Draft

COLLEGE LAKE INTEGRATED RESOURCES MANAGEMENT PROJECT

Adaptive Management Plan

Prepared for
Pajaro Valley Water Management Agency

November 2021

Pajaro Valley Water Management Agency

ESA

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Acronyms and Abbreviations

AF, AFY	acre feet, acre feet per year
AMP, Plan	adaptive management plan
BA	biological assessment
BO	biological opinion
CDFW	California Department of Fish and Wildlife
CDS	Coastal Distribution System
CHRIS	California Historical Resources Information System
Committee	Ad Hoc Adaptive Management Plan Committee
EIR	environmental impact report
IRMP	Integrated Resources Management Plan
MAVC	Mosquito Abatement and Vector Control
MMRP	mitigation monitoring and reporting program
NAVD	North American Vertical Datum
ND	No Date
NMFS	National Marine Fisheries Service
NWIC	Northwest Information Center
O&M	operations and maintenance
PEIR	programmatic environmental impact report
Project	College Lake Integrated Resources Management Plan
PV Water	Pajaro Valley Water Agency

RD 2049	Reclamation District 2049
RWQCB	Regional Water Quality Control Board
USFWS	U.S. Fish and Wildlife Service
WRP	water right permit
WSE	water surface elevation
WTP	water treatment plant
USFWS	U.S. Fish and Wildlife Service

Species Names

Alder	*Alnus* spp.
American bullfrog	*Lithobates catesbeianus*
American peregrine falcon	*Falco peregrinus*
arroyo willow	*Salix lasiolepis*
bald eagle	*Haliaeetus leucocephalus*
barnyard grass	*Echinochloa crus-galli*
Bermuda grass	*Cynadon dactylon*
black bullhead	*Ameiurus melas*
black cottonwood	*Populus trichocarpa*
bluegill	*Lepomis macrochirus*
box elder	*Acer negundo* var. *californicum*
bristly ox-tongue	*Helminthotheca echioides*
brown bullhead	*Ameiurus nebulosus*
Bryant's savannah sparrow	*Passerculus sandwichensis alaudinus*
California blackberry	*Rubus ursinus*
California red-legged frog	*Rana draytonii*
coast live oak	*Quercus agrifolia*
channel catfish	*Ictalurus punctatus*
cocklebur	*Xanthium strumarium*
common carp	*Cyprinus carpio*
coyote brush	*Baccharis pilularis*

curly dock	*Rumex crispus*
dogwood	*Cornus* sp.
encephalitis mosquito	*Culex tarsalis*
floodwater mosquito	*Aedes washinoi*
fathead minnow	*Pimephales promelas*
at-hen	*Atriplex prostrata*
giant reed	*Arundo donax*
golden eagle	*Aquila chrysaetos*
golden shiner	*Notemigonus chrysoleucas*
Himalayan blackberry	*Rubus armeniacus*
largemouth bass	*Micropterus salmoides*
nettle	*Urtica* sp.
red willow	*Salix laevigata*
rushes	*Juncus* spp.
San Francisco dusky-footed woodrat	*Neotoma fuscipes annectens*
Shining pondweed	*Potamogeton illinoensis*
shining willow	*Salix lasiandra* var. *lasiandra*
short-eared owl	*Asio flammeus*
signal crayfish	*Pacifastacus leniusculus*
smartweeds	*Persicaria* spp.
Steelhead	*Oncorhynchus mykiss*
swamp pricklegrass	*Crypsis schoenoides, C. vaginiflora*
tricolored blackbird	*Agelaius tricolor*
western burrowing owl	*Athene cunicularia*

western pond turtle	*Actinemys marmorata*
western red bat	*Lasiurus blossevillii*
western sycamore	*Platanus racemosa*
white sweetclover	*Melilotus albus*
white-tailed kite	*Elanus leucurus*
yellow warbler	*Setophaga petechial*

CHAPTER 1

Overview

This chapter states the purpose of the Adaptive Management Plan (AMP or Plan), describes its development process, and outlines the document's organization.

1.1 Purpose of the Adaptive Management Plan

Adaptive management is a structured process that allows for taking action under uncertain conditions based on the best available science and information, closely monitoring and evaluating outcomes, and then re-evaluating and adjusting decisions as more information is learned.[1]

Implementation of the College Lake Integrated Resources Management Project (Project) will be adaptively managed. The purpose of this AMP is to provide an adaptive management framework, including metrics, triggers, and management actions, to guide operations and maintenance (O&M) of the Project, and in particular to mitigate negative impacts to the College Lake ecosystem.

1.2 Adaptive Management Plan Development

This AMP has been developed to fulfill a mitigation measure of the 2014 Basin Management Plan Update Programmatic Environmental Impact Report (PEIR; Pajaro Valley Water Management Agency [PV Water] 2014) and related mitigation measures of the 2019 College Lake Integrated Resources Management Project Draft Environmental Impact Report (EIR; PV Water 2019). It has been developed consistent with the Project's objectives, regulatory requirements, and related plans, and with input from an Ad Hoc AMP Committee (Committee). The development and subsequent implementation of this Plan also fulfills Term and Condition 32 of the Project's Water Right Permit (A032881). The following sections describe the EIR and regulatory requirements, other related plans, and the involvement of the Committee.

1.2.1 EIR Requirements

This AMP fulfills Mitigation Measure BIO-2i.1 (Develop Adaptive Management Plan for College Lake Waterfowl Management and Multi-Species Mitigation) that was included in the mitigation

[1] A relevant definition of adaptive management is provided in the Delta Reform Act: "a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives" (Water Code Section 85052).

monitoring and reporting program (MMRP) adopted by PV Water's Board of Directors for the 2014 Basin Management Plan Update Programmatic Environmental Impact Report (PV Water 2014). This AMP:

- Was developed in collaboration with state and federal resource agencies and College Lake stakeholders through formation of the Committee
- Applies multi-year baseline waterfowl population and habitat use data developed to inform management
- Applies multi-year baseline steelhead surveys developed to inform management
- Integrates the results of ongoing College Lake hydrology and hydraulic analyses, as well as consultations with state and federal agencies on fish flows and fish bypass criteria
- Includes terms and conditions from applicable permits and agreements as appropriate, and defines provisions for monitoring assignments, scheduling, and responsibility
- Includes habitat replacement and revegetation, protection during ground-disturbing activities, performance standards, maintenance criteria, and monitoring requirements for temporary and permanent impacts consistent with mitigation in the 2019 College Lake Integrated Resources Management Project Draft Environmental Impact Report (2019 Draft EIR)[2] and regulatory requirements established during project-specific review
- Is in conformance with the mitigation measures from the 2019 Draft EIR, and includes terms and conditions consistent with regulatory requirements as applicable from permits

Table 1-1 provides the text of Mitigation Measure BIO-2.i-1 and two other mitigation measures (HYD-2a and BR-2) of the 2019 Draft EIR that reference the AMP. Both Mitigation Measures HYD-2a and BR-2 require monitoring that is part of management plans closely related to both the initial framework to support adaptive management planning and the anticipated AMP, and which are described in the following section.

TABLE 1-1
ADAPTIVE-MANAGEMENT-RELATED MITIGATION MEASURES OF BASIN MANAGEMENT PLAN PEIR AND COLLEGE LAKE INTEGRATED RESOURCES MANAGEMENT PROJECT EIR

BIO-2i.1: Develop Adaptive Management Plan for College Lake Waterfowl Management and Multi-Species Mitigation.
To mitigate impacts to existing waterfowl or waterfowl habitat at College Lake, an Adaptive Management Plan for waterfowl management and multi-species mitigation will be developed with the consultation of the state and federal resource agencies and College Lake stakeholders. The Adaptive Management Plan for waterfowl management and multi-species mitigation at College Lake will develop multi-year baseline waterfowl population and habitat use data for future project design, environmental permitting and CEQA impact analysis of project-level alternatives. To the extent practical, it will integrate the results of ongoing College Lake hydrology and hydraulic analyses, as well as future consultations with state and federal agencies on fish flows and fish bypass criteria.
The Management Plan will be specific to the level of impact and mitigations under site-specific and project implementation conditions. However, the following standards will apply as defined during project-level design, regulatory review and CEQA analysis: The Management Plan should include terms and conditions from applicable permits and agreements as appropriate

[2] PV Water. 2019. College Lake Integrated Resources Management Project Environmental Impact Report. SCH# 2017112063

TABLE 1-1
ADAPTIVE-MANAGEMENT-RELATED MITIGATION MEASURES OF BASIN MANAGEMENT PLAN PEIR AND COLLEGE LAKE INTEGRATED RESOURCES MANAGEMENT PROJECT EIR

and define provisions for monitoring assignments, scheduling, and responsibility. The Management Plan should also include habitat replacement and revegetation, protection during ground-disturbing activities, performance standards, maintenance criteria, and monitoring requirements for temporary and permanent impacts consistent with mitigation in this EIR and regulatory requirements during project- specific review. The Management Plan will be in conformance with the biology mitigation measures from this EIR, and will also include terms and conditions consistent regulatory requirements as applicable from the U. S. Fish and Wildlife Service (USFWS), National Marine Fisheries Services (NMFS), U. S. Army Corps of Engineers (USACE), California State Water Resources Control Board, (SWRCB), Central Coast Regional Water Quality Control Board (RWQCB), and California Department of Fish and Wildlife (CDFW) permits during project design and permitting as applicable. The Management Plan will be prepared for project level project implementation as determined needed through future CEQA review and consultation with agencies as required under the California Endangered Species Act (CESA) and federal Endangered Species Act (ESA).
Mitigation Measure BR-2: Invasive Fish Species Control Plan. PV Water shall develop an Invasive Fish Species Control Plan. PV Water would submit the plan to the appropriate resource agencies (CDFW, USFWS, and NMFS) for approval within one year of Project implementation. The Fish Species Control Plan shall be implemented at College Lake within two years of Project implementation. The Fish Species Control Plan shall include, at a minimum: 1. Measures describing PV Water's methods of draining College Lake to the greatest extent feasible; 2. Measures describing PV Water's methods, equipment, and timing of invasive species eradication efforts to be conducted in association with lake drawdown efforts; 3. Measures describing the frequency at which invasive species control efforts are to be implemented.
HYD-2a: Water Quality Adaptive Management for College Lake. To learn about potential impacts of the Project on College Lake water quality and the quality of downstream water bodies, PV Water shall monitor College Lake water for indications of Cyanobacteria blooms. When the proposed weir crest is elevated to 62.5 feet NAVD88, PV Water shall monitor College Lake water temperature within the water column to establish whether a thermocline develops. PV Water shall use results of this monitoring to support the development of the Adaptive Management Plan (refer to Section 2.7) that establishes management actions to minimize the conditions that can contribute to algal blooms, including cyanobacteria blooms, such that this impact is mitigated.

Source: PV Water 2014, 2019

1.2.2 Regulatory Compliance and Related Plans

Consistent with adopted Mitigation Measure BIO-2i.1, PV Water first engaged with state and federal resources agencies (National Marine Fisheries Service [NMFS], U.S. Fish and Wildlife Service [USFWS], Regional Water Quality Control Board [RWQCB], and California Department of Fish and Wildlife [CDFW]) to refine concepts for specific AMP objectives, and to make minor modifications to the proposed operations and maintenance described in 2019 Draft EIR Section 2.7.2 to conform with anticipated conditions in permits and other agreements. Through initial coordination with regulatory stakeholders, PV Water gained a more detailed understanding of the obligations of permits and other approvals that will govern Project O&M and be incorporated into the AMP. These requirements include avoidance and minimization measures and related monitoring and management plans that are described in the following sections.

