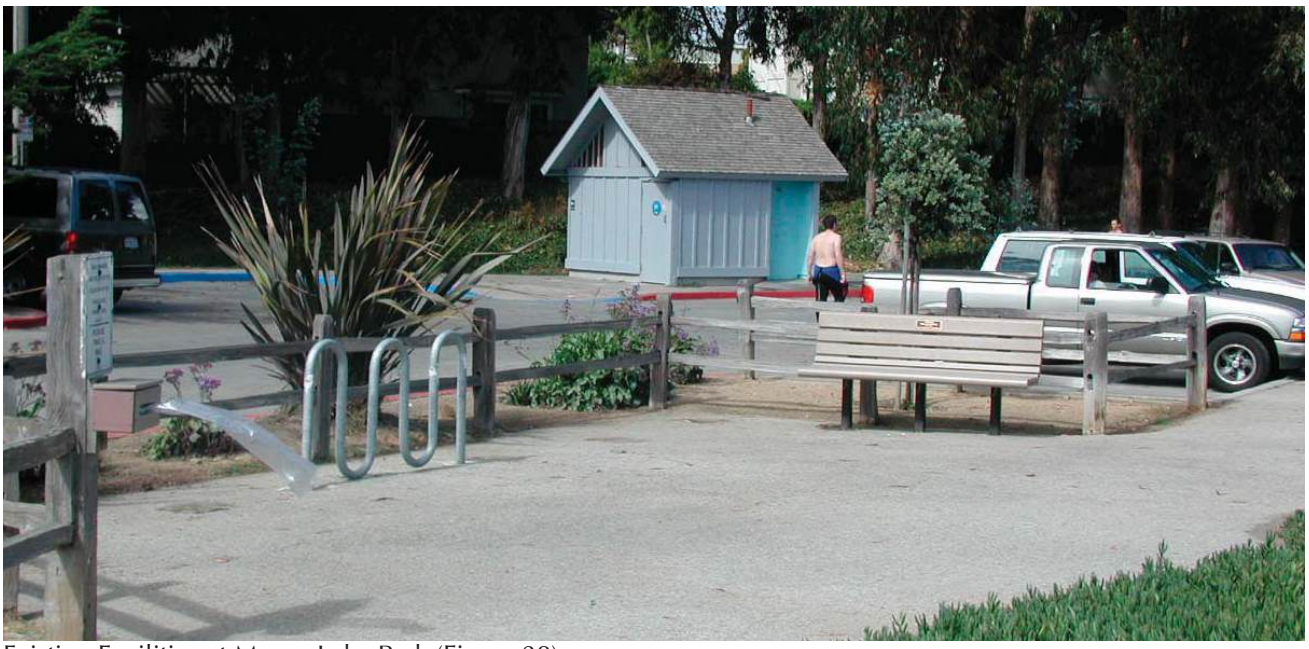
As a highly visible and utilized county park, the older facilities are in need of improvements. Improvements to the park will ensure ADA accessibility, integrate the parking area into the larger landscape systems, provide new accessible restrooms, and interpretive elements along the nature trail. Moran Lake County Park provides exceptional opportunities for public education and outreach.



View Towards East Cliff (Figure 26)



Existing Picnic Area at Moran Lake (Figure 27)



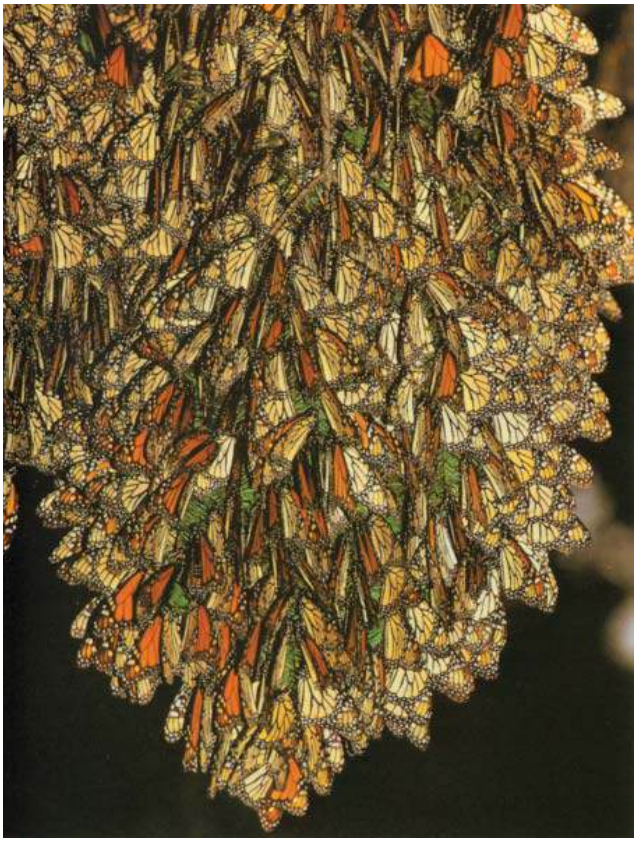
Existing Facilities at Moran Lake Park (Figure 28)

2.1 GENERAL RECOMMENDATIONS

PRESERVATION OF THE MORAN LAKE MONARCH BUTTERFLY WINTERING HABITAT

This management plan addresses issues related to the restoration, preservation and enhancement of that portion of the monarch butterfly wintering habitat at Moran Lake that lies within the bounds of Moran Lake County Park and the Santa Cruz County Sanitation Department D. A. Porath Sanitation Facility.

In order to ensure the preservation of the monarch butterfly wintering habitat at Moran Lake, private property owners must be included in the efforts to protect monarch roost areas. The plan addresses issues specific to each of the habitat areas and establishes recommendations for habitat preservation that are applicable for all properties involved.



Monarch Butterfly Cluster (Photo: Entomological Consulting Services, Ltd.) (Figure 29)

MONARCH BUTTERFLY MONITORING RECOMMENDATIONS

This report recommends the establishment of a program to monitor the monarch population at Moran Lake. It will be important to have a baseline count of the monarchs and record any changes in population because the park and habitat improvements will be phased over several decades. It is recommended that a monarch specialist/entomologist perform the monitoring according to the following guidelines:

- Butterfly counts should occur on six different occasions per year to maintain an accurate database.
- These counts should begin the first two weeks of October and continue until the first two weeks of February.
- The monitoring should include when the butterflies arrive and depart, local movement of the butterflies through the overwintering season, notes on nectar sources (i.e. status of ivy and its relationship to the tree it is climbing).
- This report recommends that an annual summary of the butterfly monitoring be submitted to the Director of the Parks Department. This will assist in maintaining consistency in the reporting over a long period of time and aid in habitat management in combination with the tree monitoring annual report.

2.1 GENERAL RECOMMENDATIONS

TREE MANAGEMENT

Given that the primary focus of management in any monarch butterfly wintering habitat must be preservation of the trees that create and protect the roost areas, management strategies must be designed to maintain:

- Grove size and spatial configuration;
- Tree density within the grove or stand;
- Upper and lower canopy densities;
- Sapling/mature tree ratios.

Equally important considerations include preservation and/or enhancement of:

- Appropriate nectar and water sources;
- Understory vegetation.

Based on the premise that most arbitrary changes in a functioning system will degrade the system rather than enhance it, the most prudent approach to the issue of tree removal and pruning in monarch butterfly wintering habitats is one of minimizing change. Trees are the most essential component of any monarch butterfly wintering habitat and as a consequence, tree loss is the greatest contributor to degradation of these habitats. In essence, trees are the habitat, thus tree loss is habitat loss. Safety pruning, rather than tree removal, should always be the first option considered in dealing with trees of concern.

In order to ensure that trees are not removed unnecessarily, a certified arborist should periodically evaluate the trees at Moran Lake to:

- Identify potentially hazardous limbs and trees;
- Assign hazard ratings to the trees;
- Recommend and prioritize actions to reduce potential hazards.

During the ensuing 3-5 years, evaluation should occur annually. Thereafter, monitoring frequency should be determined by the arborist and park manager to maintain the trees in good health and to avoid the development of safety problems.

Based on the arborist's recommendations, a monarch butterfly specialist should then examine the trees to determine what role the trees play in creating and/or protecting the monarch butterfly roost areas. Based on this analysis, the monarch butterfly specialist may suggest mitigations to reduce the impacts of unavoidable limb and tree removal.

TREE PRUNING GUIDELINES

- Hazardous limbs shall be removed with care to avoid damaging adjacent trees.

- A hazardous limb that is longer than 20-25 feet should be pruned back 15-20%.

- Pruning shall only be done between April and August with the best times occurring between April 15 and May 15 to maximize new canopy growth.

- Prior to pruning, confirm with a biologist that there are no raptors nesting in the vicinity.

2.2 GENERAL RECOMMENDATIONS

TREE REMOVAL GUIDELINES

- Confirm a monarch butterfly specialist has approved the scheduled removal.
- Hazardous trees shall be removed with care to avoid damaging adjacent trees.
- Cut wood and fallen wood shall be removed from the area to avoid infestation and propagation of insect pests such as the long-horned wood boring beetle (*Phoracantha spp.*) (Figure 30).
- After removal, monitoring of changes in the forest health and monarch butterfly habitat shall follow.
- Refer to New Tree Planting and Monitoring Guidelines for replecement guidelines.

NEW TREE PLANTING AND MONITORING GUIDELINES

- A minimum of two trees shall be planted to replace every tree removed.
- Any new tree species planted shall be from the Recommended Plant List and from the appropriate Habitat Function list. (Appendices 3.3). Follow the plans/diagrams found within Specific Recommendations for correct spatial configuration of new plantings.
- All new plantings shall receive irrigation. A temporary irrigation system should be provided to all new plantings until plants are established. There shall be routine maintenance to ensure the health of the plantings and working status of the irrigation.



Tree Felling Due to Drainage Impacts (Figure 30)

- Follow recommended tree planting detail (Figure 31).
- All new plantings shall receive periodic pruning to encourage structural development.
- All new plantings shall receive fertilizing and mulching.
- All new plantings shall receive adjusting of tree staking or herbivore protection (fencing) if used and removed at established growth stage.
- A monitoring program should be established to allow tracking of mitigation tree plantings. Each new tree should be numbered and located on a survey or map and entered into a database to track the tree's health. Trees should be inspected quarterly for the first 5 years after planting to ensure survival. Notation should be made about the habitat function the replacement trees are serving. After 5 years the monitoring can be reduced but, must be continued on an annual basis until the trees reach the height required to perform their habitat function.

  Minimum Tree Height to Reach Habitat Functions:

  - Roost tree: 50' tall
  - Primary Windbreak: 50' tall
  - Secondary Windbreak: 50' tall
  - Note: Depending on site specific conditions (ex: elevation differences), Secondary Windbreak trees may be providing windbreak before reaching 50'.

- If a tree does not survive, it should be evaluated to determine the cause of death. Any identified issues should be addressed and a new tree planted to replace the dead tree. Investigations should include review of the irrigation system, maintenance practices, soil conditions, and possibly tree species.
- This report recommends that an annual summary of the tree monitoring be submitted to the Director of the Parks Department. This will assist in maintaining consistency in the reporting over a long period of time and be helpful to Parks staff as new people take over the role of monitor.

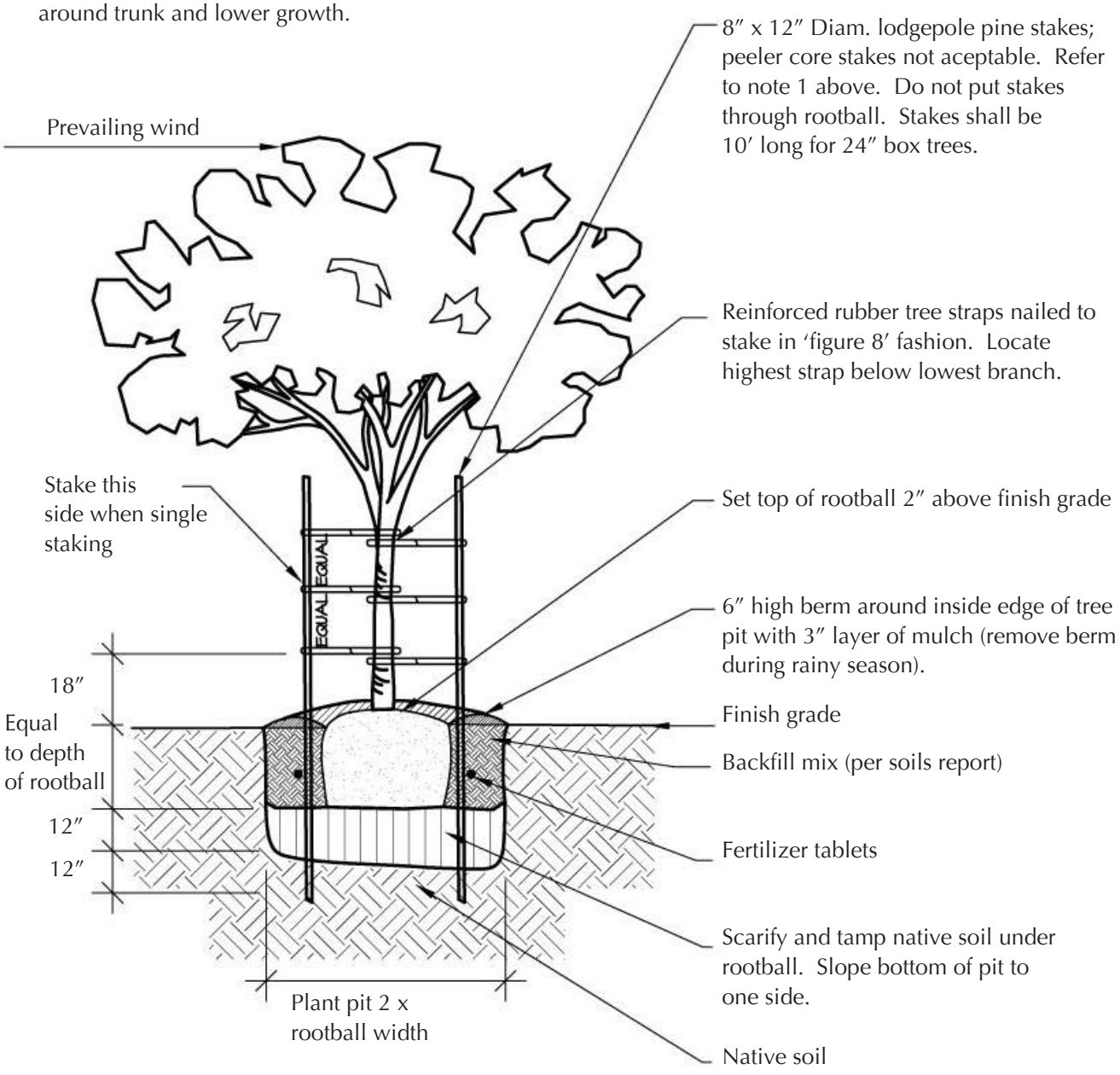
2.2 GENERAL RECOMMENDATIONS

NOTES:

1. All 15 gal. & 24″ box trees shall be double staked.

2. Remove nursery stake(s) and tags from trees upon completion of staking.

3. Provide herbivore and vandal protection around trunk and lower growth.



Typical Tree Planting Detail (Figure 31)

2.1 GENERAL RECOMMENDATIONS

UNDERSTORY VEGETATION MANAGEMENT

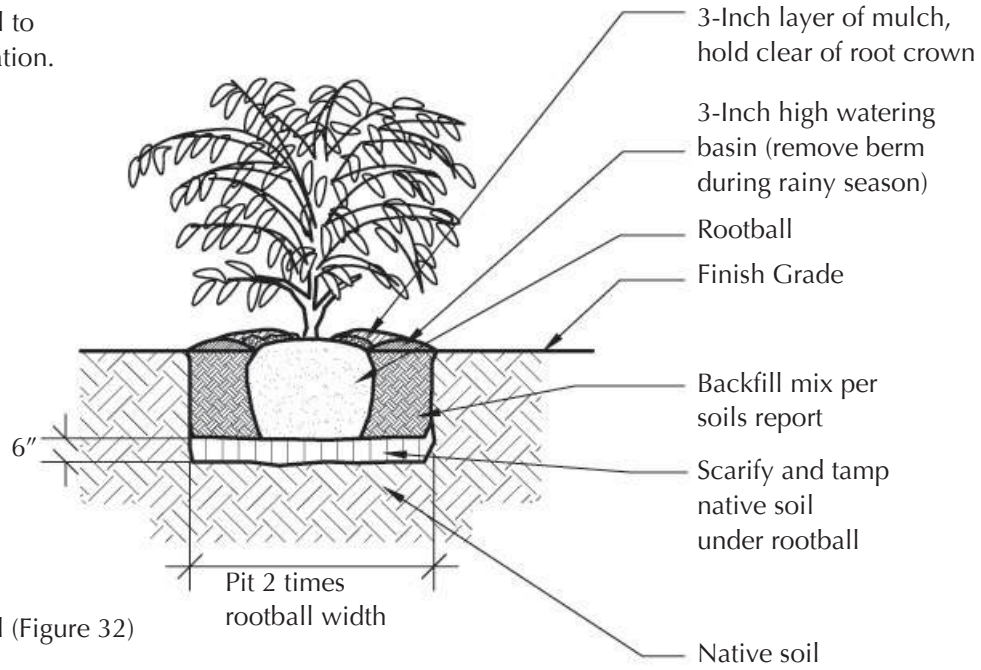
Many of the native plants that once lined the banks and upland areas adjacent to Moran Lake have been removed, disturbed, or succeeded by non-native species. The highly invasive exotics are of the most concern. To restore the lagoon and upland habitats to a more balanced condition, strategic removal of invasive non-native plants and replacement with native plants is recommended. Refer to guidelines below:

EXOTIC UNDERSTORY VEGETATION GUIDELINES

- English ivy and Cape ivy shall be selectively removed in the park and replaced with compatible native or non-invasive ornamental nectar plants.
- Ice plant, French broom and Himalayan blackberry are recommended for complete removal.
- Maintain exotic species from escaping to private properties or into Moran lake.
- Maintain exotic species from overtaking newly planted trees and shrubs.
- An exotic species removal phasing plan shall be established by Parks staff.
- Erosion control methods shall be in place after removal to prevent slope destabilization.

PLANTING GUIDELINES

- Refer to the Recommended Plant LIst (Appendices 3.3) for new species to plant.
- Take a soil test from each of the (8) habitat areas to receive new planting and send to a soil laboratory for an agricultural suitability analysis.
- Amend soil in each area to receive new planting per recommendations of soil report for that specific habitat area (see Figure 9 on page 10).
- Provide temporary irrigation to all new plantings and monitor moisture content of soil to keep moist, but not saturated until plantings are established.
- Follow recommended shrub planting detail. (Figure 32).
- Provide 3-inch layer of mulch around new plantings, hold clear of root crown.
- Schedule weekly maintenance visits to adjust and monitor the irrigation system, keep invasive species from overgrowing new plantings, and to monitor the health of the new plantings.



Typcial Shrub Planting Detail (Figure 32)

2.1 GENERAL RECOMMENDATIONS

RESTORATION OF MORAN CREEK RIPARIAN CORRIDOR

Development in the Moran Lake watershed has significantly reduced the Moran Creek riparian corridor and floodplain. At many locations the Moran Creek channel has been placed in underground culverts (Figure 34). In other areas development has encroached into the riparian corridor eliminating the low flood terrace and riparian vegetation that plays an important role in natural stream function (Figures 35-36). It would benefit the overall condition of Moran Lake to restore the floodplain and riparian corridor to a more natural function to the extent practicable. Recommendations to improve the watershed and habitat quality include:

- Controlling storm-water runoff and associated non-point source pollution within the watershed with the use of landscape based Best Management Practices (BMPs) such as bioretention, vegetated swales and constructed wetlands (Figure 33). Refer to Appendix 3.4 for BMP technical resources.
- Daylighting the stream.
- Widening the stream corridor to provide a functional riparian buffer.



Example of Bioswale in Parking Lot (UCSC Seymour Marine Discovery Center) (Figure 33)



Existing Drainage Channel Near Lode Street (Figure 34)



Existing Conditions of Lake (Figure 35)



Existing Conditions at South Creekside (Figure 36)

2.1 GENERAL RECOMMENDATIONS

PUBLIC AWARENESS & INVOLVEMENT

Currently, there are several groups working to clean the lagoon corridor and monitor water quality. These groups could work in unison to help restore the habitat and monitor the long term success of the area as habitat for the butterflies and other wildlife. Additional public educational workshops about Moran Lake would also help strengthen a commitment from residents within the Moran Lake watershed to protect the lagoon and butterfly habitat.

Applicable county agencies should work together with a certified arborist and monarch butterfly specialist to monitor the plantings, vegetation enhancements and drainage improvements on a regular basis. A collaborative approach may allow for shared funding on projects that provide multiple benefits. Additionally, private funding sources can be solicited and encouraged to support collaborative programs, particularly when the community is a partner in the restoration effort.

The following are suggestions for public involvement, thereby increasing awareness and potentially providing valuable time and effort in park maintenance:

- Develop interpretive brochures for neighbors and community
- Establish neighborhood “watch dog” group
- Provide information regarding related programs such as “Monarch Lab” and “Project Monarch”
- Provide information for planting trees and plants that support monarch butterflies
- Organize a watershed group through the California Coordinated Resource Management and Planning (CRMP) process
- Expand volunteer efforts to monitor water quality and maintain records
- Organize community volunteer stream clean up days



Community Participation (Figure 37)

2.2 SPECIFIC RECOMMENDATIONS



Habitat Management & Park Improvements Map (Figure 38)

2.2 SPECIFIC RECOMMENDATIONS

#1 – BANK STABILIZATION

- **Regrade steep and eroding banks and plant with appropriate native species.**
- **Planting at water edges must be tolerant of occasional submergence and salt exposure.**

Undertaking a bank stabilization project is important to protect the bicycle path and to reduce further erosion, restore the bank to a more natural configuration and to restore habitat value to the disturbed area.

The existing steep bank should be re-graded from a 2.5:1 to 3:1 slope and be planted with native brackish wetland species. The upper bank should be planted with salt tolerant upland herb and shrub species with the upland flat planted with scattered trees, herbs, and grasses. This design would have the benefits of creating additional wildlife habitat while reducing or eliminating the current rate of bank erosion. In order to protect the bicycle path and adjacent upland, the restored bank may need to be rebuilt in a westerly direction recapturing the bank lost to erosion.



Existing Bicycle Path Compromised by Erosion (Figure 39)



Existing Conditions of Bank at Bicycle Path (Figure 40)

2.3 SPECIFIC RECOMMENDATIONS

#2 – SOUTHEAST GROVE & MORAN WAY WINDROW

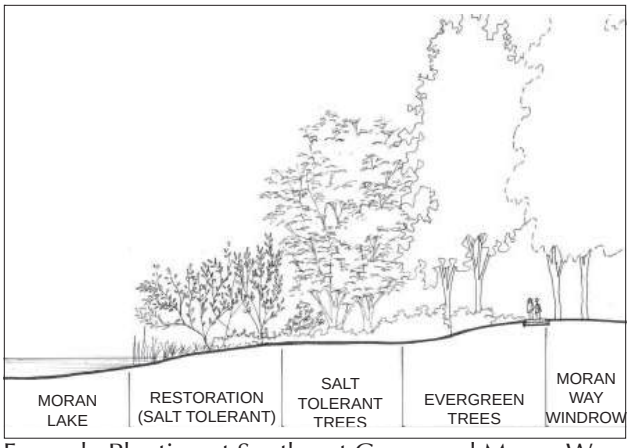
- **Establish transitional planting from Eucalyptus trees to emergent zone**
- **Trees to be field located, coordinate with neighbors to strategically locate trees**

The Moran Way windrow trees, and the trees of the southeast grove as a whole, provide critical south wind screening for the lake and gallery forest areas to the north, including the lakeside autumnal roost areas. The southeast grove also provides temporary (refuge/bivouac) habitat for monarchs migrating along the coastal flyway.

The stability of this wind barrier could be improved by planting salt tolerant eucalyptus (e.g., swamp mahogany, *Eucalyptus robustus*) on the flood plain along the northern edge of the windrow trees (Figure 41). Other tall evergreen species (e.g., Sydney blue gum, *Eucalyptus saligna*) would also be appropriate; however, wind-blown salt-spray and salt concentrations in soil and ground water in this area are likely to limit the survival of many otherwise suitable species (e.g., coast redwood, alder and willow).

The effectiveness of the southeast wind screen could also be improved by planting tall-growing, salt-tolerant, evergreen species on the flood plain along the eastern border of the park. Historically, this area supported a windrow of blue gum eucalyptus that extended from the southeast grove northward to the gallery forest trees on the east shore of the lake.

Since the initial preparation of the habitat management plan, the County Redevelopment Agency has purchased parcel APN 028-302-04 (see Figure 3) from a private property owner for inclusion as park and recreation use in conjunction with other parcels at Moran Lake Park. As there are a number of eucalyptus trees on this parcel, it is appropriate to include the findings and recommendation of the Butterfly Habitat Management Plan as they may apply to this parcel. At this time, there are no proposals for improvements at this site and any proposal would be subject to Planning Department permit requirements and community input process.



Example Planting at Southeast Grove and Moran Way Windrow (Figure 41)



Existing Conditions at Southeast Grove and Moran Way Windrow (Figure 42)

2.3 SPECIFIC RECOMMENDATIONS

#3 – UNDERSTORY VEGETATION

- **Develop a planting plan for areas around the parking lot, lake, and picnic facilities to enhance aesthetic and habitat value of park landscape.**

- **Plant native nectar source vegetation. Restrict planting of new exotic vegetation.**

Future planting plans, plant replacements, and plant infill for the public properties surrounding Moran Lake are to be chosen from the plant list provided in Appendix 3.3. Neighbors should be encouraged to plant native nectar producing vegetation in their gardens. A demonstration garden can be planted to show neighbors to how use such plants in their landscape.



Salvia mellifera (Black Sage) (Figure 44)



*Achillea millefolium (*Common Yarrow) (Figure 45)



Ceanothus spp. (California Lilac) (Figure 43)

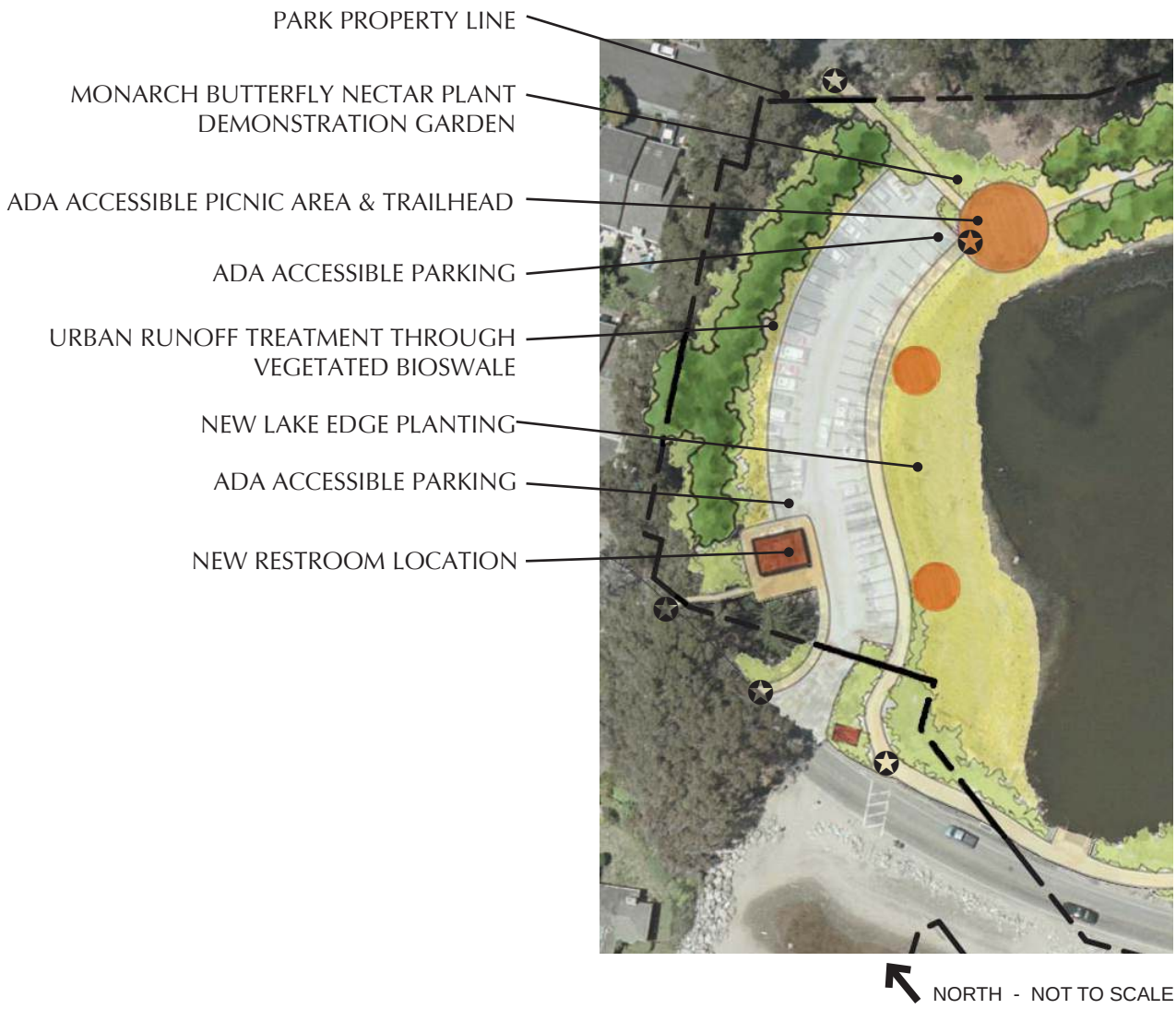


Rubus ursinus (California Blackberry) (Figure 46)

2.3 SPECIFIC RECOMMENDATIONS

#4 – PARK ACCESS IMPROVEMENTS

- **Improve parking configuration**
- **Provide ADA access to picnic areas and trail**
- **Provide new ADA accessible restrooms**
- **Improve entry signage**
- **Establish demonstrative urban runoff mitigation features**



Conceptual Park Access Improvement Plan (Figure 47)

2.3 SPECIFIC RECOMMENDATIONS

#5– SOUTHWEST WINDROW

- **Improve and maintain existing drainage**
- **Monitor for selective pruning of Eucalyptus**

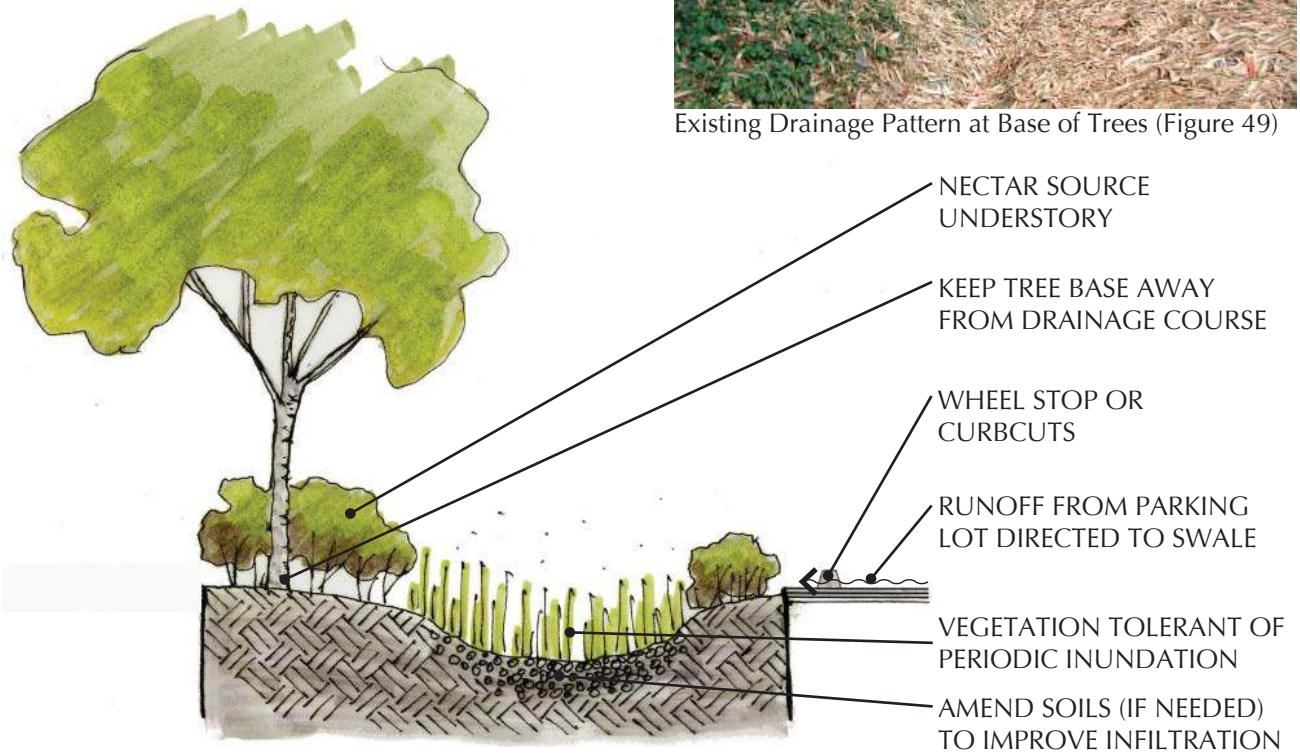
This row of trees provides important west wind screening for the parking area at the southwest end of the park and provides secondary wind protection for trees to the north along Peralta Way and to the east along Moran Way. Because visitor activities are more concentrated in the parking area than in any other area of the park, it is particularly important that these trees remain in good health. Periodic safety pruning and selective removal of dead limbs and hazardous trees under the direction of a certified arborist, should be scheduled in order to ensure human safety in this area. Redirecting drainage swales away from the base of these trees is also essential for minimizing tree losses due to soil and/or root failure (Figure 50).