1.2.2.1 Avoidance and Minimization Measures

Multiple measures required to avoid and minimize impacts to the environment will be implemented as part of the maintenance activities and operations that will be adaptively managed per this Plan. These measures are included in the Project's MMRP or its water right permit (WRP), or are proposed as conservation measures in the biological assessments prepared for NMFS and USFWS. These measures are listed in **Table 1-2** and provided in full in **Appendix A, "Measures to Avoid and Minimize Impacts of Operations and Maintenance**

Activities." Conservation measures proposed in the biological assessments (BAs) will be superseded by the conservation measures included in the biological opinions (BOs).

TABLE 1-2
MEASURES TO AVOID AND MINIMIZE IMPACTS OF OPERATIONS AND MAINTENANCE ACTIVITIES

Measure Title	Source
Promote Farming	MMRP: LU-1a
Replacement of Topsoil	MMRP: LU-1c
Nesting Bird Surveys	MMRP: BIO-2i
California Red-legged Frog Qualified Biologists	MMRP (and USFWS BA): BIO-2j, CRF-1
California Red-legged Frog Survey	MMRP (and USFWS BA): BIO-2j, CRF-2
California Red-legged Frog Training	MMRP (and USFWS BA): BIO-2j, CRF-3
California Red-legged Frog Monitoring	MMRP and USFWS BA: BIO-2j, CRF-4
Staging and Access Routes	MMRP (and USFWS BA): BIO-2j, CRF-5, WPT - 5
California Red-legged Frog Seasonal Restrictions	MMRP (and USFWS BA): BIO-2j, CRF-6
Dewatering Procedures	MMRP (and USFWS BA): BIO-2j, CRF-7
Amphibian Pathogen and Parasite Prevention	MMRP (and USFWS BA): BIO-2j, CRF-8
Water Quality Protection	MMRP: BIO-2j, CRF-9
Western Pond Turtle Qualified Biologists	MMRP: BIO-2k, WPT-1
Western Pond Turtle Survey	MMRP: BIO-2k, WPT-2
Western Pond Turtle Training	MMRP: BIO-2k, WPT-3
Western Pond Turtle Monitoring	MMRP: BIO-2k, WPT-4
Standard measures to maintain water quality and to control erosion and sedimentation	BA for USFWS: Conservation Measure (CM) 1 (California Red-legged Frog) MMRP: BIO-1b
Collection of Seeds and Revegetation	MMRP: BIO-3b
Revegetate and Restore Mixed Riparian and Willow Riparian Forest	MMRP: BIO-1c (Revised)
Open Water and Wetland Revegetation and Restoration	BA for USFWS: CM 1 (California Red-legged Frog) MMRP: BIO-1d
Delineate Work Area	BA for USFWS: CM 1 (California Red-legged Frog) MMRP: BIO-2e
Special-Status Species Clearance Surveys	BA for USFWS: CM 1 (California Red-legged Frog) MMRP: BIO-2f
Exotic Species Removal	BA for USFWS: CM 1 (California Red-legged Frog) MMRP: BIO-2g
Notification of Dead or Injured Individuals of Special-Status Species	BA for USFWS: CM 1 (California Red-legged Frog) MMRP: BIO-2h
Steep-walled Holes and Trenches	BA for USFWS: CM 1 (California Red-legged Frog)
Inspect Pipes for Special-Status Species	BA for USFWS: CM 1 (California Red-legged Frog)
Stockpile Storage	BA for USFWS: CM 1 (California Red-legged Frog)
Amphibian Friendly Erosion Control Materials	BA for USFWS: CM 1 (California Red-legged Frog)
Speed Limit	BA for USFWS: CM 1 (California Red-legged Frog)
Avoid Disturbance of Emergent Vegetation	BA for USFWS: CM 1 (California Red-legged Frog)

TABLE 1-2
MEASURES TO AVOID AND MINIMIZE IMPACTS OF OPERATIONS AND MAINTENANCE ACTIVITIES

Measure Title	Source
Invasive Plant Disposal	BA for USFWS: CM 1 California Red-legged Frog
Vegetation Removal	BA for USFWS: CM 1 (California Red-legged Frog)
Steelhead Monitoring	BA for NMFS: Steelhead CMs MMRP: BIO-2l FISH-1
Coffer Dam Monitoring	BA for NMFS: Steelhead CMs MMRP BIO-2l FISH-2
Coffer Dam Dewatering	BA for NMFS: Steelhead CMs MMRP: BIO-2l FISH-3
Dewatering Procedures	BA for NMFS: Steelhead CMs MMRP: BIO-2l FISH-4
Coffer Dam Removal	BA for NMFS: Steelhead CMs MMRP: BIO-2l FISH-5
Implement Water Quality BMPs	BA for NMFS: Steelhead CMs MMRP: BIO-2l FISH-6
Water Diversion Seasonal Restrictions	MMRP: BIO-2m
Protection of Steelhead Migratory Habitat: Seasonal Restrictions	BA for NMFS: Steelhead CMs MMRP: BIO-2n
Protection of Steelhead Migratory Habitat: Bypass Flow Requirements	BA for NMFS: Steelhead CMs MMRP: BIO-2o
Streamflow Gauging Stations	BA for NMFS: Steelhead CMs MMRP: BIO-2p
Water Quality Permits	BA for NMFS: Steelhead CMs MMRP: HWQ-1
Avoid Rapid Water Level Fluctuations	MMRP: HWQ-2
Well Production and Pumping Rates	MMRP: HWQ-3
Fish Relocations	BA for NMFS: Steelhead CMs MMRP: BR-1a
Invasive Fish Species Control Plan	BA for NMFS: Steelhead CMs MMRP: BR-2
Implement Dewatering Best Management Practices for In-Water Construction	BA for NMFS: Steelhead CMs MMRP: HYD-1
Water Quality Adaptive Management for College Lake	MMRP: HYD-2a
Avoid Flooding at Pajaro Dunes During Pumped Flow	MMRP: HYD-3
Long-Term Monitoring of CA-SCR-44/H and CA-SCR-150	MMRP: CUL-1i

Sources: PV Water, *College Lake Integrated Resources Management Project Environmental Impact Report*, Final Mitigation Monitoring and Reporting Program, October 2019; BA prepared for USFWS and BA and Essential Fish Habitat Assessment prepared for NMFS for the College Lake Integrated Resource Management Project

1.2.2.2 Related Management Plans

The Project will develop and implement several related monitoring and management plans required by the Project's EIR mitigation measures or its WRP, which are described in refer to **Table 1-3**. These related plans include a Water Quality Monitoring Plan, Steelhead Monitoring Plan, Invasive Species Management Plan, Compliance Plan, and Operations and Maintenance Plan. All of these plans have a role in implementation of the Project and will be considered in its adaptive management. The AMP serves as an umbrella document for all of these plans so that management can be evaluated holistically (i.e., these plans are part of the AMP, and adaptive management of the Project includes implementation of these plans).

TABLE 1-3
MONITORING AND MANAGEMENT PLANS RELATED TO THE ADAPTIVE MANAGEMENT PLAN

Plan	Origin	Scope	Status
Water Quality Monitoring Plan	Mitigation Measure HYD-2a, (Prevention of Cyanobacteria Formation), CDFW requested as condition to dismiss Water Right protest	Addresses monitoring of ecologically important water quality constituents (e.g., dissolved oxygen, temperature)	Drafted and submitted to regulatory agencies
Steelhead Monitoring Plan	2014 commitment by PV Water, NMFS requested as condition to dismiss Water Right protest	Addresses effectiveness of fish passage at the weir, and effectiveness of the bypass flows through Salsipuedes Creek.	Completion planned for November 2021
Invasive Species Management Plan	CEQA requirement, dismissal of Water Right protest	Addresses management of invasive species, including bullfrogs and non-native piscivorous fishes, in College Lake during Project operations and maintenance.	Drafted and submitted to regulatory agencies
Compliance Plan	SWRCB requirement	Addresses how compliance with each term of the WRP will be determined	In preparation; to be finalized after receipt of the WRP.
Operations and Maintenance Plan	Need for guidance for operations including timing of annual weir raising.	Addresses timing of weir raising, timing and size of diversions, operation of fish passageway structure, and maintenance of fish passageway passage structure; during consultations, regulatory agencies may request additional content.	To be developed after all permits secured

1.2.3 Ad Hoc Adaptive Management Plan Committee

Following initial engagement with regulatory agencies, the AMP was developed in conjunction with a series of meetings of the Committee formed by PV Water to solicit stakeholder input through a transparent and inclusive process. During these meetings, which occurred in 2021, key AMP content was discussed and Committee members provided input and made recommendations. The Committee was supported by PV Water staff and consultants, including technical experts in fisheries, terrestrial wildlife, botany and wetlands, and hydrology.

Specifically, Committee members were asked to review and provide recommendations to the PV Water Board of Directors on the following content of the AMP:

- Objectives
- Monitoring metrics
- Monitoring-based thresholds that when crossed, trigger adaptive management actions
- Management actions that could potentially be implemented when thresholds are crossed
- Reporting and Plan update procedures

Committee recommendations and feedback aided development of the draft AMP and are summarized below in Section 1.2.3.2, "Ad Hoc Committee Recommendations."

1.2.3.1 Ad Hoc Adaptive Management Plan Committee Membership

PV Water sought to represent all critical parties on a committee of a manageable size. The resulting Committee consisted of the following members:

- Tom Broz – PV Water Director
- Bob Culbertson – PV Water Director
- Stephen Rider – PV Water Director
- Joel Casagrande – NMFS
- Jessie Maxfield – CDFW
- Adam French – Amah Mutsun Land Trust (Tribal representative)
- Jonathan Pilch – Watsonville Wetlands Watch (non-governmental organization representative)
- Jerry Busch – Representative-Ventana Chapter Sierra Club (non-governmental organization representative)
- John Diffenbaugh – Neighboring landowner
- Dawn Reis – Neighboring landowner
- Christi Suchil – Disadvantaged community representative
- Frank Shields – Local environmental scientist

- John Pritchard – At-large community member

1.2.3.2 Ad Hoc Adaptive Management Plan Committee Recommendations

During its X meetings and through their review of the Draft AMP, Committee members made numerous recommendations regarding AMP content. Most of these recommendations are in the meeting summaries or comments submitted by Committee members on the draft AMP (which are provided as appendices to this Plan).

A large number of these recommendations were regarding the AMP's objectives, monitored metrics, triggers for management actions, and management actions, which were the focus of the Committee meetings. In response to these recommendations, objectives regarding vegetation and cultural resources were added to the AMP, other objectives were revised, and metrics, action triggers, and potential management actions were revised or added. However, several recommended objectives, metrics, action triggers, and management actions were not incorporated into the Plan for reasons given in the responses to comments. Important considerations in evaluating recommendations were the:

- Relative influence of Project O&M on the resource (relative to activities on adjacent lands, for example)
- Ability to reliably interpret monitored changes as being the result of O&M as opposed to other causes (e.g., environmental fluctuations).
- Consistency with the Project's approvals and permits
- Cost and cost-effectiveness

1.2.3.3 AMP Adoption

AMP 2022 was endorsed by the PV Water Board of Directors on XXX.

1.3 Organization of This Document

This document is organized as follows:

- Preceding the main document text is a list of acronyms, abbreviations, and list of species names.
- **Chapter 1, Overview.** This chapter states the purpose of the AMP, describes its development process, and outlines the document's organization.
- **Chapter 2, College Lake Setting.** This chapter provides regional and local background information about the College Lake setting related to land cover, biological resources, cultural resources, and existing management activities.

- **Chapter 3, College Lake Project.** This chapter describes the Project's components and design as well as O&M activities.

- **Chapter 4, Adaptive Management Framework.** This chapter describes the framework for adaptive management, which consists of objectives, metrics, action triggers, and potential management actions.