Existing Path Connecting East Cliff and Parking Lot (Figure 48)



Existing Drainage Pattern at Base of Trees (Figure 49)



Vegetated Bioswale (Figure 50)

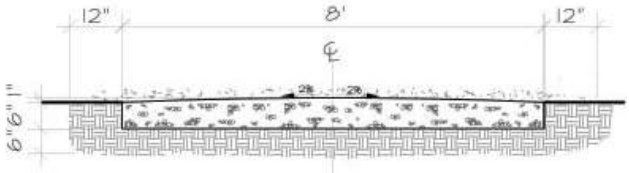
2.3 SPECIFIC RECOMMENDATIONS

#6 – PUBLIC PATH & PICNIC AREA

- **Stabilize banks, especially under and along trail**
- **Provide boardwalks over proposed swales**
- **Stabilize trail as shown in Figure 51**
- **Improve picnic facilities**
- **ADA accessibility of picnic areas and trail**

Erosion of the lake and creek banks and poorly directed runoff are affecting the stability and accessibility of the trail system throughout the park. A raised boardwalk is recommended for portions of the trail to allow drainage to flow under the boardwalk and to minimize impacts to the existing tree roots.

The existing picnic areas are to be improved by providing universal accessibility to ADA compliant picnic tables and benches (Figure 52).



Detail of new trail construction (mulch over aggregate base (Figure 51)

#7 – INTERPRETIVE ELEMENTS

- **Develop an interpretive node at the Nectar Plant Demonstration Garden to educate park users about environmental issues pertinent to the site**

The existing trails within the Moran Lake County Park are well used and present an opportunity to incorporate interpretive signage. Possible signing themes include:

- Watershed definition and how to maintain a healthy watershed;
- Lagoon wetland functions in maintaining/ enhancing water quality;
- Wildlife species information, including habitat and species' life cycles;
- Monarch butterfly habitat, migration, winter roosting, and importance of specific microclimate conditions;
- Monarch butterfly nectar plant species' identification and recognition.

As with all site ammenities, signs should be designed to minimize damage from salt air and vandalism.



Nectar Plant Demonstration Garden and Picnic Area (Figure 52)

2.3 SPECIFIC RECOMMENDATIONS

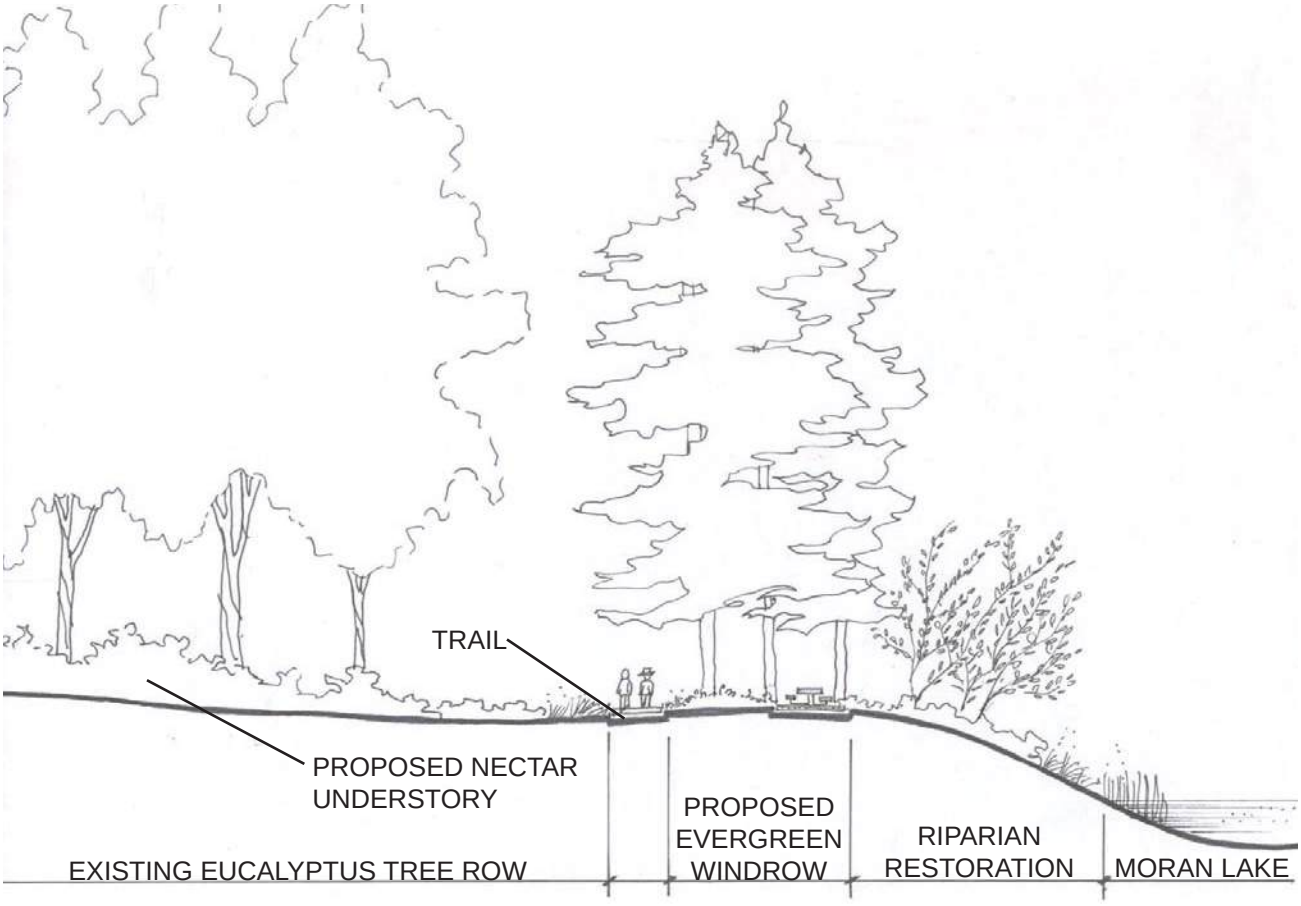
#8 – PERALTA WAY WINDROW

- **Eliminate limbing up of Eucalyptus**
- **Evergreen windrow trees to be planted**
- **Develop and implement planting plan for understory and nectar-source landscaping along edge of tree row and into park**

This windrow of blue-gum eucalyptus contributes wind protection for the lakeside autumnal roost areas by acting as an initial south and west windbreak for the gallery forest area. The effectiveness of this wind barrier could be substantially improved by planting lower-growing trees such as Monterey cypress (*Cupressus macrocarpa*) along the southern and eastern margins of the windrow and along the adjacent lake shore east of the footpath (Figure 53).

Winter storm-water drainage problems in this area are currently threatening the stability of the eucalyptus trees by periodically creating saturated soil conditions that lead to soil failure and loss of trees due to wind-throw. These drainage problems should be rectified before new trees are planted in this area. In the short-term, storm-water runoff should be re-routed by surface grading to drain the swale and prevent pooling. However, it is apparent that drainage problems in this area must ultimately be resolved by channeling neighborhood street runoff into storm drains that convey the water underground into the lake.

Tall-growing salt-tolerant evergreen trees should also be planted along the southern portion of the western lakeshore adjacent to Peralta Way to help deflect wind that would otherwise blow northward through the gallery forest.



Section - Proposed Windrow at Peralta Way (Figure 53)

2.3 SPECIFIC RECOMMENDATIONS

#8 – PERALTA WAY WINDROW



Existing Conditions near Peralta Way Windrow (Before) (Figure 54)



Proposed Planting Overlay near Peralta Way Windrow (After) (Figure 55)

2.3 SPECIFIC RECOMMENDATIONS

#9 – SOUTH LAKESIDE (SOUTH GALLERY FOREST)

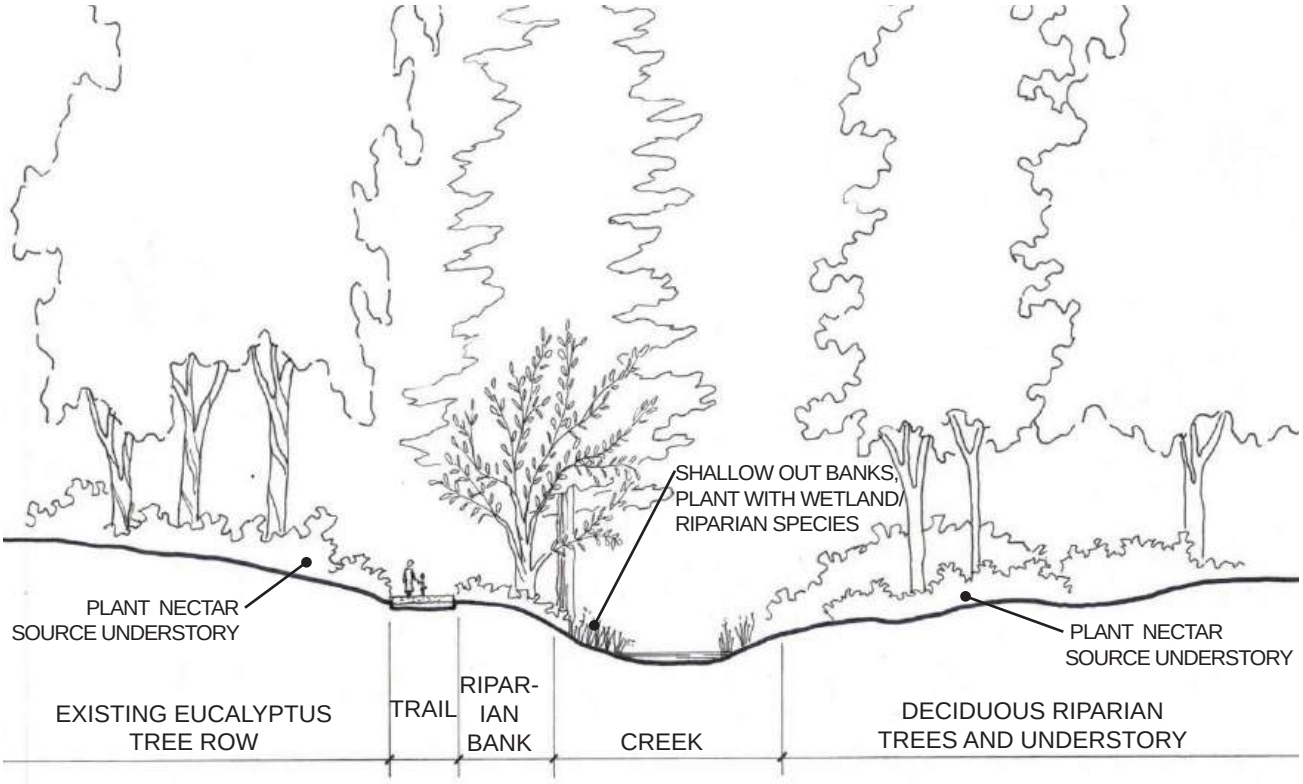
- **Control urban runoff and ponding at base of Eucalyptus**

- **Develop and implement planting plan for landscape at tree margins for understory and windscreen protection**

The gallery forest at Moran Lake is created by the two rows (windrows) of trees that line the east and west shorelines of the lake between Lakeview and Placer Streets. The gallery forest protects and supports the two lakeside roost areas (north and south lakeside roost areas).

Arbitrary tree removals, and losses due to wind-throw during the winter of 1997-98, have reduced the wind protection that these trees once provided for the autumnal roost area at the north end of the gallery forest. A mixture of flooded gum eucalyptus and coast redwood has been planted at the south margin of the north lakeside roost area as partial mitigation for these losses. These trees are now showing good growth rates, but because of the density of this planting, the trees are now beginning to compete with each other for space and will soon require thinning in order to maintain good growth rates. Since these trees are still relatively small (sapling size), it should be possible to selectively remove trees from this area and replant them elsewhere in the park.

Long range plans should include the addition of trees and understory planting on the east side of the creek after the first phase of park improvement plans have been installed (Figure 56).



Section - South Lakeside (Figure 56)

2.3 SPECIFIC RECOMMENDATIONS

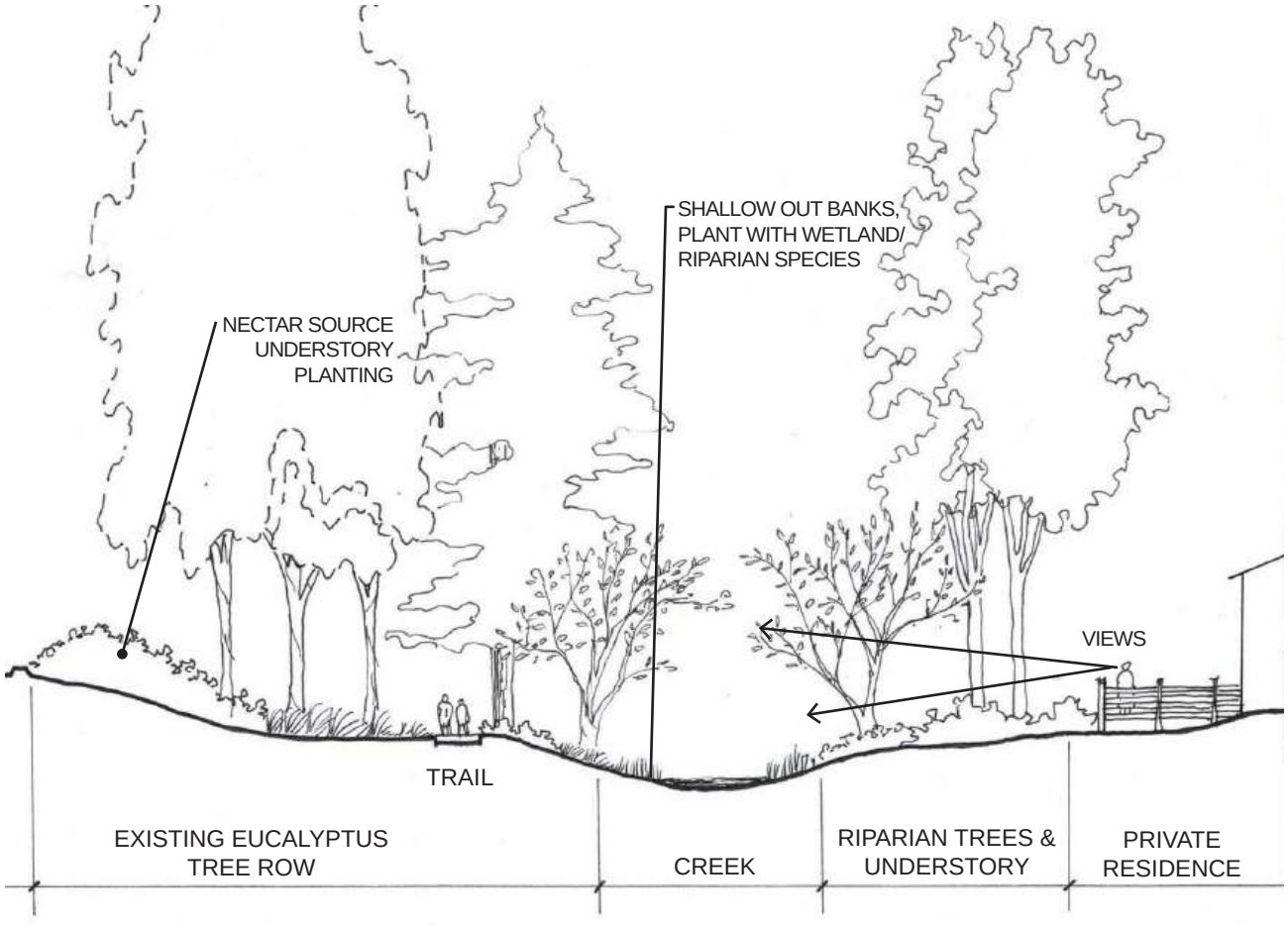
#10 – NORTH LAKESIDE (NORTH GALLERY FOREST)

- **Control urban runoff from the D. A. Porath Sanitation Facility**
- **Implement windscreen restoration planting to establish North Lakeside Roost Area and Roost Areas surrounding the D. A. Porath Sanitation Facility**
- **Provide nectar understory plants**

Mid-level evergreen trees should be planted to increase the buffer from the winds coming from the northeast. This will help create a pool of still air in this area and thus improve conditions for roosting monarchs.