- **Chapter 5, Monitoring and Targeted Studies.** This chapter describes the monitoring that will be conducted to inform O&M of the Project and identifies topics for targeted studies (research or community science) that could reduce key uncertainties

- **Chapter 6, Reporting and Plan Updates.** This chapter describes the evaluations by PV Water staff, reporting, and updating of the Plan that will be components of adaptive management of O&M of the Project

- **Chapter 7, References.** This chapter provides information on literature and other sources cited in the text.

- **Appendix A, Measures to Avoid and Minimize Impacts of Operations and Maintenance Activities.** This appendix provides the text of adopted and anticipated measures to avoid and minimize the impacts of O&M activities.

- **Appendix B, Water Quality Management Plan.** This appendix provides the plan for monitoring water quality at College Lake. It describes the existing monitoring and the additional monitoring that will be implemented in conjunction with the Project, monitoring objectives and reporting, and potential management actions.

- **Appendix C, Steelhead Monitoring Plan.** This appendix provides the plan for monitoring steelhead use of College Lake and their passage at the weir during operation of the Project. It describes the objectives and design of the monitoring plan, and data analysis, reporting, and potential management actions.

- **Appendix D, Invasive Species Management Plan.** This appendix provides the plan for managing invasive animals at College Lake during operation of the Project. It describes the monitoring, management actions, success criteria, and reporting for the management of these invasive species.

- **Appendix E, Revegetation Plan.** This appendix provides the plan for the Project's revegetation treatments (College Lake Integrated Resources Management Project – Revegetation Plan). It includes plant palettes, planting designs, success criteria, and monitoring methods.

- **Appendix F, Seasonal Wetland Monitoring Methodology.** This appendix provides the methodology for transect-based monitoring of the cover and species composition of seasonal wetland vegetation.

- **Appendix G, Plant Species List.** This appendix provides a list of the plant species that have been observed at College Lake and distinguishes native from naturalized species, and indicates which species have been identified by the California Invasive Plant Council as invasive.

- **Appendix H, Bird Species List.** This appendix provides a list of the bird species that have been observed at College Lake.

- **Appendix I, Ad Hoc Adaptive Management Plan Committee Meeting Summaries.** This appendix provides summaries of the meetings of the Committee.

- **Appendix J, Ad Hoc Adaptive Management Plan Committee Member Comments.** This appendix provides the comments on the Draft AMP submitted by members of the Committee and responses to them.

CHAPTER 2

College Lake Setting

This chapter summarizes regional and local background information about the College Lake setting related to land cover, biological resources, cultural resources, and existing management activities.

2.1 Regional Setting

The Project area, shown on **Figure 1**, is located within the Pajaro Valley. Historically, the Pajaro Valley supported a variety of vegetation communities, including extensive riparian forests along waterways, oak savanna intermixed with grasslands in the lowland areas, mixed hardwood forests on hillsides, coastal dunes near the ocean, and coastal scrub on rocky sites. Currently, the Pajaro Valley is mostly agricultural with isolated patches of remnant natural vegetation communities. The valley is drained by the Pajaro River and its major tributary, Salsipuedes Creek, as well as by the Watsonville Slough system and Carneros Creek.

College Lake is a naturally occurring seasonally wet depression that receives water inflows from the Green Valley, Casserly, and Hughes Creek subwatersheds. The College Lake watershed, consists of approximately 11,000 acres of range, rural residential, and crop lands (PV Water 2014). Outflows from College Lake enter Salsipuedes Creek.

Historically, before the construction of the weir and the straightening and widening of the channel of Salsipuedes Creek in the early 1900s, College Lake would have expanded and contracted with seasonal rainfall, but a portion of it would have remained inundated throughout most years. (In fact, the oldest museum specimens of plants from College Lake are aquatic plants: shining pondweed [*Potamogeton illinoensis*] and yellow water lily [*Nuphar polysepala*], collected in 1905 and 1908, respectively [**Appendix G, "Plant Species List"**].) Now however, Reclamation District 2049 (RD 2049, established in 1920) typically pumps the lake dry beginning in mid-March to allow agricultural use of the lakebed through the summer.

2.2 Land Cover

College Lake and portions of Salsipuedes Creek within the Project's maintenance areas support the following general habitat types as shown on **Figure 2**: riparian scrub, riparian forest, freshwater emergent wetland, coyote brush scrub, seasonal wetland, agriculture, farmed wetlands, annual grassland, urban/developed and upland tree groves, perennial stream, and

ditch. The most common habitat types in College Lake and Salsipuedes Creek in the Project area are described below:

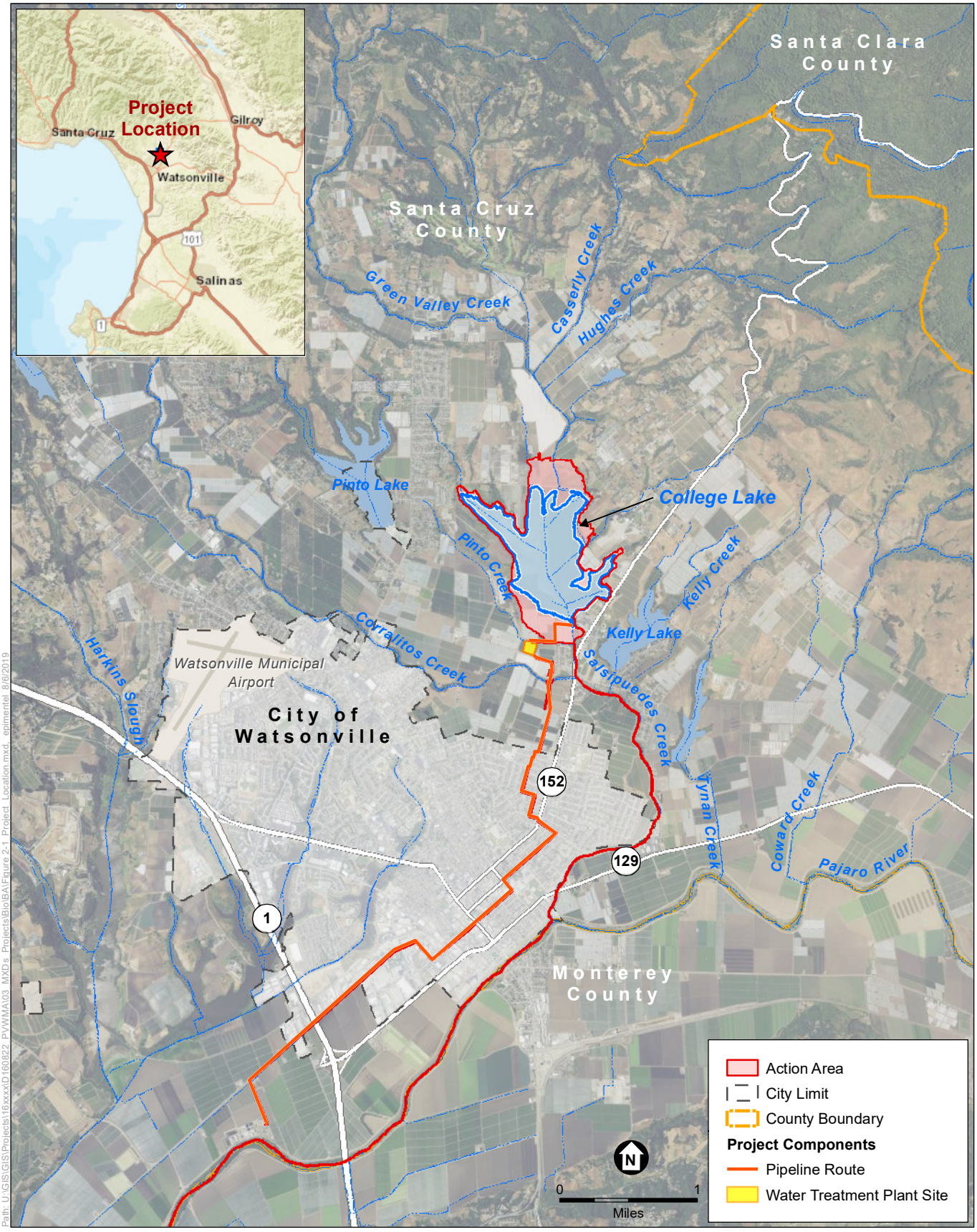
Riparian Forest—Riparian forest occurs as a large stand in the northeast quadrant of College Lake and is also present within other portions of College Lake and its tributaries. This broadleaf deciduous forest is dominated by native riparian species including arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), black cottonwood (*Populus trichocarpa*), alder (*Alnus* spp.), western sycamore (*Platanus racemosa*), coast live oak (*Quercus agrifolia*), box elder (*Acer negundo* var. *californicum*), shining willow (*Salix lasiandra* var. *lasiandra*), and dogwood (*Cornus* sp.). Associated understory species include California blackberry (*Rubus ursinus*), nettle (*Urtica* sp.), curly dock (*Rumex crispus*), and coyote brush (*Baccharis pilularis*). These understory species are also the dominants of riparian scrub (i.e., shrub and perennial-dominated riparian vegetation).

Seasonal Wetland—Seasonal wetlands are found along the margins of College Lake and in the northwestern and eastern extensions of the lake (particularly east of the main ditch). These areas support a wide variety of mostly non-native annual and perennial herbaceous species. Some abundant species include fat-hen (*Atriplex prostrata*), modest prickle grass (*Cripsus vaginiflora*) Bermuda grass (*Cynodon dactylon*); Italian ryegrass (*Festuca perennis*), bristly ox-tongue (*Helminthotheca echioides*), white sweetclover (*Melilotus albus*), smartweed (*Persicaria* spp.), curly dock (*Rumex crispus*), and cocklebur (*Xanthium strumarium*). California blackberry and Himalayan blackberry (*Rubus armeniacus*) are also prevalent in some areas that are transitional to riparian scrub.

Agriculture—Agricultural fields located at elevations above approximately 62.5 feet North American Vertical Datum of 1988 (NAVD88) can be planted with berries and orchards (i.e., crops requiring a longer growing season) while agricultural fields below 65.2 feet NAVD88 are typically planted with annual vegetable row crops. Agricultural habitats are routinely disked, planted, harvested, and subject to the application of herbicides, pesticides, and fertilizers, which prevents the establishment of non-crop perennial plant species and natural habitats.

Agricultural fields on the lakebed of College Lake are periodically fallowed, at the discretion of the farmer. In fallow years, these fields support weedy plant species, including: bristly ox-tongue (*Helminthotheca echioides*), cocklebur; swamp pricklegrass (*Crypsis schoenoides, C. vaginiflora*), fat-hen (*Atriplex prostrata*), smartweeds, and curly dock.

Farmed Wetlands—Farmed wetlands include agricultural areas within College Lake that support hydrological conditions of wetlands. This highly managed system presents a unique situation where farm fields provide aquatic habitat during the winter and early spring, seasonal wetland habitat for a brief period as College Lake is drawn down, arable farmland in the summer, and fallow fields in the fall and early winter.



Path: U:\GIS\GIS\Projects\16xxxx\D160822 PVWMA\03 MXDs Projects\Bio\BA\Figure 2-1 Project Location.mxd epimentel 8/6/2019

SOURCE: Carollo Engineers, 2019; ESRI World Imagery, 7/23/2016; ESA, 2019

College Lake Integrated Resources Management Project

Figure 1
Project Location Map

ESA

College Lake

Pinto Creek

Holohan Rd

Corralitos Creek

Salsipuedes Creek

Kelly Lake

152

Project Area

1-foot Elevation Contour

Existing Land Cover

- Perennial Stream
- Ditch
- Freshwater Emergent Wetland
- Seasonal Wetland
- Annual Grassland
- Riparian Forest
- Riparian Scrub
- Coyote Brush Scrub
- Farmed Wetland
- Agricultural
- Urban/Developed/Upland Tree Groves

N

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SOURCE: USDA, 2016; ESA, 2019

College Lake Integrated Resources Management Project

Figure 2
Existing Land Cover

ESA

2.3 Biological Resources

Several biological resources are particularly important for Project O&M either because of their potential sensitivity to management actions or their potential to affect sensitive biological resources or Project O&M. These resources include:

- Phytoplankton, zooplankton, and macroinvertebrates of the aquatic ecosystem
- Cyanobacteria
- Invasive animal species
- Invasive plant species
- Riparian forest
- Farmed and seasonal wetlands
- South-central California coast steelhead
- Special-status wildlife species
- Waterfowl and other birds

The following sections briefly describe each of these resources and how\ existing and planned land uses affect them.

2.3.1 Phytoplankton, Zooplankton, and Macroinvertebrates of the Aquatic Ecosystem

As the bed of College Lake becomes inundated, its agricultural, seasonal wetland, and other land cover types become an aquatic ecosystem. Along with the incoming water, phytoplankton, zooplankton, other aquatic invertebrates, and fish enter the lakebed along with lakebed invertebrates that emerge from a dormant state or dormant phase of their life cycle. Together with continued inputs of nutrients, detritus, and organisms from upstream, photosynthesis by phytoplankton, other algae, and vascular plants, and decomposition of the lakebed's organic matter support the food web of College Lake's open water ecosystem. This ecosystem provides food for steelhead and migrating waterfowl and shorebirds.

Water management in general affects the area and duration, and seasonality of the aquatic ecosystem. It also affects the depth, residency time, and quality of water, all of which affect the productivity and composition of the aquatic food web. In addition, agricultural practices and vegetation management can affect the quality and availability of organic matter.

2.3.2 Cyanobacteria

Cyanobacteria are single-celled or filamentous, photosynthetic bacteria that are a component of the phytoplankton in College Lake's aquatic ecosystem. These bacteria were previously

known as “blue-green algae.” Although they are primary producers in the food web providing food for steelhead, waterfowl, wading birds, and shorebirds. Some cyanobacteria produce compounds that are toxic to humans in small amounts (cyanotoxins). When these cyanobacteria become very abundant (during cyanobacteria “blooms”), water quality is degraded.

Water management determines the depth and seasonal timing of inundation, and thus potentially affects the development of cyanobacteria blooms. Nutrient-driven cyanobacteria blooms, and associated cyanotoxins, have been a persistent water quality problem at nearby Pinto Lake (Central Coast Regional Water Quality Control Board 2020). Pinto Lake is a perennial body of water that develops thermal stratification during warmer months, which results in greater nutrient availability that promotes cyanobacteria blooms. Although cyanobacteria are present at College Lake, their concentration and the concentration of cyanotoxins have been much lower than at Pinto Lake (PV Water 2019). Increasing duration and depth of inundation at College Lake could potentially result in water temperatures, nutrient concentrations, and cyanobacteria concentrations more similar to Pinto Lake.

2.3.3 Invasive Animal Species

Invasive (non-native [naturalized]) species that compete with or prey on native species are present in College Lake and include common carp (*Cyprinus carpio*), fathead minnow (*Pimephales promelas*), golden shiner (*Notemigonus chrysoleucas*), channel catfish (*Ictalurus punctatus*), black bullhead (*Ameiurus melas*), and brown bullhead (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), American bullfrog (*Lithobates catesbeianus*), and signal crayfish (*Pacifastacus leniusculus*). Other non-native species also may be present.

Water management affects the area and duration of inundation and thus the availability of habitat for invasive animal species. The current RD 2049 operations of draining the lake in spring and periodic pumping during the agricultural season reduces wetted habitat in the summer and fall to the drainage ditches within the lake. While this pumping practice does not entirely eliminate populations of invasive species, it likely helps to control and reduce populations annually by significantly limiting habitat availability. Retention of water in the lake bed for a longer period could potentially allow populations of non-native competing or predatory species to increase.

Management actions hat remove invasive species directly affects their presence and abundance (e.g., actions described in **Appendix D, “Invasive Species Management Plan”**).

2.3.4 Invasive Plant Species

Invasive plants, those naturalized species[3] that spread and become abundant on the landscape, are major threats to biological diversity, in large part because they displace native plant species, creating monotypic patches of vegetation with different and lesser values as animal habitat.

At College Lake, naturalized species account for more than half of observed plant species (48 of 90 species, see **Appendix G, "Plant Species List"**). Of the naturalized plant species at College Lake, 22 are included in the California Invasive Plant Council's (Cal IPC's) inventory of invasive plant species, and two of them with a "high" rating because of their severe ecological impacts on physical processes, plant and animal communities, and vegetation structure: giant reed (*Arundo donax*) and Himalayan blackberry (*Rubus armeniacus*) (Cal IPC 2021).

Besides impacting biodiversity, giant reed and Himalayan blackberry, and other invasive plants also can impede O&M by altering water flow and sediment deposition, reducing visibility, and impeding access (California Department of Water Resources 2016). Agriculture and other land uses facilitate the spread of invasive species by inadvertently introducing their seed on equipment or in materials brought to College Lake, and by creating disturbed areas where those seed can become established plants. Management of water and vegetation also facilitates or impedes the spread of invasive species by affecting growing conditions, causing mortality, and altering competition for resources.

2.3.5 Riparian Forest

As described in Section 2.2, "Land Cover," riparian forest at College Lake is dominated by native broadleaf, deciduous trees, including black cottonwood and several species of willows. Black cottonwood and willows are among the first riparian tree species to establish on a site (i.e., early successional species) and as such their dispersal and establishment is of particular importance to O&M.

Cottonwoods and willows produce large numbers of extremely small seeds that are dispersed by wind over large areas, and because they float on water, these seed will often accumulate in bands along shorelines. Seed release is concentrated in spring, but the timing of seed release varies between species and among years. If dispersed to exposed soil that is kept moist by a slowly receding water surface (less than approximately 1.5 inches of decline in stage per day [Mahoney and Rood 1998]), these seed germinate and develop into rapidly growing seedlings. Cottonwood and willow seed do not germinate under water or on soil whose surface is moist for less than approximately one week. Seedlings are killed by desiccation, mechanical damage from soil disturbance, and prolonged inundation (of the entire seedling) during the growing season.

Besides eliminating seasonal or farmed wetlands, the development of additional riparian forest could conflict with land uses by altering water flows and sediment deposition, impeding access,

[3] Naturalized species are species that established in California after European contact as a direct or indirect result of human activities.

or reducing visibility. Water management affects the frequency and extent of areas suitable for seedling establishment, and agriculture and other vegetation management can kill seedlings by mechanical damage or application of herbicides.

2.3.6 Farmed and Seasonal Wetlands

At College Lake, wetlands and seasonal wetlands are seasonally inundated, typically for periods of approximately six months in most years, and are then pumped dry by RD 2049. Following the dewatering of the lake basin, seasonal wetland vegetation begins to develop. On farmed wetlands, this developing vegetation is removed by tillage and cultivation, whereas on fallow and idled farmland, and at the margins of fields, seasonal wetland vegetation continues to develop. Seasonal wetland vegetation, while initially sparse, soon covers the soil surface. As described in Section 2.2, "Land Cover," seasonal wetlands at College Lake are characterized by a wide variety of, mostly naturalized, herbaceous species, some of which produce seed that are important food resources for waterfowl. These waterfowl food plants include fat-hen (*Atriplex prostrata*), barnyard grass (*Echinochloa crus-galli*), modest prickle grass (*Cripsus vaginiflora*), and smartweeds (in particular *Persicaria lapthifolia*) (Smith et al. 1994, Lane and Jensen 1999)[4].

Water management, agricultural practices, and other vegetation management affect the area, plant cover, height, and species composition of farmed and seasonal wetlands, farmed and seasonal wetlands by determining the period of inundation and the timing and type of disturbances.

2.3.7 South-Central California Coast Steelhead

South-Central California Coast (S-CCC) steelhead (Oncorhynchus mykiss) occur in College Lake. Adult steelhead migrate up coastal streams in winter to spawn. Juvenile steelhead grow (rear) in these coastal streams before migrating out to the ocean in April and May. Upstream of College Lake, Casserly Creek and two of its tributaries, Banks Creek and Gaffney Creek, are known to support steelhead. Based on a 2011 study, it is likely that at least some juvenile steelhead from the upper watershed spend time rearing in College Lake during winter and early spring prior to migrating out to the ocean (Podlech 2011).

In general, water management affects the passage of steelhead by causing water depth to drop below or exceed minimum depths, the availability of habitat on the inundated lake bed by altering the area and duration of inundation, and the survival of fish by causing stranding or entrainment.

2.3.8 Special-Status Wildlife Species

There are a number of special-status wildlife species that are either known to occur, or have potential to occur within the Project area. California red-legged frog (*Rana draytonii*) and

[4] Unpublished data collected at College Lake by Jerry Bush and John Pritchard in 2014–2016 document that these species of waterfowl food plants are abundant, with a combined cover of 43–87 percent along five permanently marked transects in the Berry and Church fields. (Annual mean combined cover along the five transects was 59–78 percent cover.

western pond turtle (*Actinemys marmorata*) have not been observed at College Lake, but have potential to occur in suitable aquatic and riparian habitat.

A variety of special-status birds have potential to forage and/or nest at College Lake including tricolored blackbird (*Agelaius tricolor*), short-eared owl (*Asio flammeus*), western burrowing owl (*Athene cunicularia*), Golden eagle (*Aquila chrysaetos*), white-tailed kite (*Elanus leucurus*), American peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), yellow warbler (*Setophaga petechia*), and Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*).

Also, in the Project area's riparian habitats, two special-status western red bat (*Lasiurus blossevillii*) and San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*) could occur.

Human land uses could affect these special-status species by harming individuals, disrupting their activities, or altering, creating, or eliminating their habitat. As noted in Section 1.2.2.1, "Avoidance and Minimization Measures," PV Water will be implementing comprehensive sets of measures to avoid and minimize these effects, in particular for California red-legged frog, western pond turtle, and nesting birds:

- Potential effects to California red-legged frogs will be reduced by conducting maintenance activities during the frog's active season (April 1–November 1) to the extent practicable, surveying potential frog habitat prior to maintenance activities, minimizing disturbed areas, clearly marking project boundaries, training personnel in the measures to avoid and minimize effects to California red-legged frogs, having a biologist on-site to monitor activities, and implementing other measures listed in **Table 1-2**.

- Potential effects to western pond turtles will be reduced by surveying potential turtle habitat prior to maintenance activities, minimizing disturbed areas, clearly marking project boundaries, training personnel in the measures to avoid and minimize effects to western pond turtles, and monitoring of activities by a biologist.

- Potential effects to nesting birds will be reduced by surveying for nesting birds prior to maintenance activities that disturb ground or remove vegetation during the breeding season (February 1–August 31) and if active nests are observed establishing no-work buffers around the nest or rescheduling the activity until the nest is no longer active.

These and the other measures that will be implemented to avoid and minimize effects to special-status species are described in full in **Appendix A, "Measures to Avoid and Minimize Impacts of Operations and Maintenance Activities."**

2.3.9 Waterfowl and Other Birds

College Lake, also historically referred to as Laguna Grande, is the largest freshwater lake in Santa Cruz County. It is located within the lower Pajaro Valley in the Interlaken area that includes Pinto Lake, Kelly Lake, Drew Lake, and Lake Tynan. The Interlaken area is north of

Elkhorn Slough and west of the Upper Pajaro River, both of which are recognized by Audubon as "important bird areas" of statewide significance (Cooper 2004). College Lake is recognized as a regionally important waterfowl over-wintering area that supports large numbers of migratory duck species and a diverse assemblage of wading birds, shorebirds, raptors, and songbirds. College Lake differs from the other neighboring Interlaken lacustrine habitats and the coastal slough wetland habitats due to annual draining and conversion of much of the lakebed to agriculture use.