This area is close to the roosting area and has ample sun exposure to accomodate many of the native understory nectar producing plants. These plants should be added to this area to provide additional sources for the monarchs.

Long range plans should include the addition of trees and understory planting on the east side of the creek after the first phase of park improvement plans have been installed (Figure 57).



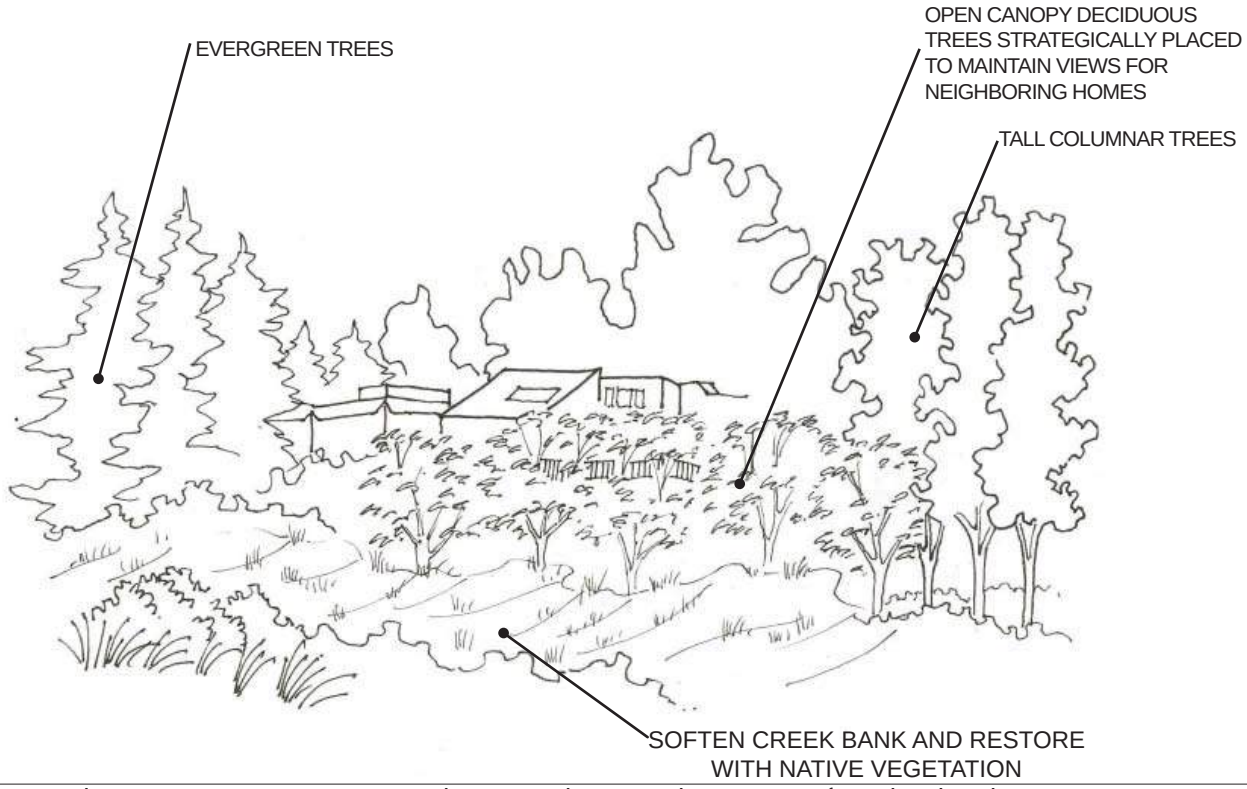
Section - North Lakeside (Figure 57)

2.3 SPECIFIC RECOMMENDATIONS

#10 – NORTH LAKESIDE (NORTH GALLERY FOREST)



Existing Conditions Northeast of North Lakeside Roost Area (Figure 58)



Proposed Long Range Improvement Northeast Windscreen Enhancement of North Lakeside Roost Area (Figure 59)

2.3 SPECIFIC RECOMMENDATIONS

#11 - SOUTH CREEKSIDE

- **Prune selective branches that are of particular danger (20 feet long or more).**
- **Exotic understory nectar species shall be controlled and selectively removed as replacement nectar plants demonstrate that they are providing the food supply necessary for overwintering monarchs.**
- **Plant new trees where sunlight and open space permit planting. Refer to Figure 62 for approximate locations and species.**

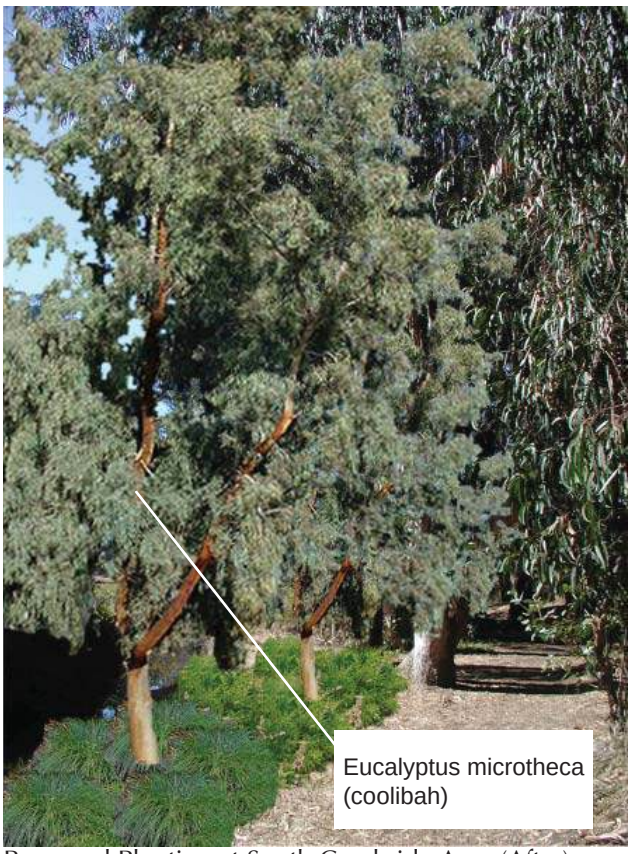
The South Creekside area is critical habitat for the butterflies. There is a public access trail that is heavily used and presents liability issues with the trees. There are several trees of poor structure and overhanging limbs that are a threat to public safety (Figure 61). However, they are part of an important dynamic of the butterfly habitat. New trees of better structure should be planted in open areas to allow future pruning and/or removal of the unsafe trees and will help replace the windbreak lost after trees were removed in 1998-1999.



Dead or Dying Branches to be Removed (Figure 61)



Existing Conditions at South Creekside Area (Before) (Figure 60)



Proposed Planting at South Creekside Area (After) (Figure 62)

2.3 SPECIFIC RECOMMENDATIONS

#12 – NORTH CREEKSIDE

- **Prune selective branches that are of particular danger (20 feet long or more).**

- **Exotic understory nectar species shall be controlled and selectively removed as replacement nectar plants demonstrate that they are providing the food supply necessary for overwintering monarchs.**

- **Plant new trees where sunlight and open space permit planting. Refer to Figure 64 for approximate locations and species.**

The North Creekside area is an extension of the habitat found in the South Creekside. New trees of better structure should be planted in open areas to allow future pruning and/or removal of the unsafe trees.



Existing Conditions at North Creekside Area (Before) (Figure 63)



Proposed Planting Overlay at North Creekside Area (After) (Figure 64)

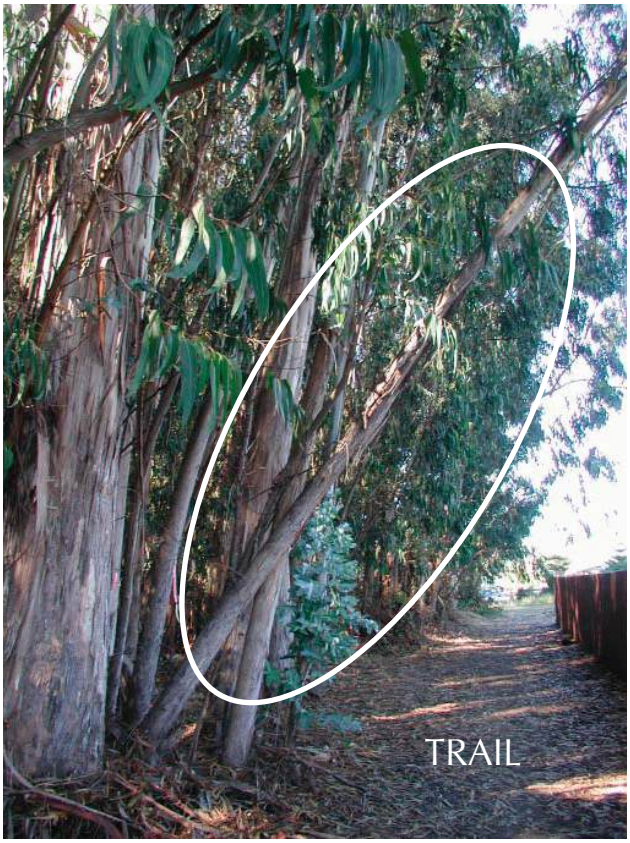
2.3 SPECIFIC RECOMMENDATIONS

#13 – PRIMARY ROOSTING AREA

- **Selective crown height reduction and branch end weight reduction pruning on trees tagged by James P. Allen & Associates. Refer to additional recommendations in description.**
- **Plant new trees where sunlight and open space permit planting.**
- **As the new trees begin to reach heights of 25-30' tall, individual trees that pose the greatest risk can be removed.**
- **Exotic understory nectar species shall be controlled and selectively removed as replacement nectar plants demonstrate that they are providing the food supply necessary for overwintering monarchs.**

This area serves as the primary roost areas for the butterflies. There is a dirt road bisecting the main roost area that serves as access for the Sanitation District to reach their storage yard. Between the north side of the roost area and the fence of the storage yard is an access road/trail. There are overhanging branches that pose a safety threat to the public and the Sanitation District employees that use this access road/trail. Selective pruning of overhanging branches may be done within the established timelines. (Figure 65).

James P. Allen & Associates (Arborists) have prepared a "Tree Risk Management Plan" (Dated October 16, 2003) for the trees in this area. Many trees have been numbered and tagged to receive either crown height reduction pruning or branch end weight reduction pruning. This report recommends the pruning occur in phases over three to five years. Concurrently a tree replacement program should begin. Part of the work performed by Allen's report has already begun this process. Several *Umbellularia californica* (California bay tree) and *Eucalyptus sideroxylon* (red ironbark) have already been planted and seem to be doing well. However, this report does not recommend planting *Eucalyptus sideroxylon* (red ironbark). A continuation of new plantings should be done in stages while selective pruning is done to minimize the amount of risk.



Branch to be Removed (Figure 65)


Cape Ivy Growing in Eucalyptus Tree to Remain (Figure 66)

2.3 SPECIFIC RECOMMENDATIONS

#13 – PRIMARY ROOSTING AREA



Existing Conditions at Primary Roosting Area (Before) (Figure 67)



Proposed Planting Overlay at Primary Roosting Area (After) (Figure 68)

2.3 SPECIFIC RECOMMENDATIONS

#14 – WIND BUFFER AND FIELD

- **Selective and minimal drop-crotch pruning of branches that pose a risk to the neighboring private properties and Lode Street.**
- **Plant new trees where sunlight and open space permit planting.**
- **Remove exotic understory species (French broom).**
- **Plant understory nectar plants from the Recommended Plant List.**

This portion of the forest is intersected by the entrance to the D. A. Porath Sanitation Facility on Lode Street. Tree hazards include falling branches or unstable trees.

Removal of exotic understory species (e.g. French broom) is acceptable in these areas, as butterflies do not seek nectar in this part of the forest (Figure 69).

Drainage is coming from off site locations resulting in ditches that cut through the field in several locations and then flow into the drainage channel that surrounds the D. A. Porath Sanitation Facility (Figure 70).


Existing French Broom to be Removed (Figure 69)


Existing Drainage Channel (Figure 70)

2.3 SPECIFIC RECOMMENDATIONS

#15 – CRITICAL WINDBREAK

- **Stabilize existing drainage channel by shallowing banks to a 3:1 slope where possible and installing erosion control blanket, if necessary. Refer to Figure 73.**

- **Selective and minimal drop-crotch pruning of branches that pose a risk to the neighboring private properties.**

- **Remove dead coast redwood trees and other recently planted dead or dying plants (Figure 71).**

- **Plant new trees where there are opportunities. Refer to Figure 75 for approximate locations and species.**

- **Do not remove existing trees until the replacement trees have reached a height of 50 feet in order to maintain a solid windbreak.**

- **Exotic understory nectar species shall be controlled and selectively removed as replacement nectar plants demonstrate that they are providing the food supply necessary for overwintering monarchs.**



Recently Planted Coast Redwood Tree - Dead (Figure 71)

This area provides essential windbreak, sheltering the primary roost area from the south easterly winds. These trees are located in a narrow strip between the corp yard of the D. A. Porath Sanitation Facility and the property line. Several of the trees have overhanging branches onto the private properties directly to the southwest that present a safety hazard. A drainage channel runs through the area and empties the runoff into Moran Lake. If improvements are not made, erosion of the ditch will continue and eventually undermine the stability of the already declining forest.

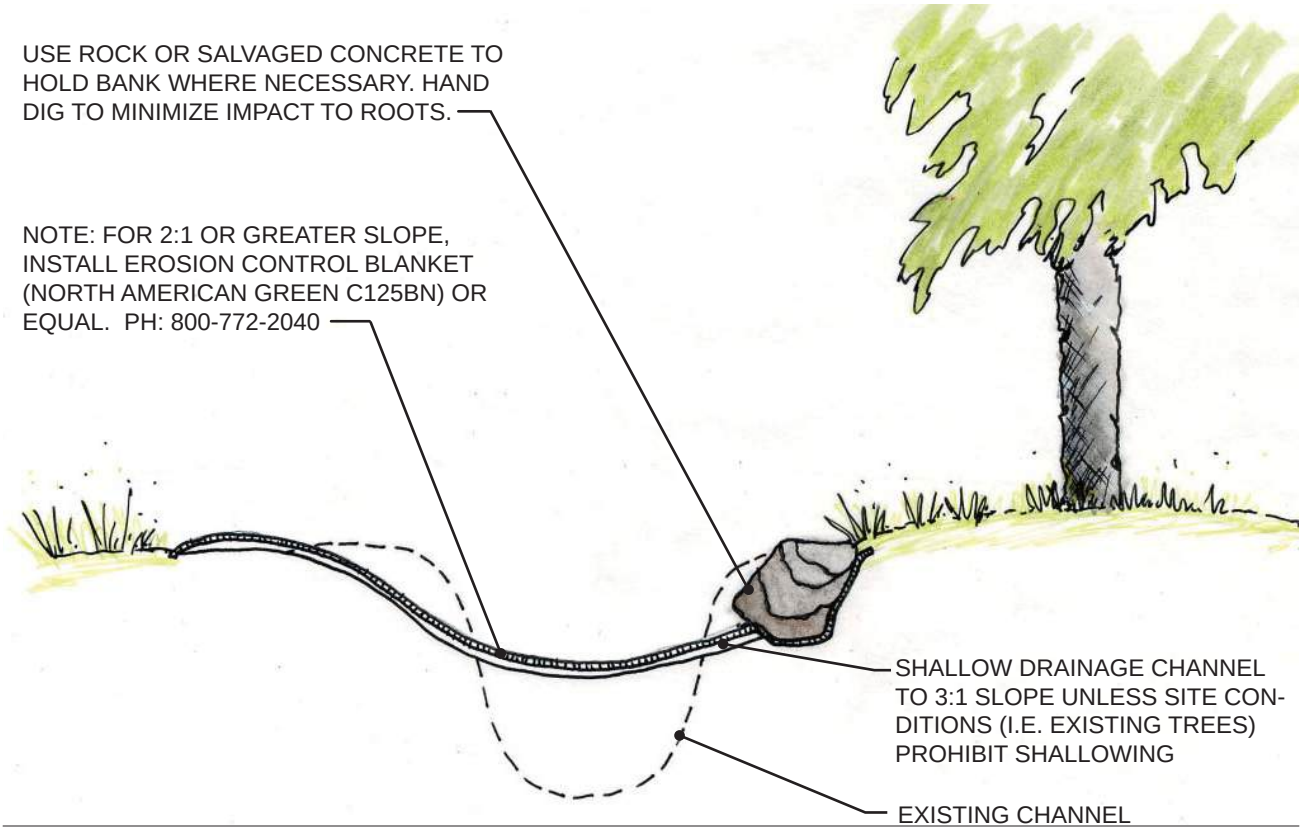
The health of these trees is declining and in order to maintain the essential windbreak for the butterfly habitat a tree replacement program should be started. There is evidence that this was attempted in the past. There are several coast redwoods that have been planted sometime in the last several years, but they have all died. It doesn't appear that there was irrigation to the trees which could be the reason for failure.

2.3 SPECIFIC RECOMMENDATIONS

#15 – CRITICAL WINDBREAK



Existing Drainage Channel at Critical Windbreak (Figure 72)



Proposed Improvements to Drainage at Channel, Typical (Figure 73)

2.3 SPECIFIC RECOMMENDATIONS

#15 – CRITICAL WINDBREAK



Existing Conditions at Critical Windbreak (Before) (Figure 74)

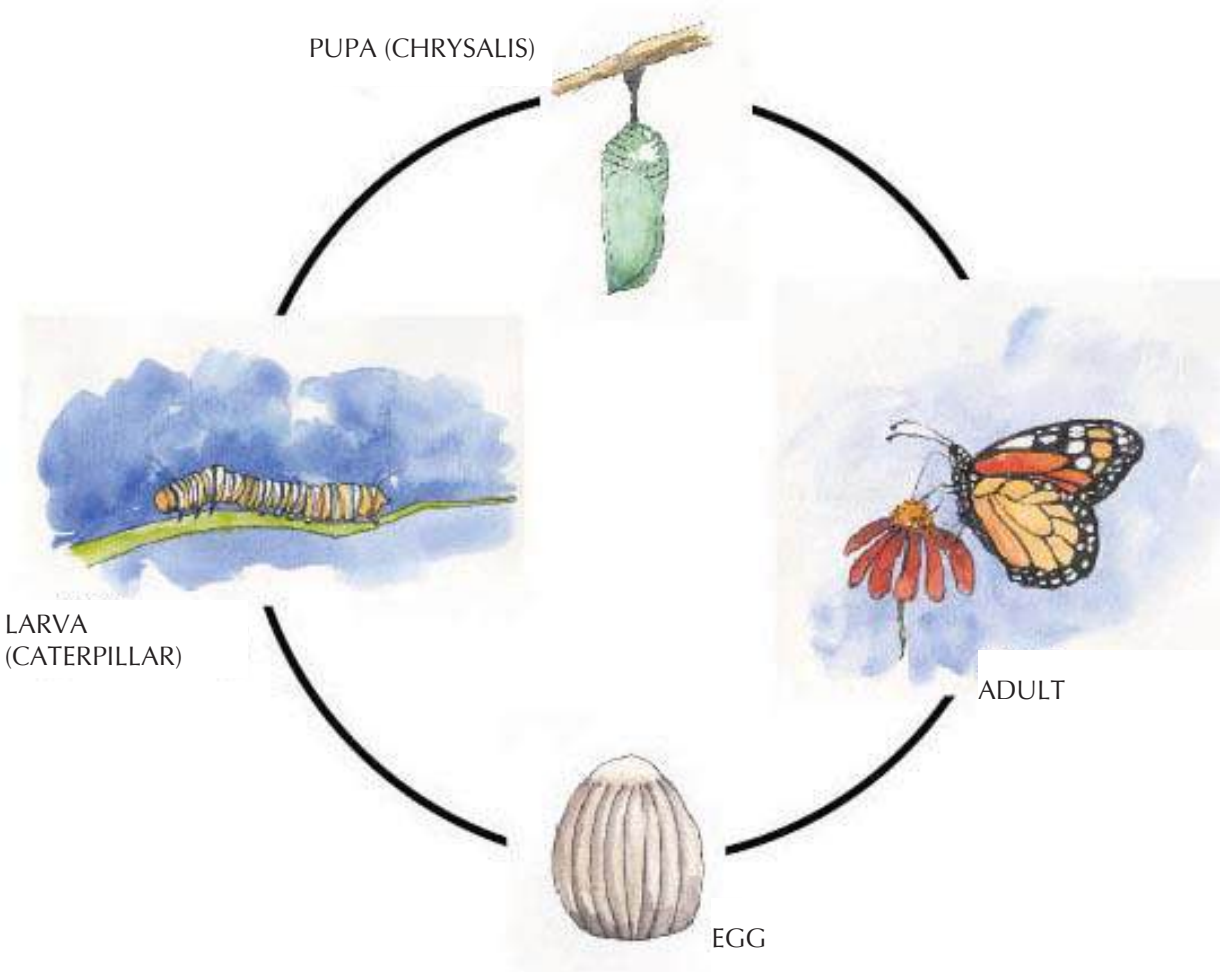


Proposed Planting Overlay at Critical Windbreak (After) (Figure 75)

APPENDICES
3.1 MONARCH BUTTERFLY NATURAL HISTORY

LIFE CYCLE OF THE MONARCH BUTTERFLY

The life cycle of the monarch (*Danaus plexippus* L.) consists of four morphologically distinct stages: egg, larva (caterpillar), pupa (chrysalis) and adult. Monarchs are ectothermic ("cold blooded") animals, thus their activity and metabolism vary in accord with their body temperature, which is largely dependent on the heat they gain from their environment. Under ideal temperature conditions, monarchs spend around 4 days in the egg stage, 14 days as caterpillars, 10 days as pupae and from 1 to 9 months as adults. The variation in adult life depends on whether the butterflies become reproductive immediately (in which case they live 1-2 months as adults) or migrate, overwinter and then become reproductive (in which case they live approximately 8-9 months as adults). Monarch adults that emerge from August through October typically migrate and overwinter before becoming reproductive the following spring.



APPENDICES
3.1 MONARCH BUTTERFLY NATURAL HISTORY

MONARCH BUTTERFLY LIFE HISTORY

The life history of the monarch butterfly can be divided into two temporally defined periods: a spring/summer reproductive period and a fall/winter non-reproductive (wintering) period. During the spring and summer, monarchs exploit the widely distributed North American milkweed flora (Asclepias spp.) as food for their larvae. In the fall, the adult butterflies that are produced during the latter part of summer migrate to wintering habitats in coastal California or central Mexico to spend the winter months.

The availability of overwintering habitats is particularly important for monarchs, since they are unable to survive prolonged periods of freezing temperature in any stage of their life cycle. Thus, in order to exploit the North American milkweed flora during the spring and summer, monarchs must migrate to warmer climates to overwinter (October through February). As is the case with other migratory animals, both the breeding grounds and wintering habitats of the monarchs are crucial in the maintenance of viable populations.

Monarch survival during the winter depends on their ability to find habitats where they can avoid physical damage from weather and predators, while optimizing utilization of their limited fat reserves. Since they are ectothermic animals, monarch activity is largely a function of body temperature which, in-turn, is mainly a function of ambient air temperature and exposure to sunlight (insolation). During periods of low temperature (<55 degrees F), monarchs must roost in wind protected locations that provide some periodic exposure to sunlight. During periods of warm weather they seek cool, shady roost areas in order to keep their metabolic activity levels low enough to conserve their limited fat reserves.

Thus, monarch survival through the wintering period is primarily a function of being able to find a wind protected habitat, with suitable microclimatic conditions, that is sufficiently heterogeneous to permit shifts of roost location in accord with prevailing weather conditions and seasonal variation in insolation. In California, such environments are typically found in coastal eucalyptus groves.

Prior to the decimation of the coastal forests, woodlands and riparian habitats that accompanied the invasion of California during and after the "gold rush" period (1850-1870), monarchs are thought to have utilized areas of Monterey pine forest and various wind-sheltered riparian plant communities as wintering habitat. Although eucalyptus groves are quite common along the coast of California, very few of the groves are utilized by monarchs as wintering habitats. The specific range of environmental conditions that the monarchs seek is apparently only rarely realized in nature.

CONSERVATION STATUS

Wintering habitats, because of their narrow distribution and relative rarity - in comparison to the broad geographic range of the summer breeding grounds - are the "Achilles' heel" of the monarch migratory phenomenon. Loss of these habitats could result in a complete collapse of the annual migration cycle and would vastly reduce the numbers of monarchs in North America. As human population pressures continue to increase the frequency of wintering habitat degradation and destruction, the success of the monarch's annual migration increasingly requires active conservation of overwintering habitats both in Mexico and along the California coast.

Although monarchs, as a species, are not currently threatened on a global scale—because of their broad distribution—they are recognized as a "species of concern" by the California Department of Fish and Game (CNDDB Rank: G5S3) because of the restricted range and relative rarity of their wintering habitats. Monarch butterfly wintering habitats are also legally protected as environmentally sensitive habitat areas (ESHAs) under the California Environmental Quality Act (CEQA), the Santa Cruz County General Plan, and Local Coastal Programs (LCPs) mandated by CEQA. Monarch habitats are also frequently protected by local heritage tree ordinances and state-wide laws that protect riparian habitats, wetlands and watercourses.

APPENDICES
3.1 MONARCH BUTTERFLY NATURAL HISTORY

WINTERING SITE TERMINOLOGY

Monarchs roost in trees at night and during periods of inclement weather and/or low temperature. During the summer monarchs tend to roost singly, whereas during the winter they roost gregariously (socially). Masses of gregariously roosting monarchs are referred to as clusters. Trees that support clusters of gregariously roosting monarchs are called roost (or cluster) trees. Trees surrounding the roost trees that provide immediate (line-of-sight) wind protection for the roost trees are referred to as primary windbreak trees. Primary windbreak trees that stand to the south of the roost trees also create shade and diffuse sunlight.

The roost trees and their associated primary windbreak trees define the basic unit of monarch wintering habitats, the roost area. Trees that provide wind protection for the trees that compose a roost area are referred to as secondary windbreak trees. A monarch butterfly wintering habitat is thus composed of one or more roost areas and all of the secondary windbreak trees that protect them. Although monarchs utilize relatively few of the trees in a habitat as roost trees, most of the other trees play essential roles in creating a suitable microclimate—moderate temperature, high humidity, diffuse sunlight—and in providing wind protection for the clusters on the roost trees.

Although topographic (landform) features, and buildings, may also contribute to site suitability—by providing wind protection and/or shade—tree configuration is usually the most important determinant of site suitability. Some monarch wintering habitats contain only one roost area, others (if not most) provide several roost areas that are utilized sequentially during the wintering period and/or as refuges during inclement weather. Moreover, individual monarchs may utilize the same habitat in different ways; thus the same habitat may function as a temporary refuge for some monarchs, and as a part-term or full-term overwintering site for others.

Monarch wintering habitats are commonly categorized on the basis of the average duration of residence of the wintering populations. Those habitats (aka: sites) that typically support clusters of wintering monarchs for a few days to a month (or two) are grouped as Temporary Habitats; whereas those that typically host clusters of monarchs for two to six months are referred to as Overwintering Habitats.

Overwintering habitats are often subdivided on the basis of duration of residence: sites that typically support monarch populations from October into December are referred to as part-term overwintering habitats; whereas those that support monarch populations for the entire season—October through February in most years—are referred to as full-term overwintering sites. With regard to state-wide preservation of monarch populations, full-term overwintering sites are the most crucial type of wintering habitat.

In describing roost areas and temporary habitats four functional variations are generally distinguished: refuge areas, bivouac areas, autumnal roost areas, and mid-winter roost areas. Refuge areas, as the name suggests, provide temporary protection from inclement weather and/or convenient areas to roost overnight while migrating. Bivouac areas generally host populations of migrants for a few days to several weeks. Autumnal roost areas typically host monarch populations throughout the month of October (often into November), and are frequently associated with conspicuous nectar sources (such as fall-blooming composites and English ivy). Mid-winter roost areas host clusters from around mid-December through February in habitats with a series of sequentially occupied roost areas.

APPENDICES
3.2 PLANT IDENTIFICATION PHOTOGRAPHS



English Ivy



Poison Oak



Cape Ivy



Coyote Bush



French Broom



Himalayan Blackberry

APPENDICES
3.3 RECOMMENDED PLANT LIST FOR WINTERING HABITAT RESTORATION

BOTANICAL NAME	COMMON NAME	POTENTIAL ECOLOGICAL ROLE
Evergreen Trees		
Cupressus macrocarpa	Monterey cypress	Windscreen
*Eucalyptus saligna**	Sydney blue gum	Windscreen
Eucalyptus robusta	Swamp mahogany	Windscreen
*Eucalyptus microtheca**	Coolibah	Roost tree
Sequoia sempervirens	Coast redwood	Windscreen
Deciduous Trees (Lake and Creek Margins)**		
Alnus rhombifolia	California white alder	Windscreen
Alnus rubra	Red alder	Windscreen
Salix hindsiana	Hinds willow	Winter nectar source
Salix lucida	Western black willow	Winter nectar source; windscreen
Salix lasiolepis	Arroyo willow	Winter nectar source; windscreen
Mid-level and Understory Shrubs		
Arctostaphylos spp.	Manzanita	Lower windscreen
*Callistemon citrinus**	Bottlebrush	Nectar source
Ceanothus spp.	California lilac	Nectar source
*Echium fastuosum**	Pride-of-Madeira	Nectar source
*Escallonia spp.**	Escallonia	Nectar source
Heteromeles arbutifolia	Toyon	Lower windscreen
*Leptospermum laevigatum**	Australia tea tree	Nectar source
*Myoporum laetum**	Myoporum	Lower windscreen
Myrica californica	Pacific wax myrtle	Lower windscreen
Prunus ilicifolia	Holly-leaf cherry	Lower windscreen; nectar source
Prunus caroliniana	Carolina cherry	Lower windscreen; nectar source
*Rosmarinus officinalis**	Rosemary	Nectar source
Rubus ursinus	California blackberry	Nectar source
*Viburnum tinus**	Lauraltinus	Nectar source
Low-growing Shrubs, Herbs & Grasses		
Achillea millefolium	Common yarrow	Nectar source
Asclepias eriocarpa	Woollypod milkweed	Nectar source
Asclepias speciosa	Showy milkweed	Nectar source
*Carex spp.***	Sedge	Erosion control
Encelia californica	California brittlebush	Nectar source
*Festuca spp.***	Fescue (native spp.)	Erosion control
Heliotropium curassavicum	Seaside heliotrope	Nectar source
*Juncus spp.***	Rush	Erosion control
*Lantana montevidensis**	Lantana	Nectar source
Mahonia repens	Creeping mahonia	Erosion control
Monardella antonina	Monardella	Nectar source
*Salvia leucantha**	Mexican bush sage	Nectar source
Salvia mellifera	Black sage	Nectar source
Verbena spp.	Verbena	Nectar source

* Indicates non-native nectar-source plant

** Riparian restoration planting

APPENDICES
3.4 BEST MANAGEMENT PRACTICES REFERENCE GUIDE

Bay Area Storm Water Management Agencies Association (BASMAA) Start at the Source and Using Site Design Techniques to Meet Development Standards for Storm Water Quality: A Companion Document to Start at the Source www.basmaa.org

Bureau of Environmental Services, 2004. Stormwater Management Manual, Portland, OR

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Appendix F

Site Photographs



Photograph 1. Gap of trees and wind protection along the southern boundary of the Sanitation facility. Plant with red ironbark or blue gum eucalyptus (*sideroxylon* or *globulous*) trees.



Photograph 2. Gap of mid-canopy trees and wind protection along the eastern side of the Sanitation Facility. Plant with mid-canopy replacement trees, Monterey cypress in this area.



Photograph 3. Gap along the southern boundary of the windbreak, along the Sanitation Facility boundary Plant with mid-canopy replacement tree, Monterey cypress.



Photograph 4. Dead redwood tree planted as a replacement but did not survive. Remove and replant with red ironbark or blue gum eucalyptus replacement tree.



Photograph 5. English ivy that will be managed to keep it from invading the tree canopies.



Photograph 6. View of the open sunny area to be planted with nectaring plants, to the right of the creek.