To date, 235 bird species have been documented at College Lake (eBird 2021), which is the fifth highest number of species for a documented habitat area in Santa Cruz County.[5] By comparison, neighboring perennial Pinto Lake has 209 species recorded and Harkins Slough and Struve Slough, which were reclaimed and farmed in the past like College Lake, have 211 species recorded. Nearby Elkhorn Slough in north Monterey County is an estuary with a mix of fresh and saltwater wetlands that has 251 species recorded.

Water management, agriculture, and other vegetation management could affect waterfowl and other birds by several different mechanisms including: the rate of drawdowns and duration of inundation affecting the area, duration, and food resources of aquatic habitat, or disrupting their activities, destroying their nests or harming birds.

2.4 Cultural Resources

2.4.1 Archaeological Resources

Records searches, a cultural resources survey, and geoarcheaological assessment conducted for the Project identified two known archaeological sites within the water storage area of College Lake and at least a moderate probability of undocumented, significant archaeological resources being present.

Records searches conducted through the California Historical Resources Information System (CHRIS) Northwest Information Center (NWIC) revealed that 138 cultural resources studies have been conducted within a one-half-mile radius of the Project, 22 of which overlap the Project area[6]. As a result of these surveys, the majority of the land within one-half mile of the Project site has been included in previous cultural resources surveys.

These previous cultural resource studies recorded seven archaeological resources recorded within a one-half-mile radius of the Project site. In addition, two resources within the one-half-mile radius but not on file at NWIC include one prehistoric archaeological site and one

[5] **Appendix F, "Bird List,"** provides a list of all bird species observed during Project monitoring.

[6] Records searches for the Project were conducted through the California Historical Resources Information System (CHRIS) Northwest Information Center (NWIC) housed at Sonoma State University on June 22, 2017 (File No. 16-2078) and August 4, 2017 (File No. 17-0246) and updated on September 19, 2017 (File No. 17-0246) and April 25, 2018 (File No. 17-2410).

historical-period archaeological site. Of the nine resources, two overlap the water storage area at College Lake resulting from the Project.

No archaeological resources were identified as a result of the cultural resources survey, which is described in the following section.

The geoarchaeological assessment indicated that the majority of the Project area has a high sensitivity for prehistoric archaeological resources and that these resources could be shallowly or deeply buried[7]. Areas that have the highest probability of containing significant resources are within 200 meters (656 feet) of the high-water mark of the College Lake water storage area. The lower elevation floodplain area has a moderate probability of containing significant resources include the low-lying floodplain area.

2.4.2 Historical Resources

A 2018 cultural resources survey of the Project area did not identify any historical resources eligible for listing in the National Register or California Register. Approximately 40 percent of the Project area was surveyed systematically or opportunistically on foot, or through a "windshield" survey. Other areas were not surveyed because of access limitations, no visible native ground surface, or inundation. All resources meeting the California Office of Historic Preservation's 45-year-old age threshold for consideration as historical resources were documented on California Department of Parks and Recreation 523 series forms.

A total of five newly identified historic architectural resources meeting the California Office of Historic Preservation's 45-year-old age threshold were documented during the 2018 survey: ESA-Built-001 (pump intake house and weir), ESA-Built-002 (76 Holohan Road – residence), ESA-Built-003 (38 Holohan Road – agricultural buildings), ESA-Built-004 (canal segment), and ESA-Built-005 (railroad spur). These resources were evaluated for listing in the National Register and California Register and found ineligible.

2.4.3 Plants and Animals of Cultural Significance

In the context of this AMP, cultural resources include plants and animals that have cultural significance for the Amah Mutsun Tribe. Steelhead, and most of the waterfowl, other birds, and special-status species of College Lake described in Section 2.3, "Biological Resources," have cultural significance for the Amah Mutsun. Many of the plant species growing at College Lake also have cultural significance for the Amah Mutsun for utilitarian and non-utilitarian reasons. These plants are identified in **Appendix G, "Plant Species List."**

[7] The geoarchaeological study was based on a review of previously recorded archaeological sites obtained through records searches at the CHRIS-NWIC, a literature review, and a review of geologic maps, soils maps, and historical aerial photos and maps covering the project area.

2.5 Existing Management of College Lake

2.5.1 Water Management

The majority of the water in College Lake enters from the north side of the lake through Casserly Creek, and is supplemented by inflows from the Green Valley and Hughes Creek subwatersheds (Resource Conservation District Santa Cruz County 2014). During wet weather, flow direction in the reach of Salsipuedes Creek between College Lake and Corralitos Creek can reverse due to high flows in Corralitos Creek, and surface water enters the lake as backflow from Salsipuedes Creek. During other periods, outflow from College Lake drains into Salsipuedes Creek, which is a tributary to the Pajaro River. RD 2049 pumps College Lake dry in the spring to accommodate summer farming of the lakebed. Pumping usually begins in mid-March, depending on the amount of spring rain.[8] Pumping the lake dry generally takes 30 to 40 days, typically resulting in a dry lakebed by May 1st to May 10th.[9] Intermittent pumping into Salsipuedes Creek continues after this date as needed to maintain a dry lakebed.

An existing weir with crest at elevation 60.1 feet NAVD88 associated with the pumps spans the Salsipuedes Creek channel and, under certain conditions, controls the water level in College Lake.[10] When the lake water surface elevation (WSE) is at the existing weir crest elevation, approximately 228 acres of the lake basin is inundated, storing about 1,150 acre-feet of water (Resource Conservation District of Santa Cruz County 2014). Subsurface tile drains are present within the College Lake basin; during the summer farming period, flow from these drains is collected and pumped into a channel at the center of the College Lake basin. Water in the channel flows to the weir and pumps.

2.5.2 Farming

Once the lake has been pumped and agricultural land within the lakebed is dry enough to accommodate heavy machinery (typically around May 30th), tractors turn the soil; it then takes about one month to prepare the land for planting. Most of the crops in College Lake require at least 60 to 90 days to reach maturity; depending on the water year, two crops can be grown. Growers aim to complete harvesting and other agricultural operations in the lake basin before the fall–winter rains, generally by the end of October, although farming can and has occurred later in the year. Vegetable row crops (including varieties of kale, lettuces, and onions) comprised the largest area under cultivation from 2014 to 2018. Tree and vine crops (e.g.,

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[8] RD 2049 was formed in 1920 and was granted express legal authority under State law (California Water Code Section 50000 et. seq.) to pump water from College Lake to reclaim the land for agricultural production.

[9] Peixoto, Dick, Lakeside Organic Gardens, LLC, Letter to Mary Bannister, May 12, 2014.

[10] The primary purpose of the existing weir is to prevent pumped water from flowing from Salsipuedes Creek into College Lake.

apples, raspberries and blackberries), comprising about 3 acres in total, are grown at higher elevations and extend to just below 64 feet NAVD88.

Farmed lands are periodically disked, planted, harvested, treated with herbicides, pesticides, and fertilizers, and periodically left fallow at the discretion of the farmer.

2.5.3 Mosquito Abatement

The College Lake area has a long history of seasonal floodwater mosquito production.[11] The Santa Cruz County Mosquito Abatement and Vector Control (MAVC) implements mosquito control measures in the creek adjacent to the fairgrounds to limit hatching of floodwater mosquitos and the eastern section of Casserly Creek also has issues with mosquitoes.

In Santa Cruz County, mosquito species are breeding, developing, and maturing (emerging as adults) during most of the year. For example, aquatic larvae of the floodwater mosquito (*Aedes washinoi*) develop in temporarily inundated areas in late winter and the adults emerge in spring; whereas the encephalitis mosquito (*Culex tarsalis*), whose habitats also include temporarily inundated areas, breeds throughout summer and fall (Binding, ND).

MAVC employs integrated mosquito management methods that emphasizes the prevention of mosquito production by reducing breeding sources and when necessary the control of aquatic stages to interrupt the mosquito life cycle. MAVC routinely monitors known mosquito breeding locations. Control measures are implemented when a site-specific threshold is exceeded. These thresholds are based on monitoring data (mosquito species, larval stage, and density) and site attributes (distance to residents, presence of mosquito predators and sensitive species), and other factors. Control measures include the application of larvicides, preferentially the selective and non-persistent mosquito growth regulator methoprene (synthesized juvenile hormone) or microbes (*Bacillus thuringiensis israelensis* and *B. sphaericus*).

11 Binding, Paul. Santa Cruz County Mosquito and Vector Control CSA 53. Comments on the Notice of Preparation for Proposed College Lake Integrated Resources Management Project. January 4, 2017

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CHAPTER 3

College Lake Integrated Resources Management Project

This chapter describes the multiple components of the Project, as well a proposed operations and maintenance activities.

Throughout the Pajaro Valley Groundwater Basin, overdraft conditions[12] have caused groundwater levels to drop below sea level, creating a landward pressure gradient that causes seawater to move inland. Seawater intrusion has elevated the chloride concentrations in groundwater up to approximately three miles inland from the coast, in some areas contaminating the groundwater to the point that it is unsuitable for agricultural irrigation and domestic (potable) uses without treatment.

The purpose of the Project is to help balance the groundwater basin, by decreasing demands on groundwater, preventing further seawater intrusion, and meet water supply needs within PV Water's Coastal Distribution System (CDS) service area by developing College Lake as a water storage and supply source for agricultural irrigation, while accommodating the release of fish bypass flows and facilitating fish passage between Salsipuedes Creek and College Lake.

3.1 Project Design

The essential function of the Project is to store water in and divert water from College Lake for treatment, transmission, and distribution for agricultural irrigation. The Project includes the following components:

Weir Structure and Intake Pump Station. The Project includes a weir structure with an adjustable crest, and a diversion and intake pump station to divert surface water from College Lake. The diversion weir will have an adjustable weir crest that will be operational through a range of 60.1 to 62.5 feet NAVD 88. The proposed weir crest elevation could be adjusted with one or more pneumatically actuated gates (e.g., Obermeyer Spillway Gates). The intake pump station will pump raw (untreated) water from an intake just upstream of the weir to the proposed College Lake water treatment plant (WTP) via a 30-inch diameter intake pipeline.

[12] Overdraft occurs when the amount of groundwater withdrawn from a basin exceeds the volume of freshwater replenishing the basin.

A fish passage structure will be located on the west side of the weir and will route fish around the diversion weir during periods when passage over the weir is not possible.

The proposed adjustable weir will be capable of raising the College Lake water level by up to 2.4 feet above the elevation of the existing weir to a water surface elevation of 62.5 feet NAVD88. The storage capacity of College Lake is approximately 1,150 acre feet (AF) at a water surface elevation of 60.1 feet NAVD88 and approximately 1,800 AF at a water surface elevation of 62.5 feet NAVD88.

Water Treatment Plant. The WTP will remove sediment, filter, and disinfect the water diverted from College Lake. The WTP will contain sedimentation basins and solids drying beds, filtration and disinfection systems, and a treated water pump station.

College Lake Pipeline. The Project will include an approximately 6-mile-long, 24-inch-diameter pipeline from the proposed WTP to the CDS.

3.2 Project Operations

This section describes the Project's operations: fish passage flows, weir operations, and water supply diversions.

3.2.1 Fish Passage Flows

The proposed weir structure will be designed to accommodate release of fish bypass flows and to facilitate fish passage between Salsipuedes Creek and College Lake. **Table 3-1** lists proposed minimum lake levels and minimum flows for fish passage for adult steelhead migration (December 15th through April 30th) and smolt outmigration (May 1st through May 31st).

Fish bypass releases will begin only when the water surface elevation in College Lake increases to the minimum level at which passable conditions for fish will have occurred without the existing weir in place and with flows being regulated only by the existing channel topography in Salsipuedes Creek. Based on a critical riffle analysis, these water surface elevations are 59.5 feet NAVD88 for the adult season, which corresponds to a depth of 0.6 feet at the critical riffle, and 59.3 feet NAVD88 for the smolt season, which corresponds to a depth of 0.4 feet at the critical riffle. Releases for fish passage will not exceed total inflows into College Lake during any time interval.

TABLE 3-1
PROPOSED FISH PASSAGE FLOWS

Proposed Fish Passage, Bypass of Casserly Creek Flows[a]	Adult Steelhead Migration		Smolt Outmigration
	Dec. 15 – Mar. 31	Apr. 1 – Apr. 30	May 1 – May 31[c]
Bypass flow between Corralitos-Salsipuedes Confluence and Pajaro River	21 cfs	8 cfs when natural flows are < 18 cfs; or 21 cfs when natural flows are ≥ 18 cfs	8 cfs
Bypass flow at weir[b] and in Salsipuedes Creek between weir and Corralitos Creek	1.8 cfs	1.8 cfs	1.0 cfs
Minimum lake level	59.5 feet NAVD88	59.5 feet NAVD88	59.3 feet NAVD88

Source: State Water Resources Control Board (2021) Right to Divert and Use Water, Draft Permit Application AO32881

NOTES:

cfs = cubic feet per second

NAVD88 = North American Vertical Datum of 1988

[a] Instream flow requirements based on critical riffle surveys conducted in 2017 and 2018. Each minimum flow requirement will be the number specified in this table or the flow resulting from bypassing the total inflow into College Lake, whichever is less. Minimum flow between the Corralitos Creek-Salsipuedes Creek confluence and Pajaro River is for the combined flow from Corralitos Creek and College Lake. Refinements to fish passage assumptions and modeling may occur during permitting based on agency consultations.

[b] The minimum flows may be refined during design phase of the proposed weir and fish passage structure.

[c] The smolt outmigration season begins in March, but instream flow requirements for adult steelhead prior to May 1 meet or exceed the smolt requirement and are therefore protective of smolt instream flow needs.

In addition, PV Water anticipates that other future conditions may warrant pumping flows from College Lake into Salsipuedes Creek during the summer and fall. The Project design includes a 30-inch bypass pipeline from the pump station to the downstream side of the proposed weir structure for this purpose. This bypass pipeline could be used to drain College Lake for equipment maintenance or equipment repair, to ensure the lake bottom is able to dry out for purposes of predator control, or to prevent water quality issues such as low dissolved oxygen, algal blooms, or other unforeseen issues from developing within the lake. Although PV Water is not presently able to anticipate the frequency of such operations, the bypass pipeline will be operated in compliance with all applicable regulatory permit conditions.

3.2.2 Proposed Weir Operations

PV Water will manage the proposed adjustable weir[13] to avoid exacerbating flood risk while retaining water from late season precipitation events for subsequent treatment and distribution to irrigators in the Pajaro Valley. The proposed weir will be raised to 62.5 feet NAVD88 following the last anticipated significant storm event of the season. Factors that affect the timing of the weir adjustment include water surface elevation and corresponding duration of drawdown, short- and long-term meteorological forecasts, and downstream channel conditions. In the event a significant storm is predicted to occur after the weir has been raised

[13] The weir crest could be adjusted from 60.1 feet NAVD88 (the height of the existing weir) to 62.5 feet NAVD88.

to 62.5 feet NAVD88, PV Water would initiate a pre-storm lowering of the weir from an elevation of 62.5 to 60.1 feet. cbec eco engineering conducted analyses to estimate the rate at which College Lake would drain over the proposed weir to meet pre-event drawdown criteria to prevent exacerbating existing downstream flood risks.[14] Based on the results of these analyses, lowering of the weir from 62.5 feet to 60.1 feet under existing downstream channel conditions would result in an initial draining rate at the weir of approximately 75 cfs, and this rate would decline quickly (i.e., within one hour) as Salsipuedes Creek below the weir reaches capacity.[15] Additional information on estimated drawdown times is provided in College Lake Integrated Resources Management Project Hydrologic and Hydraulic Modeling Technical Memorandum (cbec, inc. 2018, provided as Appendix HYD-1 of PV Water 2019)

3.2.3 Water Supply Diversions

Anticipated typical annual water diversion rates for the Project will range between 1,800 and 2,300 AF per year (AFY) and the maximum will be 3,000 AFY. PV Water has estimated monthly demands based on existing conditions for irrigation water for four modeled water year types (i.e., ranging from very wet to extremely dry). Operational criteria used in the water budget model to determine the extent to which projected monthly demand could be met included the following restrictions:

- Water supply diversions could not begin until College Lake achieves the water levels for adult steelhead migration and smolt outmigration shown in **Table 3-1**; and

- For the period December 15 to May 31, only College Lake inflows exceeding the proposed minimum fish bypass flows in **Table 3-1** could be diverted to the treatment plant for irrigation supply.

Depending on water year type, and time of year, monthly demand has been estimated at from a minimum 14 AF to maximum of 470 AF (cbec, inc. 2018).

3.3 Project Maintenance

This section describes maintenance of the Project's facilities and of the water storage area. **Table 3-2** summarizes these maintenance activities. Measures to avoid and minimize environmental impacts will be implemented in conjunction with these activities. The adopted and anticipated measures are provided in **Appendix A, "Measures to Avoid and Minimize Impacts of Operations and Maintenance Activities**."

[14] cbec, inc. eco engineering, College Lake Integrated Resources Management Project Hydrologic and Hydraulic Modeling Technical Memorandum, prepared for Environmental Science Associates by cbec, inc., November 8, 2018.

[15] cbec, inc. eco engineering, unpublished data provided to M. Podlech on February 12, 2020.

TABLE 3-2
SUMMARY DESCRIPTION OF ANTICIPATED MAINTENANCE ACTIVITIES

Activity	Frequency	Anticipated Annual Quantity	Seasonal Timing	Description
Weir, pipeline, pump station Inspections	Weekly	—	Year-round	—
Weir, pipeline, pump station repair	As needed	1	Year-round	Typically, an unscheduled activity conducted when facilities are damaged. Standard equipment will include light duty trucks, small winches, crane, front end loader, haul truck, chainsaw, and hand tools.
Weir repair or maintenance requiring dewatering	As needed	0.2 (1 in 5 years)	Summer – fall	Channel adjoining weir dewatered for weir maintenance and repair.
Weir maintenance	Annually	3	Late summer – early fall	Typical weir maintenance activities will include debris/sediment removal, cleaning, minor erosion control measures (including replacement of fill in eroded areas), and replacement of the weir gate. Standard equipment will be the same as for weir repair.
Sediment and debris removal	Annually	Up to 11,700 cubic yards of sediment	Late summer – early fall	Sediment deposited in channels will be removed every 1–2 years (from 0–100 % of channel length/year), typically by using excavators and bulldozers to load material onto haul trucks for transport to landfill or other upland location. Sediment deposits outside of channels will also be removed in some years.
Channel reshaping	Periodic	1 site	Late summer – early fall	Channel banks "laid back" (bank angle decreased) or other modifications are made to reduce erosion or encourage deposition in away from weir and pumps.
Vegetation management—channels	Annually	1.4 acres[1]	Late summer – early fall	Aquatic vegetation in channels is removed in association with sediment and debris removal. Removal is mechanical using a drag-line and excavator bucket. Removed aquatic vegetation is loaded into haul trucks and deposited in a landfill or upland location.
Vegetation management—lakebed	Annually	75 acres[2]	Late summer – early fall	Uncultivated areas of the lakebed that are not already in woody riparian vegetation may be disked, tilled, ripped or mowed every 1–2 years if necessary to prevent new establishment of woody plants that could trap sediment, or restrict flow or drainage.

Source: Table content adapted from Draft College Lake Integrated Resources Management Project Environmental Impact Report (PV Water 2019) and draft permit applications for the Project.

Notes:

[1] Corresponds to acreage of entire existing ditch system

[2] Corresponds to the existing acreage of farmed wetland below an elevation of 59 feet NAVD 88 and potentially uncultivated in most years after Project implementation.

3.3.1 Weir Structure, Pump Station, Water Treatment Plant, and College Lake Pipeline

Once the Project is fully operational, PV Water staff will periodically conduct routine inspections (e.g., for visual signs of wear and tear, obstructions or leakage) and perform scheduled maintenance of the weir structure, pump station, WTP, and pipelines. Should damage to facilities occur, PV Water would dispatch a crew to conduct the necessary repairs. Typical weir maintenance activities will include debris removal, cleaning, minor erosion control measures (including replacement of fill in eroded areas), and replacement of the weir gate. Standard equipment includes light duty trucks, small winches, crane, front end loader, haul truck, chainsaw, and hand tools. An excavator, backhoe, or crane could be required to lift metal parts from the gate or adjustable weir for maintenance or if sediment removal is required.

To the greatest extent feasible, inspections, maintenance, and repairs to the weir and intake structure will be conducted during periods of low water surface elevations in the lake (i.e., late summer and early fall). However, dewatering of the channel surrounding these structures may be necessary at times. The anticipated frequency of dewatering activities is not expected to exceed once every five years and would occur at a time of year when water surface elevations are low.

Dewatering of surface water could occur by isolating the work area through the use of sheet-pile coffer dams and bypassing flows around the construction site. A passive gravity bypass system could be used if feasible. If not feasible due to site conditions, water may be actively pumped around the work area using pumps. Bypass pumps will be screened in accordance with current NMFS and CDFW guidelines.

If subsurface water is encountered, the water would be discharged to agricultural lands, storm drains, or other waterways, and would be discharged in accordance with applicable regulatory requirements. The contractor would treat water from excavated areas as necessary prior to discharge. The treatment could include settling tanks or filter bags to allow sediment to settle out.

3.3.2 College Lake Water Storage Area

PV Water will conduct routine (annual or semi-annual) vegetation management and sediment and debris removal activities within College Lake to:

- Preserve water storage capacity

- Avoid exacerbating existing flood hazards[16]

- Manage habitat in a manner consistent with requirements established in permits and approvals and in accordance with the AMP.

These maintenance activities may occur in the lake's existing ditches and channels, on portions of the lake bed, and upstream of the weir structure. The amount of these activities needed in any given year will depend on weather and hydrologic conditions, and frequency and extent of past maintenance activities. Additional details regarding methods and timing of maintenance activities will be determined once the Project has been implemented.

3.3.2.1 Vegetation Management

Figure 3 depicts areas proposed for vegetation management; these are areas that are farmed under baseline conditions and that are expected to support seasonal wetland vegetation with implementation of the Project. Vegetation management will not reduce the current extent of riparian forest but aims to limit new establishment of woody riparian plants that could trap sediment and restrict flow or drainage. PV Water is not proposing any specific vegetation management activities within the existing riparian forest habitat on land currently owned by PV Water.

Vegetation management methods will include disking, tilling, and ripping. Vegetation may also be trimmed or mowed if necessary. These activities may occur in most or all years in portions of the lakebed. Removal of flow-constricting vegetation within channels and around Project components and equipment may also occur annually. Aquatic vegetation in channels may also be removed mechanically using a drag-line and excavator bucket, and in association with sediment and debris removal described below. Debris from vegetation management will be loaded into haul trucks and deposited in a landfill or upland location.