Appendix G

Xerces Society's Coastal California Plant List



Bloom		Common Name	Scientific Name	Flower Color	Max. Height	Water Needs	Notes
		Forbs			(Feet)	Low, Medium, or High	All species are perennials. Monarchs are typically present in coastal California from September through March, but can be found year-round in some parts of the re
Spring to Fall	1	Coastal sand verbena	*Abronia latifolia*	Yellow	1	L/M	Tolerates salt spray and prefers sandy soils. Can bloom year-round.
Summer to Fall	2	California goldenrod	*Solidago velutina* ssp. *californica*	Yellow	3	L	Important late-season forage for bees, butterflies, wasps, beetles, and more.
	3	Common sandaster	*Corethrogyne filaginifolia*	Yellow/purple	3	L/M	Host plant for Gabb's checkerspot (Chlosyne gabbii).
	4	Dunn's lobelia	*Lobelia dunnii* var. *serrata*	Purple	2	H	Excellent butterfly plant.
	5	Roughleaf aster	*Eurybia radulina*	Purple	2	M	High drought tolerance once established.
	6	Sweetscent	*Pluchea odorata*	Pink/purple	3	L	Mostly coastal, brackish plant. Can tolerate saline sites.
	7	Western goldentop	*Euthamia occidentalis*	Yellow	6	M/H	Wetland-riparian.
Winter to Spring	8	Bluedicks	*Dichelostemma capitatum*	Purple	3	L	Attracts other bees, butterflies, and hummingbirds. An early spring bloomer.
Winter to Summer	9	Seaside fleabane	*Erigeron glaucus*	Purple	2	L/M	A great butterfly plant.
		Shrubs and Trees					
Spring to Summer	10	Black sage	*Salvia mellifera*	Blue/purple	6	L	Important butterfly and hummingbird plant. Quail eat the seeds.
	11	Blueblossom	*Ceanothus thyrsiflorus*	Blue	15	L	Amazing pollinator plant. Host plant to many butterfly species. Birds will eat the seeds.
Spring to Fall	12	Dune ragwort	*Senecio blochmaniae*	Yellow	3	L/M	Limited distribution.
Summer to Fall	13	California broomsage	*Lepidospartum squamatum*	Yellow	6	L/M	Can be used in restoration and stream stabilization projects.
	14	Saltmarsh baccharis	*Baccharis douglasii*	White	3	M/H	Important nectar source for many species of wasps, butterflies, and flies.
Fall	15	California goldenbush	*Ericameria ericoides*	Yellow	3	L/M	Great late season nectar source for bees and butterflies.
Fall to Winter	16	Coyotebrush	*Baccharis pilularis*	Yellow/white	8	L	Easy to grow and extremely drought-tolerant. Attractive to many insects.
Fall to Summer	17	Bladderpod spiderflower	*Cleome isomeris*	Yellow	4	L	Tolerates salt spray. Also attracts bees.
Winter	18	Desertbroom	*Baccharis sarothroides*	Pink/white	10	L	Can be used for streambank stabilization.
Winter to Spring	19	Arroyo willow	*Salix lasiolepis*	Yellow/white	20	H	Tolerates sand and seasonal flooding; good for erosion control. Important wildlife plant.
	20	Hollyleaf cherry	*Prunus ilicifolia*	Yellow/white	14	L	Fruits eaten by many birds and small mammals.
	21	Morro manzanita	*Arctostaphylos morroensis*	Pink/white	20	L	Limited distribution. On CA rare/threatened/endangered list.
	22	Refugio manzanita	*Arctostaphylos refugioensis*	White	7	L	Limited distribution. On CA rare/threatened/endangered list.
	23	Sugar sumac	*Rhus integrifolia*	Pink	8	L/M	Good for erosion control on coastal bluffs. Fruits are eaten by birds and other wildlife.
Winter to Summer	24	California brittlebush	*Encelia californica*	Yellow	4	L/M	Tolerates salt spray. Can be used to stabilize slopes. Good bee and butterfly plant.



Appendix H

January 2026 Tree Risk Assessment for Moran Lake Park

Tree Risk Assessment

Moran Lake Park

Prepared for:

Rob Tidmore

December 8, 2025
Revised January 29, 2026

Prepared By:

Richard Gessner
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Summary

[1]There are five defects or conditions identified that could lead to tree failure at some point which are as follows:

1. Adventitious branches arising from topping cuts
2. Dead branches
3. Codominant stems
4. Buried/not visible root collars
5. History of failure, excessive soil moisture, and fill soils

There were no defects or conditions identified where failure was probable, or expected in the next two years except of dead and adventitious branches. The likelihood of the remaining defects or conditions to lead to failure is possible, the likelihood of striking a target is high with severe or significant consequences. The result is the trees around the perimeter pose a moderate risk. Routine pruning maintenance and monitoring, would result in a low residual risk.

Assignment

Inspect the crown, trunk, root collar, above ground roots, and site conditions around the exterior Tasmanian blue gums (*Eucalyptus globulus*) following the guidelines for a Level 1: Limited Visual Assessment[2] on foot as described in *Best Management Practices: Tree Risk Assessment:* International Society of Arboriculture, 2017.

Limits of Assignment

- The assessment is limited to the tree and site conditions during my visit on December 3, 2025. The tree risk assessment considers only known targets and visible or detectable conditions.
- Any tree, whether it has visible weakness or not, will fail if the forces applied exceed the strength of the tree or its parts.
- Not all defects are detectable and not all failures are predictable.
- The assessment is only valid for the day of the inspection.
- The time period for "risk categorization" shall not be considered a "guarantee period" and is not to be construed as an absolute prediction. The given time period for this assessment is two years.

---

[1] January 29, 2026 revision includes clarification and ID number corrections in the Appendix B table and site maps (Appendix D) to indicate the locations of the individual trees called out.

[2] Level 1: Limited Visual Assessment: a visual assessment from a specified perspective such as foot, vehicle, or aerial patrol of an individual tree or a population of trees near specified targets, to identify specified conditions or obvious defects.

Purpose and Use

The purpose of this report is to inform the property owner and/or managers and their agents about the likelihood of the trees or their parts failing, likelihood of striking a target, and the consequences to provide a risk rating. The report is to be used by the property owners and managers, or their agents to help make decisions about the future management of the trees.

Observations

The park has been broken down into several sections as depicted by Creekside Science in the Moran Lake Butterfly Habitat Management Plan (Image 1).



IMAGE 1: SECTIONAL BREAKDOWN OF MORAN LAKE PARK GROVES

Area A1 has been completely cleared and no longer a factor for tree risk at this time.

Area A2 runs adjacent to “Ryans Way” and includes one house at the corner of Moran Way. Within the A2 grove there are several defects or conditions observed which include leans, codominant stems oriented toward residences, buried or not visible root collars, and dead branches. Residences are oriented to the south of the grove and failure have occurred failing to toward the northwest and the drainage.

Area B consists of several residences along Peralta Way and the ends of Lakeview Drive and Fresno Street. These trees have all been recently pruned to reduce crown height and spread. There are several trees located at the top of the bank consisting of fill soils and adjacent to roadways which have been paved which could fragment root zones. Some trees lean toward residences. Residences are oriented to the northwest of the grove.

Area C consists of trees along the edge of baker Street ranging from Fresno Street to Placer Street. Most of these trees have also been topped after the 2024 storms. In one area only tree #262 remains while all its other associates have been removed. Residences are oriented to the northwest of the grove.

Area H/G is along Placer Street between the sanitation district and 2775 Placer Street at the end and extending northwest up to 2691 Placer Street. The southeast trees are largely intact and are oriented with the residence to the south of the grove while the closest trees along Placer have been previously topped.

Area D is southeast of the sanitation district and contains one tree #668 bowed toward the creek and the residence yard. The tree is not large enough to strike the residence upon total failure but would damage features in the yard.

Areas E and F have boundary trees that should be regularly maintained. There are no issues at this point but there are three residences nearby. This is a southerly wind protected area and winds from the north would push trees away from residences.

Discussion

Topping and Adventitious Branches

Topping is a pruning technique to reduce tree size while arbitrarily cutting to a predetermined crown limit or height. When trees are topped they can become problematic over time. The tree part that has sustained the pruning wound will not compartmentalize properly and decay will occur at the cut site. Once the wound starts to decay the area becomes weaker and newly generated sprouts or remaining branches can be prone to failure.

Adventitious branches growing near topping wounds do not form proper attachments. The branches form a shell over the wound or near the cutting site and are not firmly attached like original branches. The attachments can be weak and prone to failure as the limbs grow larger and the support becomes weakened or decayed. The likelihood of these branches to fail is probable, and could occur during normal weather conditions within the next two year (Dunster, J, Smiley, E, Matheny, N, and Lilly, S. 2017).

Codominant Stems

Codominant stems are branches or trunks of relatively equal size that join at the same point on the main stem. This architecture is well understood and there is always potential for failure at the attachments. When trees have codominant stems with acute angle attachments failure is possible or probable (Smiley, E, Matheny, N, Lilly, S. 2017). The forces on the stems are generally downward versus outward and the likelihood of one of these codominant stems to fail is possible, but not expected under normal conditions.

Buried Root Collar

The root collar is the transition portion of the tree attaching the roots to the main stem/trunk. Because the root collar is actually part of the main stem and not the root system it is important to keep moisture off this area to help prevent rot conditions or vascular disorders. By excavating the root collar you can keep moisture away and monitor the structural roots for decay and disease. Some trees do not have visible structural roots above ground or they are covered in hardscape adjacent to paved pathways or roads. The likelihood of this condition to lead to tree failure is possible. The root zones covered in hardscape or soil as with most trees and predicting underground conditions is not possible. Removing soil and debris from the base of the trees and having them re-inspected on a schedule is appropriate mitigation.

Dead Branches

Dead branches should be removed. There is no way to determine the integrity of a dead branch and failures can occur under normal conditions at any point, regardless of weather conditions. Dead branches should be removed during routine maintenance.

History of Failures, Soil Moisture, and Fill

In depth forensic assessments and advanced geotechnical analysis of the soils and drainage are beyond the scope of this assignment. However, anecdotally trees have failed in areas where soil moisture, high water table, or standing water have been historically present on the site. These failures are exacerbated by wind events and long term exposure to these conditions. Many of the trees in these areas have either failed or been removed. Identifying these conditions throughout the park with the help of other experts could be a useful tool in helping to determine which trees and areas are most at risk for failure.

Tree Risk Assessment and Rating

The tree risk assessment is based on the following five components:

- Review of past and present site conditions.
- Assessment of the significance of the targets and their occupancy rates.
- Identification and assessment of structural defects in the crown, trunk, root collar, above ground roots, and site conditions.
- Evaluation of the most likely and significant parts of the tree to fail.
- Development of the risk rating.

Tree risk assessment considers the likelihood of a tree or its parts failing and impacting a target, along with the consequences within a given time period. The risk evaluation is placed in a matrix to establish an overall risk rating (Smiley, E, Matheny, N, Lilly, S. 2017). For this assignment the targets specified are the residences around the exterior of the park[3]

The time period for the assessment is two years. The parts of the trees most likely to fail are as follows:

1. Adventitious branches arising from topping cuts
2. Dead branches
3. Codominant stems

[3] The assessment does not consider park users or people inside the park.

The following conditions could lead to failure:

1. Buried/not visible root collars
2. History of failure, excessive soil moisture, and fill soils

The second step is to determine the likelihood of failure based on structural conditions, defects, response growth, and potential loads (usually gravity or wind). As indicated above dead and adventitious branches are the most likely to fail, then codominant stems. Topped trees are now lower and subject to lower wind speed accounting for those in Area B, C, and H. Trees with buried root collars may pose a risk if structural roots under the soils are not present or rotted due to excess moisture over time. It is possible these trees could fail but not expected under normal condition.

Next is to determine the likelihood of a the tree or a particular part to strike a target in a given time period. The likelihood of failure is possible[4] to probable[5] in contrast with imminent[6]. Failure of dead or adventitious branches could occur within the given time period and the likelihood is "probable" meaning it could occur under normal conditions. The remaining conditions or defects are "possible" but not likely to lead to failure under normal circumstances over the next two years.

Once the defect or condition is identified determining the likelihood of a failure to strike a target is the next step. In this circumstance the target is static and consists of the residences.

The consequences of failure are based on the significance of the targets and are categorized as negligible[7], minor[8], significant[9], or severe[10].

---

[4] possible: Pertaining to the likelihood of failure: Failure could occur, but it is unlikely during normal weather conditions within a specified period of time.

[5] probable: Pertaining to the likelihood of failure: Failure may be expected under normal weather conditions within a specified period of time.

[6] imminent: Pertaining to the likelihood of failure:Failure has started or is most likely to occur in the near future, even if there is no significant wind or increase in load, the imminent category overrides the stated time frame.

[7] negligible: No personal injury, low-value property damage, or disruptions that can be replaced or repaired.

[8] minor: Minor personal injury, low to moderate value property damage, or small disruption of activities.

[9] significant: Substantial personal injury, moderate to high value property damage, or considerable disruption of activities.

[10] severe: Serious personal injury or death, high value property damage, or major disruption of important activities.

The matrix combines the likelihood of a failure impacting a target including the consequences to produce a risk rating of extreme[11], high[12], moderate[13], or low[14].

The consequences of failure in this assessment are significant or severe in the event a tree or its parts would fail and strike a person or residence.

Conclusion

This is a large park with an urban interface. There are five defects or conditions identified that could lead to tree failure at some point which are as follows:

1. Adventitious branches arising from topping cuts
2. Dead branches
3. Codominant stems
4. Buried/not visible root collars
5. History of failure, excessive soil moisture, and fill soils

There were no defects or conditions identified where failure was probable, or expected in the next two years except of dead and adventitious branches. The likelihood of the remaining defects or conditions to lead to failure is possible, the likelihood of striking a target is high with severe or significant consequences. The result is the trees around the perimeter pose a moderate risk. Routine pruning maintenance and monitoring, would result in a low residual risk. Trees in area A have already beed removed, trees in area A1 are along the southern portion where prior failures have been to the north away from residences. Area B, C, and H have been pruned recently or removals have occurred with some exceptions. Trees along the Placer Street edge in area H have also been topped in recent years and have protection within the stand of dense trees. Areas D, E, and F have a few residences in striking distance and should be routinely pruned as typical maintenance. General routine maintenance and inspection is recommended.

---

[11] extreme: Defined by its placement in the risk rating matrix (Matrix 2); Failure is imminent with high likelihood of impacting the target, and the consequences of the failure are severe.

[12] high: High risk situations are those for which consequences are “significant” and likelihood is “very likely” or “likely” or consequences are “severe” and likelihood is “likely”.

[13] moderate: Situations for which consequences are “minor” and likelihood is “very likely” or “likely”; or likelihood is “somewhat likely” and consequences are “significant” or “severe”.

[14] low: pertaining to the risk categorization. Trees with low risk applies to those regardless of consequences when the likelihood is unlikely; or consequences are negligible or minor and likelihood is somewhat likely.

Recommendations

Perform work as scheduled or as budgets allow. Work should be performed within two years of the date of this report.

Routine Pruning

Prune the blue gums mourned the exterior to maintain their “natural form” to the following specifications:

Reduce the height of the trees to help reduce the risk of stem failure and to reduce the risk of a failure contacting the residence..

Remove dead, dying, broken, or weakly attached branches between 2 and 4 inches in diameter.

Reduce the height by approximately twenty-five percent where possible.

No more than fifty percent of the total live foliage shall be removed at one time. Interior “thinning” of the trees is not advised and may cause greater issues.

Large pruning cuts/wounds should be avoided where possible. Branch removal cuts are preferable with the understanding branch reduction cuts will be required to achieve the proper height reduction.

As needed: Restoration prune topped trees to remove forty percent (40%) of the sprouts, reduce thirty percent (30%) of the sprouts in length, and maintain thirty (30%) percent of the growth to help establish new structure. Remove any dead, broken and rubbing branches one inch (1”) in diameter and greater.

Root Collar Excavation and Examination

When indicated: Clear the soil and debris around the root collars of both trees to examine the structural integrity of this portion. This can be performed with hand tools or using pneumatic excavating tools. Have the root collar re-examined after excavation.

Re-inspection

- Restrict access under the trees during storm evens or high winds.
- Have the trees reassessed periodically and after any significant storm events for changes in condition.

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Appendix A: Risk Assessment Matrices

The table below is the matrix that defines the likelihood of tree failure impacting a target (Matrix 1).

Likelihood of failure	**Likelihood of impacting a target**			
	Very Low	**Low**	**Medium**	**High**
Imminent	Unlikely	Somewhat Likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat Likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat Likely
Impossible	Unlikely	Unlikely	Unlikely	Unlikely

The table above is established in the ISA Best Management Practices: Tree Risk Assessment, 2017.

The table below is the matrix that defines the likelihood of tree failure and the consequences (Matrix 2).

Likelihood of Failure and Impact	**Consequences**			
	Negligible	**Minor**	**Significant**	**Severe**
Very Likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat Likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

The table above is established in the ISA Best Management Practices: Tree Risk Assessment, 2017.