The Project's MMRP includes measures to avoid and minimize impacts to existing habitat features in College Lake and additional measures are being determined in consultation with regulatory agencies with approval authority over the Project. See **Appendix A, "Measures to Avoid and Minimize Operations and Maintenance Activities,"** for adopted and proposed measures for avoiding and minimizing impacts of maintenance activities.

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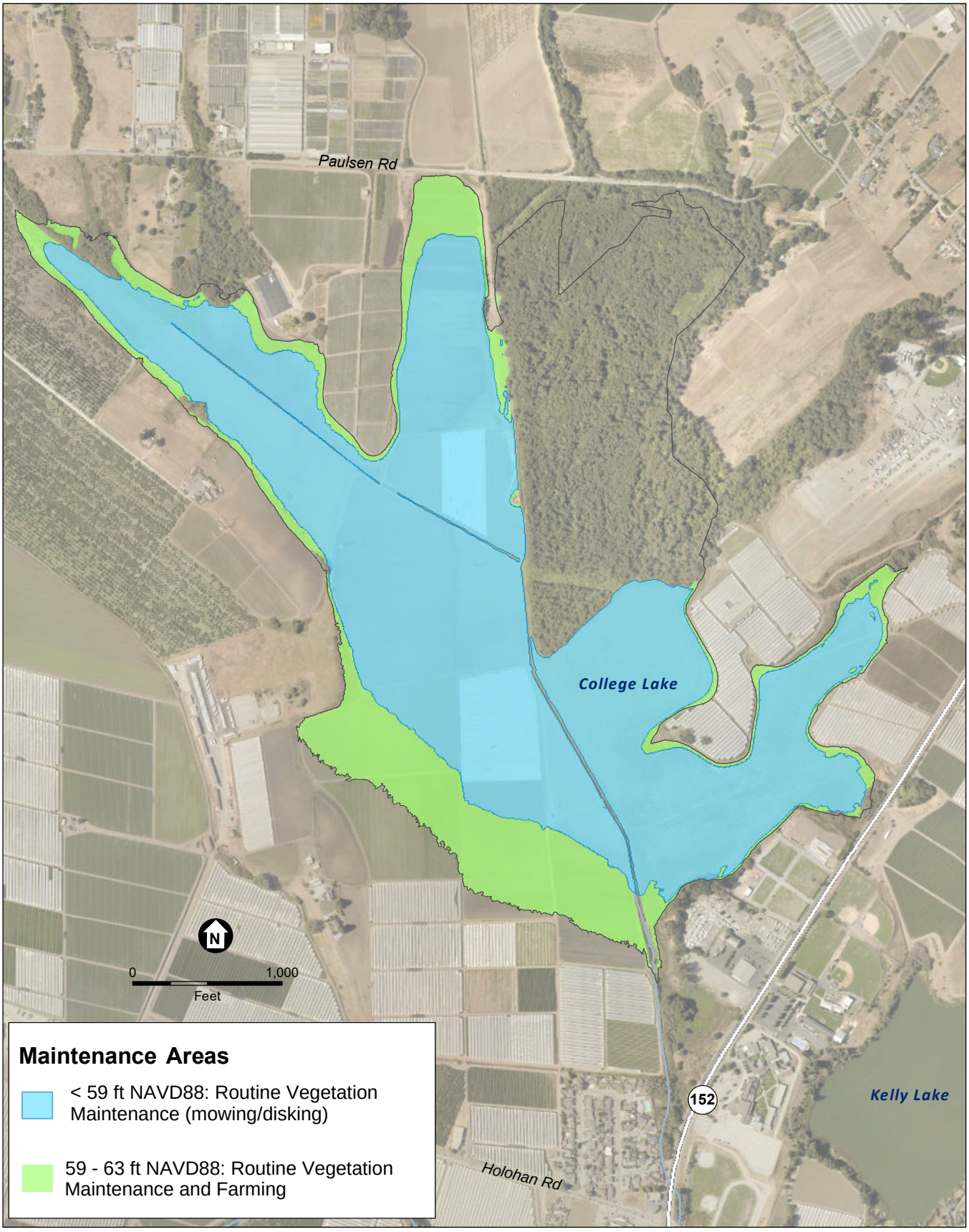
16 The Santa Cruz County Flood Control and Water Conservation District Zone 7 (Zone 7) is responsible for the provision of drainage improvements in the project area. Zone 7 was formed for the primary purpose of improving the flood carrying capacity of the Pajaro River, Salsipuedes, Creek and Corralitos Creek systems within the Pajaro Valley floodplain. This is achieved through funding the maintenance of and minor capital improvements to existing drainage facilities within the zone's boundaries. Santa Cruz County Flood Control and Water Conservation District Zone 7 does not currently have an existing stream maintenance plan or other adopted sediment management plan for the College Lake area. (County of Santa Cruz Department of Public Works, Flood Control and Water Conservation District: Zone No. 7, 2019. Available online at http://www.dpw.co.santa-cruz.ca.us/Home/FloodControlStormwater/FCWCZone7.aspx. Accessed on April 10, 2019.)



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SOURCE: USDA, 2016; ESA, 2018

Note: NAVD88 = North American Vertical Datum of 1988

College Lake Integrated Resoures Management Project

Figure 3
Proposed Maintenance Areas within College Lake

ESA

3.3.2.2 Sediment and Debris Removal

PV Water will remove excess sediment and debris from certain areas of College Lake and upstream of the weir structure. The need for sediment removal will be evaluated annually during routine facility monitoring.

Sediment removal is the act of mechanically removing sediment that has deposited within a channel or on the lakebed, typically using excavators and bulldozers, loading material onto haul trucks. Sediment and debris removal will be conducted during the dry season, and could be implemented if sediment accumulations (for example) impede fish passage, significantly compromise channel capacity, or impair operation of the proposed weir and intake structure. Channels within the lakebed may also be reshaped to minimize bank erosion (e.g., laying back banks) or help minimize stranding of fish as water levels recede.

Removed sediment and debris will be hauled to the Buena Vista Landfill or other upland location for disposal.

3.4 Anticipated Inundation and Land Cover Changes and Related Uncertainties

Project operations will alter the duration and timing of inundation at College Lake, requiring changes in existing land use activities. Associated changes in land cover are also anticipated. Table 3-3 summarizes these anticipated changes. The primary effect is anticipated to be on the extent of farmed wetlands below elevation 59 feet NAVD88. These farmed wetlands are frequently submerged or in seasonal wetland vegetation for part of the year and also in agricultural production for part of the year. With operation of the Project, these farmed wetlands will be inundated for longer periods of time than under RD 2049's management of College Lake, which will preclude or substantially reduce the frequency of their cultivation.

There are several uncertainties regarding the effects of these changes in inundation and cultivation:

- **Cyanobacteria response**— with implementation of the Project, the area and depth of inundation will be greater in summer, and therefore, the potential for a thermocline to form and a cyanobacteria bloom to develop will be increased.

- **Aquatic food web response**—changes in the depth and residency time of water, and duration of inundation, will affect populations of phytoplankton, zooplankton, and macroinvertebrates (Opperman 2012). Changes in vegetation type or management may also affect the aquatic food web and its production of food for vertebrates. Studies of inundated floodplains have not identified substantial differences among agricultural practices (e.g., discing fields or allowing vegetation to develop on fallowed cropland) in food resources provided for salmon (Katz et al. 2017, Sommer et al. 2020), and studies in wetlands managed for waterfowl have not identified preferred management practices for macroinvertebrate production (Anderson and Smith 2000, Davis and Bidwell 2008, Tapp and

Webb 2015). However, different vegetation types at College Lake could have macroinvertebrate communities with different values for birds.

- **Steelhead response**—fish bypass flows under the Project will allow for steelhead migration and smolt outmigration either over the weir when water levels are high enough, or via the fish passage structure when water levels are below the weir crest, and extensive entrainment and stranding will no longer occur. The Project also will increase the area and duration of habitat on the inundated lakebed, and although steelhead use College Lake during summer months is not expected, there is some uncertainty regarding the seasonal duration of steelhead use of the lakebed.

- **Invasive animal response**—current RD 2049 operations reduce wetted habitat in summer–fall to drainage ditches, which likely limits the size of invasive animal populations. With implementation of the Project, water will be retained in College Lake for a longer period of time in the spring, summer, and fall compared to existing conditions. This extended inundation season could potentially allow populations of non-native species to increase.

- **Vegetation response**— changes in the duration and seasonal timing of inundation are anticipated to affect the extent of vegetation types as summarized in **Table 3-3**, but also could cause other changes to vegetation. Although the area of seasonal wetland is anticipated to increase because of a reduction in farmed wetlands, the extended period of inundation could result in sparser vegetation or reduced abundance of waterfowl food plants in some areas. The more gradual removal of water from the lake could facilitate more frequent or extensive establishment of woody riparian plants in farmed and seasonal wetlands. or the establishment and spread of invasive plant species.

Some of these uncertainties either will be addressed by monitoring, as described in Section 5.1.1, “Monitoring of Metrics for Objectives,” by other actions of related plans incorporated into this Plan (e.g., the invasive species management plan [**Appendix D**]) and the others could potentially be addressed by targeted studies, as described in Section 5.2, “Targeted Studies.”

TABLE 3-3
ANTICIPATED CHANGES TO INUNDATION PERIODS AND LAND COVER AT COLLEGE LAKE

Maintenance Area	Water Surface Elevation (feet NAVD88)	Existing Inundation Period[a]	With Project Inundation Period (62.5 foot weir)[b]	Land Cover (Wetland/Water/Upland)	With Project Land Cover, Anticipated Change
Routine Vegetation Maintenance (mowing/disking) (< 59 feet NAVD88)	50 up to 57	4-7 months	7-11 months	Ditch (Other Water)	No land cover type change. Ditches will continue to be managed for water conveyance and fish passage.
				Farmed Wetland (Wetland) Consists of: 1. Open water (November 1 to March 31) 2. Seasonal wetland vegetation (April 1 to May 31) 3. Agriculture[c] (June 1 to October 31)	Farmed wetland will convert to managed seasonal wetland which will consist of: 1. Open water (November 1 to July or August) 2. Mudflat with sparse seasonal wetland vegetation (July or August to October 31) No farming will occur at this elevation with the Project. Vegetation management (mowing, disking) will occur annually to maintain open water and mudflat and prevent woody plant encroachment.
				Riparian Forest (Wetland)	No land cover type change. Riparian Forest present below 57 feet NAVD88 is expected to persist with its current riparian species composition and abundance in the short term but may shift in species composition and abundance in the future with a dominance of inundation-tolerant species such as Pacific willow (*Salix lasiandra*), and possibly a sparser overstory canopy with freshwater emergent plants in the understory. A small 0.7-acre area of freshwater emergent wetland occurs within the larger riparian forest and will not be actively maintained.
				Seasonal Wetland (Wetland)	No land cover type change, though seasonal wetlands that are not currently managed annually through mowing and tilling will be subject to these management practices in the future to prevent woody plant encroachment. The increase in management frequency, combined with the longer inundation period in this elevation range will likely result in sparser vegetation, dominated by annual species.
	57 up to 59	4 months	6-7 months	Ditch (Other Water)	No land cover type change. Ditches will be continued to be managed for water conveyance and fish passage.
				Farmed Wetland (Wetland) Consists of: 1. Open water (December 1 to March 31) 2. Seasonal wetland vegetation (April 1 to May 31) 3. Agriculture[c] (June 1 to November 30)	Farmed wetland will convert to managed seasonal wetland, similar to 50 to 57 feet NAVD88. No farming will occur at this elevation with the Project. Vegetation management (mowing, disking) will occur annually to maintain open water, mudflat, and seasonal wetland and prevent woody plant encroachment.
				Riparian Forest (Wetland)	No land cover type change, though species composition may change as this forest matures and older trees senesce. A small 0.2 acre area of freshwater emergent wetland occurs within the larger riparian forest and will not be actively maintained.
				Seasonal Wetland (Wetland)	No land cover type change. This area will be managed as seasonal open water and wetland through mowing and disking, to prevent woody plant encroachment, similar to existing conditions.
Routine Vegetation Maintenance and Farming (59-63 feet NAVD88)	59 up to 62	1-4 months	2-6 months	Ditch (Other Water)	No land cover type change. Ditches will continue to be managed for water conveyance and fish passage.
				Farmed Wetland (Wetland) Consists of: 1. Open water (January 1 to March 31) 2. Seasonal wetland vegetation (April 1 to May 31) 3. Agriculture[c] (June 1 to December 30)	No land cover type change. Although this elevation range will be inundated for longer durations (especially at the lower end of the range) these areas will continue to be used for seasonal crops in years and locations where at least one crop rotation is feasible. Areas that are not farmed will be managed as seasonal open water and wetland through mowing and disking, to prevent woody plant encroachment, similar to existing conditions.
				Riparian Forest (Wetland)	No land cover type change.
				Seasonal Wetland (Wetland)	No land cover type change.
	62 up to 63	1-6 weeks, not continuous	2-8 weeks, not continuous	Ditch (Other Water)	No land cover type change. Ditches will continue to be managed for water conveyance and fish passage.
				Farmed Wetland (Wetland)	No land cover type change. Although this elevation range will be inundated for longer durations these areas will continue to be used for seasonal crops in years and locations where at least one crop rotation is feasible. Areas that are not farmed will be managed as seasonal open water and wetland through mowing and disking, to prevent woody plant encroachment, similar to existing conditions.