Appendix B: Specific Trees of Concern

Table 3: Trees of Concern

Location	I.D. #	Issue of Concern	Mitigation
Area A2	1278	Buried root collar	Clear root collar
Area A2	1279	Codominant stem oriented toward houses	Subordinate codominant stem
Area A2	1280	Buried root collar	Clear root collar
Area A2	1282	Buried root collar	Clear root collar
Area A2	1283	Leans away	Monitor
Area A2	1284	Codominant stem oriented toward houses	Subordinate codominant stem
Area A2	1304	Bowed toward residence	Reduce/monitor
Area A2	1328	Leans toward residence, on path	Reduce/monitor
Area A2	1311	45 Feet to residence	Reduce/monitor
Area A2	1348	36 Feet to residence, adjacent tree failed toward creek. Tree on slope	Reduce/monitor
Area B	1035	Leans toward residence	Reduce/monitor
Area B	1037	Leans toward residence	Reduce/monitor
Area B	1087	Codominant stem oriented toward houses	Subordinate codominant stem
Area B	1088	Top of fill bank	Monitor
Area B	1089	Top of fill bank	Monitor
Area B	1092	Totem	Retain and monitor/ Restoration Prune
Area B	1094	Top of fill bank, adjacent to road	Monitor
Area B	1095	Top of fill bank, adjacent to road	Monitor
Area B	1096	Top of fill bank, adjacent to road	Monitor
Area B	1097	Top of fill bank, adjacent to road	Monitor
Area B	1098	Top of fill bank, adjacent to road	Monitor
Area B	1121	Last two remaining against fence	Retain and monitor
Area B	1122	Last two remaining against fence	Retain and monitor
Area B	1141	At road cut asphalt to trunk	Monitor

Location	I.D. #	Issue of Concern	Mitigation
Area B	1191	Edge near residence all topped recently	Monitor and restoration prune
Area B	1192	Edge near residence all topped recently	Monitor and restoration prune
Area B	1195	Edge near residence all topped recently	Monitor and restoration prune
Area B	1193	Top above the rear	Monitor
Area C	1262	Lone tree left remaining topped emergency pruned	Retain and monitor/ Restoration Prune
Area D	668	Bowed toward residence yard	Reduce in height or remove
Area H, F, E		Routine Maintenance	Routine pruning

Appendix C: Photographs

C1: Buried root collar and codominant stems



C2: Topped trees area B and C



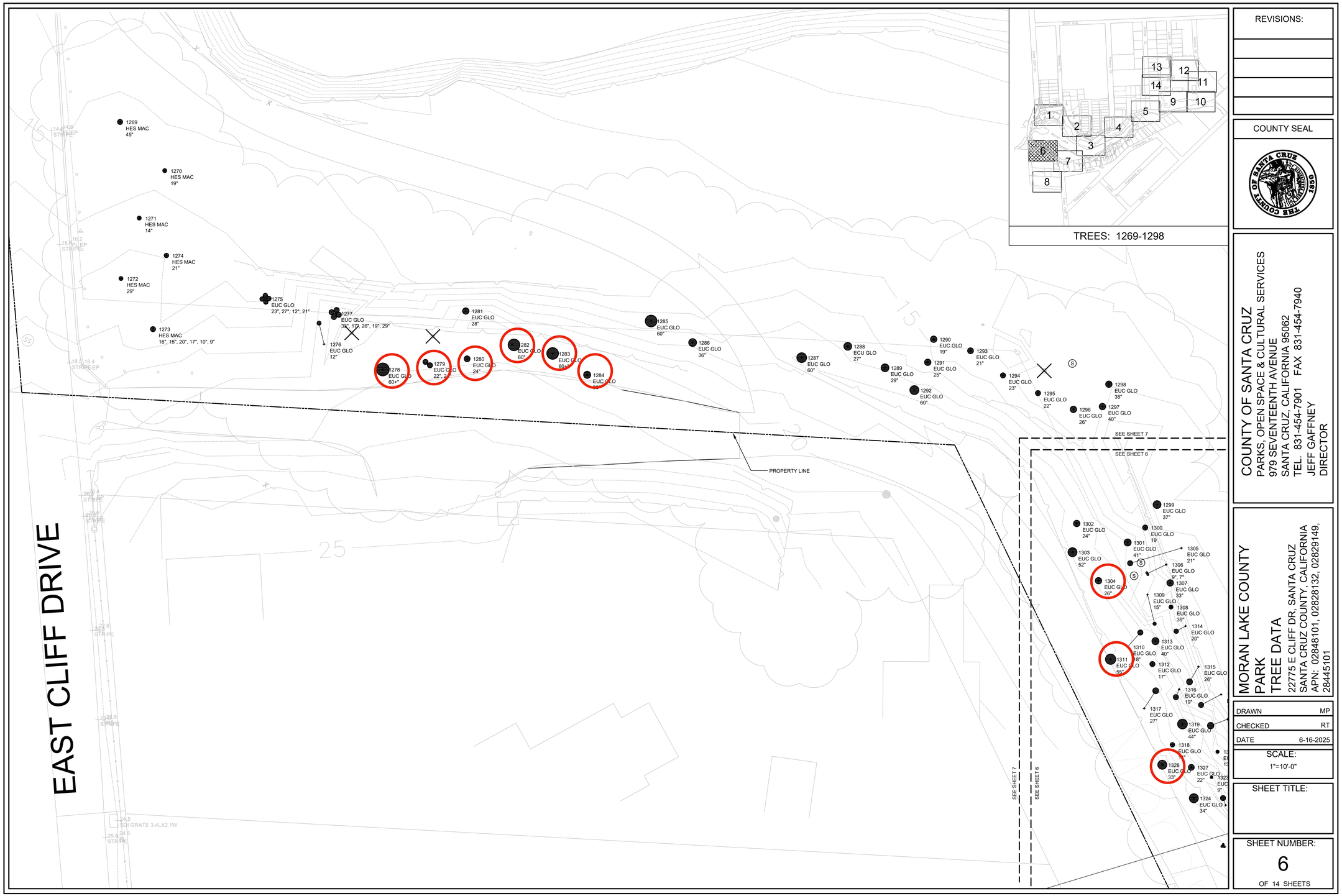
C3: Edge trees along the F boundary



C4: Lone tree #262 remaining in Area C



Appendix D: Site Plan Tree Locations



TREES: 1269-1298

REVISIONS:

COUNTY SEAL

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JEFF GAFFNEY
DIRECTOR

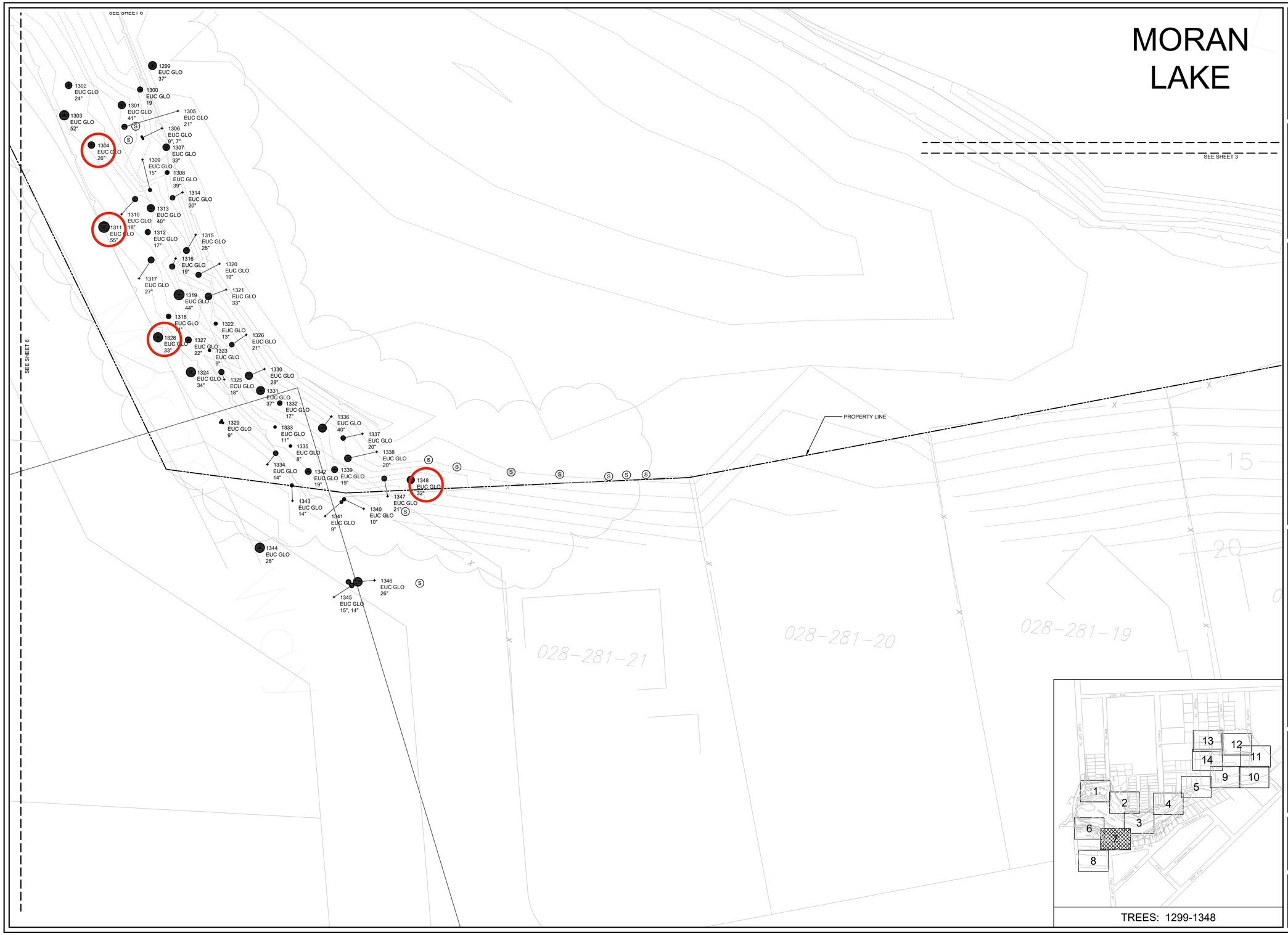
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SANTA CRUZ COUNTY, CALIFORNIA
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CHECKED	RT
DATE	6-16-2025

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SHEET TITLE:

SHEET NUMBER: 6
OF 14 SHEETS



MORAN LAKE

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MORAN LAKE COUNTY PARK
TREE DATA
22775 E CLIFF DR, SANTA CRUZ
SANTA CRUZ COUNTY, CALIFORNIA
APN: 02848101, 02828132, 02829149, 28445101

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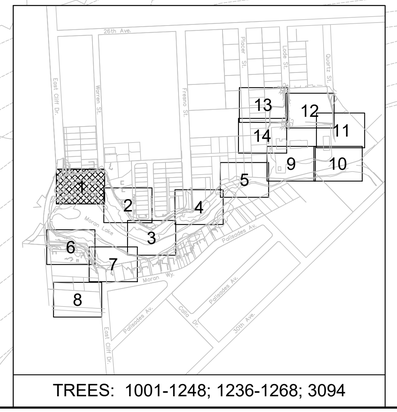
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STUMP MISSING
TAG MISSING
#1029 TAG
SUCKER GROWTH FROM STUMP
TRAIL EDGE, TYP.
SSMH
RIM 12.80
INV 6.9
BOLLARD
SEE SHEET 2

*1007
*1008
*1009
*1010
*1011
*1016
*1017
*1021
*1022
*1023

1001 HES MAC 16"
1002 HES MAC 34"
1003 HES MAC 6"
1004 HES MAC 8"
1005 HES MAC 17"
1006 HES MAC 21"
1014 EUC GLO 16", 12"
1015 EUC GLO 10"
1018 EUC GLO 17"
1019 EUC GLO 44"
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1034 EUC GLO *TBD
1034 EUC GLO 36"
1035 EUC GLO 25"
1036 EUC GLO 17"
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HWR 8/21-22/25
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EWR 7/30/25 HWR 8/4/25 HWR 8/6/25 HWR 8/21-22/25



TREES: 1001-1248; 1236-1268; 3094

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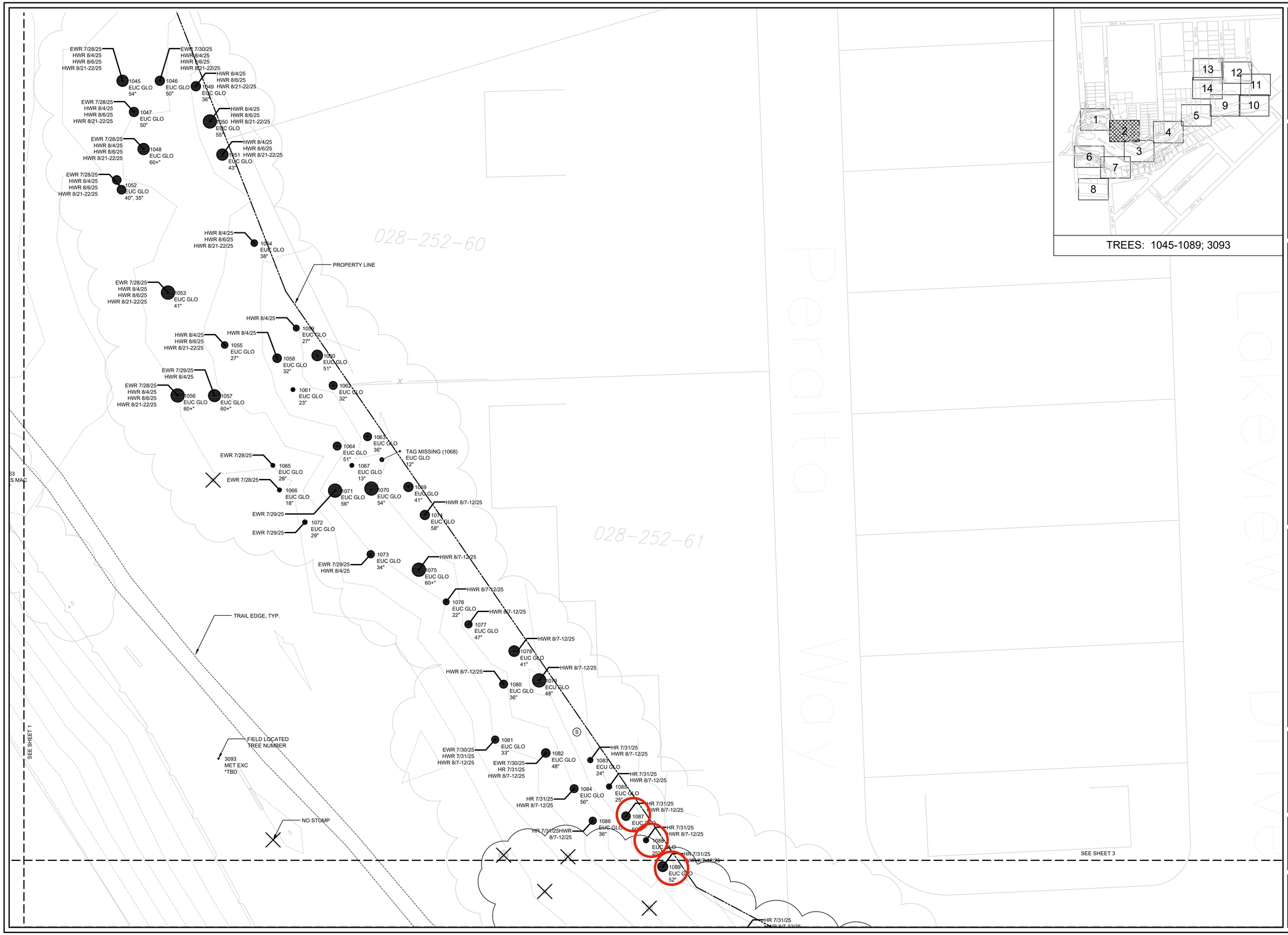
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SANTA CRUZ COUNTY, CALIFORNIA
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SHEET NUMBER: 1 OF 14 SHEETS



TREES: 1045-1089; 3093

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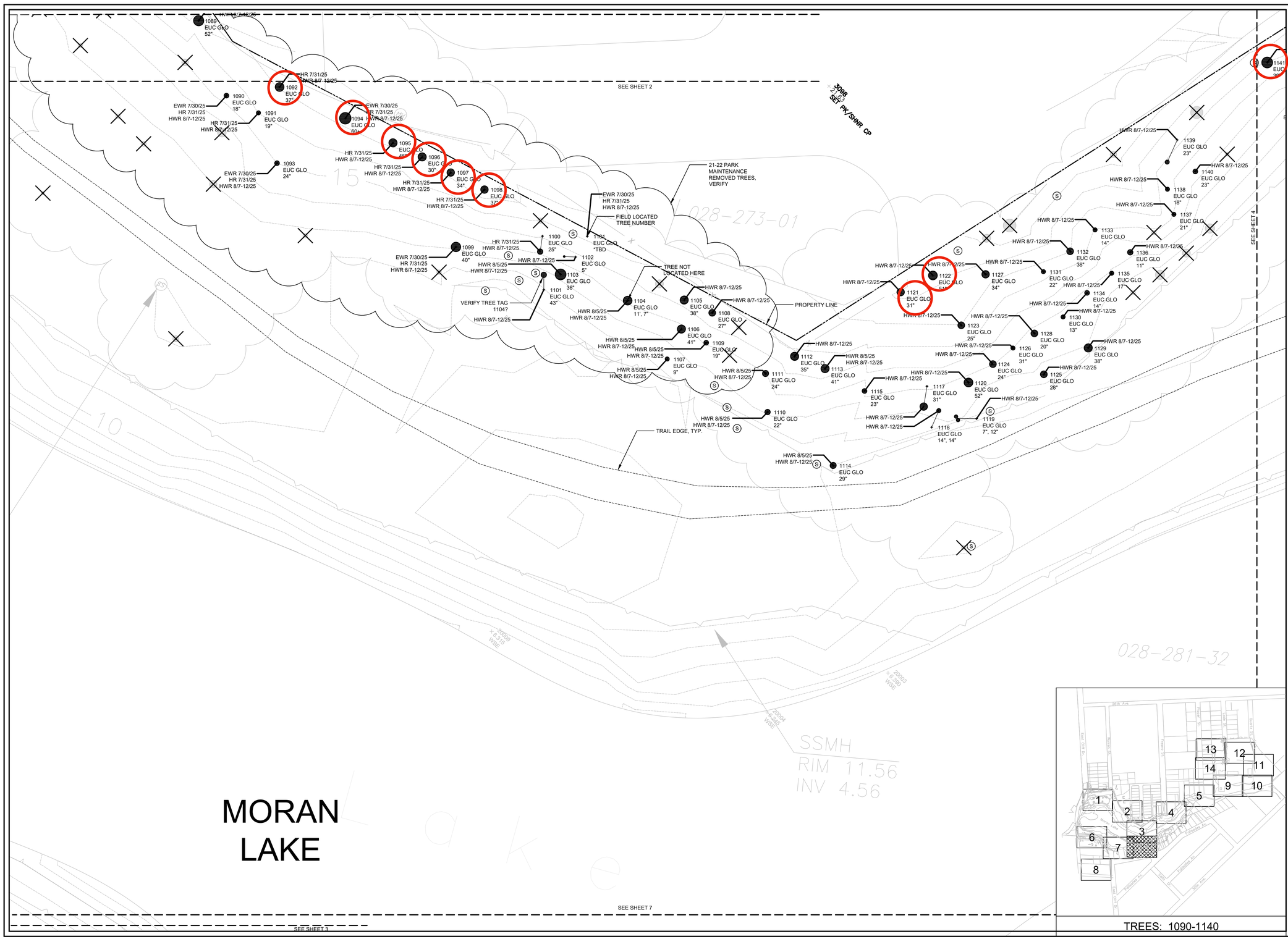
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SANTA CRUZ COUNTY, CALIFORNIA
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OF 14 SHEETS



TREES: 1090-1140

REVISIONS:

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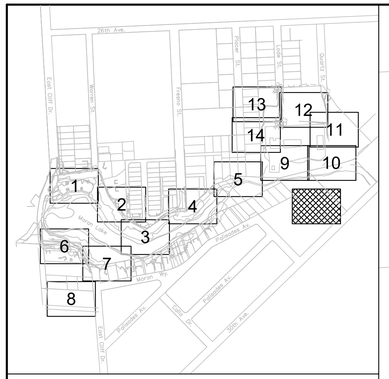
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SHEET NUMBER: 3
OF 14 SHEETS



TREES: 1041-1217

028-263-66

028-263-67

SEE SHEET 5

SEE SHEET 3

PROPERTY LINE

339± lf rnsg / annrd 1994

TRAIL EDGE, TYP.

SUCKER GROWTH FROM STUMP

#1252, VERIFY

#1152, VERIFY

MORAN LAKE

HWR 8/11-20/25
HWR 8/21-22/25
1217
EUC GLO
14", 6", 8"

HWR 8/11-20/25
HWR 8/21-22/25
1216
EUC GLO
16", 18"

HWR 8/11-20/25
HWR 8/21-22/25
1213
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11"

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EUC GLO
17"

HWR 8/11-20/25
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HWR 8/11-20/25
HWR 8/21-22/25
1195
EUC GLO
28"

HWR 8/11-20/25
HWR 8/21-22/25
1194
EUC GLO
16"

HWR 8/11-20/25
HWR 8/21-22/25
1193
EUC GLO
41"

HWR 8/11-20/25
HWR 8/21-22/25
1192
EUC GLO
20"

HWR 8/11-20/25
HWR 8/21-22/25
1191
EUC GLO
28"

HWR 8/11-20/25
HWR 8/21-22/25
1190
EUC GLO
58"

HWR 8/11-20/25
HWR 8/21-22/25
1189
EUC GLO
51"

HWR 8/11-20/25
HWR 8/21-22/25
1188
EUC GLO
25"

HWR 8/11-20/25
HWR 8/21-22/25
1187
EUC GLO
24"

HWR 8/11-20/25
HWR 8/21-22/25
1186
EUC GLO
22"

HWR 8/11-20/25
HWR 8/21-22/25
1185
EUC GLO
38"

HWR 8/11-20/25
HWR 8/21-22/25
1184
EUC GLO
27"

HWR 8/11-20/25
HWR 8/21-22/25
1183
EUC GLO
16"

HWR 8/11-20/25
HWR 8/21-22/25
1182
EUC GLO
20"

HWR 8/11-20/25
HWR 8/21-22/25
1181
EUC GLO
40"

HWR 8/11-20/25
HWR 8/21-22/25
1180
EUC GLO
20"

HWR 8/11-20/25
HWR 8/21-22/25
1179
EUC GLO
29"

HWR 8/11-20/25
HWR 8/21-22/25
1178
EUC GLO
20"

HWR 8/11-20/25
HWR 8/21-22/25
1177
EUC GLO
34"

HWR 8/11-20/25
HWR 8/21-22/25
1176
EUC GLO
52"

HWR 8/11-20/25
HWR 8/21-22/25
1175
EUC GLO
19"

HWR 8/11-20/25
HWR 8/21-22/25
1174
EUC GLO
36"

HWR 8/11-20/25
HWR 8/21-22/25
1173
EUC GLO
21"

1172
EUC GLO
23"

1171
EUC GLO
55"

1170
EUC GLO
43"

1169
EUC GLO
9"

1168
EUC GLO
18"

1166
EUC GLO
9"

1165
EUC GLO
28"

HWR 8/7-12/25
1163
EUC GLO
51"

HWR 8/7-12/25
1164
EUC GLO
38"

HWR 8/7-12/25
1160
EUC GLO
32"

HWR 8/7-12/25
1159
EUC GLO
38"

HWR 8/7-12/25
1158
EUC GLO
37"

HWR 8/7-12/25
1157
EUC GLO
9", 9", 14"

HWR 8/7-12/25
1156
EUC GLO
10", 6"

HWR 8/7-12/25
1155
EUC GLO
16", 6"

HWR 8/7-12/25
1154
EUC GLO
7", 4", 4"

HWR 8/7-12/25
1153
EUC GLO
9", 4"

HWR 8/7-12/25
1152
EUC GLO
13", 19", 9"

HWR 8/7-12/25
1151
EUC GLO
22"

1161
EUC GLO
9"

1162
EUC GLO
36"

HWR 8/7-12/25
1150
EUC GLO
31"

HWR 8/7-12/25
1149
EUC GLO
51"

HWR 8/7-12/25
1148
EUC GLO
10", 9", 14"

HWR 8/7-12/25
1147
EUC GLO
30"

HWR 8/7-12/25
1145
EUC GLO
25"

HWR 8/7-12/25
1144
EUC GLO
32"

HWR 8/7-12/25
1143
EUC GLO
30"

HWR 8/7-12/25
1142
EUC GLO
44"

HWR 8/7-12/25
1141
EUC GLO
30"

REVISIONS:

COUNTY SEAL

COUNTY OF SANTA CRUZ
PARKS, OPEN SPACE & CULTURAL SERVICES
979 SEVENTEENTH AVENUE
SANTA CRUZ, CALIFORNIA 95062
TEL. 831-454-7901 FAX 831-454-7940
JEFF GAFFNEY
DIRECTOR

MORAN LAKE COUNTY PARK
TREE DATA
22775 E CLIFF DR, SANTA CRUZ
SANTA CRUZ COUNTY, CALIFORNIA
APN: 02848101, 02828132, 02829149, 28445101

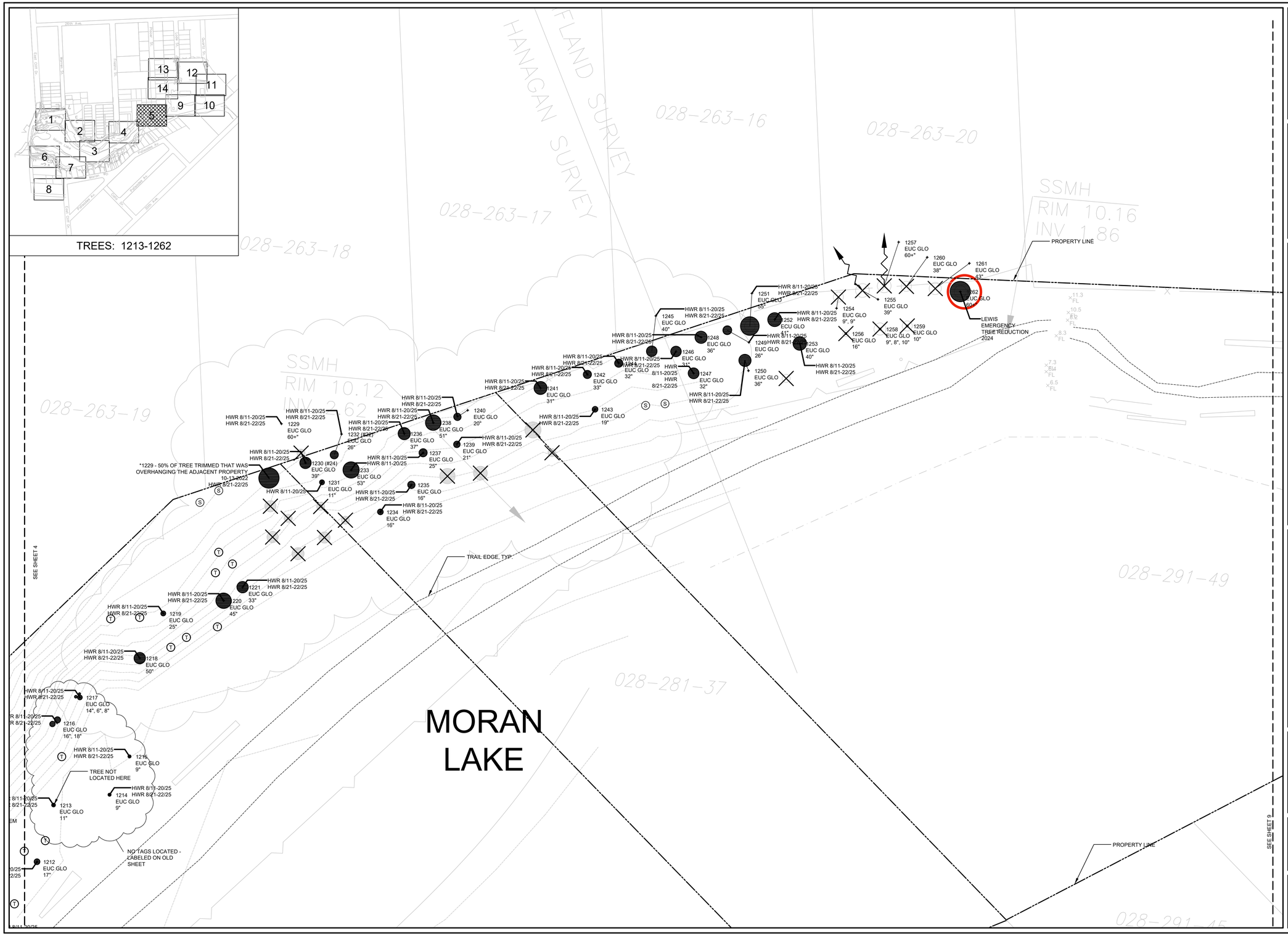
DRAWN	MP
CHECKED	RT
DATE	6-16-2025

SCALE:
1"=10'-0"

SHEET TITLE:

SHEET NUMBER:
4
OF 14 SHEETS

TREES: 1213-1262



REVISIONS:

COUNTY SEAL

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SANTA CRUZ, CALIFORNIA 95062
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MORAN LAKE COUNTY PARK
TREE DATA
22775 E CLIFF DR, SANTA CRUZ
SANTA CRUZ COUNTY, CALIFORNIA
APN: 02848101, 02828132, 02829149, 28445101

DRAWN	MP
CHECKED	RT
DATE	6-16-2025

SCALE:
1"=10'-0"

SHEET TITLE:

SHEET NUMBER:
5
OF 14 SHEETS



TREES: 504-711; 736; 3055-3060

REVISIONS:

COUNTY SEAL

COUNTY OF SANTA CRUZ
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MORAN LAKE COUNTY PARK
TREE DATA
22775 E CLIFF DR, SANTA CRUZ
SANTA CRUZ COUNTY, CALIFORNIA
APN: 02848101, 02828132, 02829149, 28445101

DRAWN	MP
CHECKED	RT
DATE	6-16-2025

SCALE: 1"=10'-0"

SHEET TITLE:

SHEET NUMBER: 9 OF 14 SHEETS

Qualifications, Assumptions, and Limiting Conditions

Any legal description provided to the consultant is assumed to be correct. Any titles or ownership of properties are assumed to be good and marketable. All property is appraised or evaluated as though free and clear, under responsible ownership and competent management.

All property is presumed to be in conformance with applicable codes, ordinances, statutes, or other regulations.

Care has been taken to obtain information from reliable sources. However, the consultant cannot be responsible for the accuracy of information provided by others.

The consultant shall not be required to give testimony or attend meetings, hearings, conferences, mediations, arbitration, or trials by reason of this report unless subsequent contractual arrangements are made, including payment of an additional fee for such services.

This report and any appraisal value expressed herein represent the opinion of the consultant, and the consultant's fee is not contingent upon the reporting of a specified appraisal value, a stipulated result, or the occurrence of a subsequent event.

Sketches, drawings, and photographs in this report are intended for use as visual aids, are not necessarily to scale, and should not be construed as engineering or architectural reports or surveys. The reproduction of information generated by architects, engineers, or other consultants on any sketches, drawings, or photographs is only for coordination and ease of reference. Inclusion of said information with any drawings or other documents does not constitute a representation as to the sufficiency or accuracy of said information.

Unless otherwise expressed: a) this report covers only examined items and their condition at the time of inspection; and b) the inspection is limited to visual examination of accessible items without dissection, excavation, probing, or coring. There is no warranty or guarantee, expressed or implied, that structural problems or deficiencies of plants or property may not arise in the future.

Certification of Performance

I Richard Gessner, Certify:

That I have personally inspected the tree(s) and/or the property referred to in this report, and have stated my findings accurately. The extent of the evaluation and/or appraisal is stated in the attached report and Terms of Assignment;

That I have no current or prospective interest in the vegetation or the property that is the subject of this report, and I have no personal interest or bias with respect to the parties involved;

That the analysis, opinions and conclusions stated herein are my own;

That my analysis, opinions, and conclusions were developed and this report has been prepared according to commonly accepted Arboricultural practices;

That no one provided significant professional assistance to the consultant, except as indicated within the report.

That my compensation is not contingent upon the reporting of a predetermined conclusion that favors the cause of the client or any other party, nor upon the results of the assessment, the attainment of stipulated results, or the occurrence of any other subsequent events;

I further certify that I am a Registered Consulting Arborist® with the American Society of Consulting Arborists, and that I acknowledge, accept and adhere to the ASCA Standards of Professional Practice. I am an International Society of Arboriculture Board Certified Master Arborist® and Tree Risk Assessor Qualified. I have been involved with the practice of Arboriculture and the care and study of trees since 1998.

Richard J. Gessner 

ASCA Registered Consulting Arborist® #496
ISA Board Certified Master Arborist® WE-4341B
ISA Tree Risk Assessor Qualified

ASCA RCA #496
Registered Consulting Arborist®

BOARD CERTIFIED MASTER ARBORIST ISA ™

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