TABLE 3-3
ANTICIPATED CHANGES TO INUNDATION PERIODS AND LAND COVER AT COLLEGE LAKE

Maintenance Area	Water Surface Elevation (feet NAVD88)	Existing Inundation Period[a]	With Project Inundation Period (62.5 foot weir)[b]	Land Cover (Wetland/Water/Upland)	With Project Land Cover, Anticipated Change
				Riparian Forest (Wetland)	No land cover type change.
				Seasonal Wetland (Wetland)	No land cover type change.
				Agriculture (Upland)	Farmed wetland. This is not likely to change the land use practices or habitat value[d]
				Annual Grassland (Upland)	Seasonal Wetland.
None/No Maintenance Action (>63 feet NAVD88)	63 up to 64	1-6 weeks, not continuous	2-8 weeks, not continuous	Ditch (Other Water)	No land cover type change. Ditches will be continued to be managed for water conveyance and fish passage.
				Farmed Wetland (Wetland)	No land cover type change. Although this elevation range will be inundated for longer durations these areas will continue to be used for seasonal crops in years and locations where at least one crop rotation is feasible. Farmers may continue to manage farmed wetlands for agricultural purposes.
				Riparian Forest (Wetland)	No land cover type change.
				Seasonal Wetland (Wetland)	No land cover type change.
				Agriculture (Upland)	Farmed wetland. This is not likely to change the land use practices or habitat value.[d]
				Annual Grassland (Upland)	Seasonal Wetland.
				Riparian Scrub (Upland)	No land cover type change
	64 up to 70	Periodic inundation of one week or less	Periodic inundation of one week or less	Ditch (Other Water)	No land cover type change. Ditches will continue to be managed for water conveyance and fish passage.
				Farmed Wetland (Wetland)	No land cover type change. These farmed wetlands are currently supported by seeps and not by inundation of the College Lake Basin. So changes in the College Lake basin hydrology will not likely change these farmed wetlands. Farmers may continue to manage farmed wetlands for agricultural purposes.
				Riparian Forest (Wetland)	No land cover type change.
				Seasonal Wetland (Wetland)	No land cover type change. These seasonal wetlands are currently supported by seeps and not by inundation of the College Lake Basin. So changes in the College Lake basin hydrology will not likely change these farmed wetlands
				Agriculture (Upland)	No land cover type change.
				Annual Grassland (Upland)	No land cover type change.
				Coyote Brush Scrub (Upland)	No land cover type change.
				Riparian Scrub (Upland)	No land cover type change.
				Developed (Upland)	No land cover type change.

NOTES:

[a] Based on observed water surface elevation during 2016.

[b] Based on the modeled above-average rainfall year (2016). See Appendix HYD and Figures 3.3-7a through 3.3-7d in Section 3.3, Surface Water, Groundwater, and Water Quality in College Lake EIR.

[c] Agriculture includes a fallow period after harvest during which time fields are bare, tilled soil.

[d] The anticipated change of agricultural land to farmed wetland will not affect the agricultural land use of this area.

SOURCES: cbec, inc. eco engineering, Inundation Statistics and Monthly Flows, December 18, 2018; Draft College Lake Integrated Resources Management Project Environmental Impact Report (PV Water 2019)

CHAPTER 4

Adaptive Management Framework

Adaptive management is a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives[17]. This structured process for making decisions informed by monitoring is well suited to situations with clear objectives, some ability to modify actions, and a moderate level of uncertainty. Such situations are common in natural resource management, and include implementation of the College Lake IRMP.

This chapter describes the framework for adaptively managing implementation of the IRMP, as described in the Consolidated Final Environmental Impact Report for the College Lake Integrated Resources Project (PV Water 2019). The framework consists of:

- Objectives (desired outcomes)
- Metrics (monitored variables)
- Action triggers (thresholds, decision criteria)
- Potential management actions

Table 4-1 presents this framework, which is described further in the following sections.

[17] The Delta Reform Act provides a relevant definition of adaptive management: "a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives" (Water Code section 85052)

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TABLE 4-1
SUMMARY OF PROPOSED MANAGEMENT OBJECTIVES, METRICS, AND TRIGGERS

Objective	Metric	Management Action Trigger	Potential Management Actions
Flooding—Avoid exacerbating existing flood hazards outside the proposed water storage area.	College Lake water surface elevation at weir	Water surface elevation exceeds 62.5 feet NAVD88 when weir is raised above 60.1 feet NAVD88	Evaluate procedure for defining last major storm event and potential runoff from that event and potentially adjust. Potential procedure evaluations/modifications include: Relationship of forecasted precipitation to observed precipitation and adjust precipitation factor of safety Calibration of hydrologic model Downstream hydraulic conditions/hydraulic model.
Fish Passage—Facilitate fish passage between the Pajaro River and College Lake between December 15th and May 31st.	Fishway chamber depths, leap heights, and velocities under identified range of flows	Chamber depths, leap heights, and velocities fail to meet approved design passage criteria	Inspect monitoring equipment to confirm no bias resulting from instrumentation. Review operational guidance and records, to confirm compliant bypass flows have been released. Adjust fishway gate controls to meet design passage criteria. Evaluate potential structural and hydraulic issues affecting passage at the weir, and rectify identified issues. Reassess flow requirements for passage at critical riffle, and associated fish passage flows as necessary. Evaluate fish passage needs at potentially critical riffles in Salsipuedes and Creek to verify continued adequacy of bypass flow requirements Coordinate with NMFS and CDFW regarding potential management actions.
	Water depths at critical riffles in lower Salsipuedes Creek, and modeled depths in upper Salsipuedes Creek[a]	Water depth at one or more critical riffles less than minimum required for passage (0.6 feet for adults, 0.4 feet for smolts).	
	Number of outmigrating PIT-tagged smolts detected upstream of weir versus number of smolts trapped downstream of weir	Significant difference between upstream and downstream detections	
	Relative abundance of Age 0 steelhead (% of juveniles) in Casserly Creek	Relative abundance in Casserly Creek significantly lower than in nearby reference stream	
Water Storage—Preserve water storage capacity within College Lake.	Sediment/debris in ditches—Flow obstructions (presence and location) and ditch depth	Presence of a flow obstruction or depth decrease of 25% or more.	Evaluate need for sediment removal. Remove sediment deposits that are reducing storage capacity or obstructing flow/impeding drainage. Evaluate and consider modifications to ditch system Consider small sediment detention basins or other systems for managing the location of sediment deposition Identify watershed factors contributing to sediment production, transport, and deposition, and coordinate with upstream landowners and Resource
	Sediment/debris on lakebed—elevation	Elevation increase > 3 inches by sediment/debris deposited on > 1,000 square feet (> 9 cubic yards).	

TABLE 4-1
SUMMARY OF PROPOSED MANAGEMENT OBJECTIVES, METRICS, AND TRIGGERS

Objective	Metric	Management Action Trigger	Potential Management Actions
			Conservation District of Santa Cruz County to reduce sediment deposition in College Lake.
Water Quality—Minimize conditions that can contribute to algal blooms, including cyanobacteria blooms.	Temperature profile (°C)	Water column temperature gradient > 5 °C[b]	Review monitoring data and consult technical experts and regulatory stakeholders regarding potential responses. Reassess temperature gradient and constituent concentrations used as triggers for management actions Coordinate with the California Cyanobacteria and Harmful Algal Bloom Network (CCHAB) regarding potential management actions Identify watershed factors contributing to phosphorus availability in concentrations in College Lake, and coordinate with upstream landowners and Resource Conservation District of Santa Cruz County to reduce sediment deposition in College Lake. Treat College Lake with aluminum sulfate Lower water level in or drain College Lake
	Total phosphorus (mg/L)	Concentrations > 0.17 mg/L[b]	
	Chlorophyll-a (µg/L)	Concentrations > 25 µg/L[b]	
	Microcystins, total (µg/L)	Concentrations > 0.8 µg/L[b]	
Farming—Promote farming within the College Lake basin between 59 feet and 63 feet elevation NAVD88.	Acreage cultivated between 59 feet and 63 feet elevation NAVD88 by year	Agricultural land at 59–63 feet in elevation is cultivated in less than one in five of the preceding average, dry, and very dry water years.	Conduct landowner outreach to identify factors limiting area of cultivation Develop revised terms for use in future leases. Adjust rate or timing of water diversions. Adjust timing, frequency, or methods of sediment and debris removal. Maintain, improve, or expand tile drain system.
Vegetation— Sustain seasonal wetland and native vegetation	Seasonal wetland vegetation—acreage	Acreage less than 2017–2022 range of acreage	Evaluate potential relationships of change in vegetation to hydrology (e.g., duration of inundation) and operations and maintenance activities, particularly inundation period and vegetation management Modify timing or techniques of vegetation management, including consider of alternatives to mechanical and chemical treatments (e.g., grazing, controlled burns). Modify weir operations or water supply diversions (e.g., to modify drawdown rate). Implement woody riparian plant control measures: disking, or localized hand removal. Monitor treated areas and retreat or revegetate as needed. Reassess practices for limiting introduction and spread of invasive plants, and revise as appropriate. Implement invasive plant control measures: hand removal of new/smaller infestations, other mechanical treatments if effective for species, or chemical treatment of larger areas. Monitor treated areas and retreat or revegetate as needed.
	Combined cover of waterfowl food plants	Annual combined cover significantly less than cover in preceding years before and after the beginning of Project operations[c]	
	Woody riparian plants—location, estimated area, abundance, and height)	1 location > 0.1 acres in area with >0.5% cover of seedlings of woody riparian plants > 3 inches in height	
	Prioritized Invasive Plants—Infestation coordinates, area, and species	1 new invasive plant infestation or >25% increase in area of existing infestation.	

TABLE 4-1
SUMMARY OF PROPOSED MANAGEMENT OBJECTIVES, METRICS, AND TRIGGERS

Objective	Metric	Management Action Trigger	Potential Management Actions
	Percent tree survival, invasive cover, and understory cover in revegetated riparian areas[d]	Tree survivorship ≥ 80% in Years 1–5[d] Invasive plant cover ≤ 5% in tree planting basins[d] Understory plant cover > 50% in Years 2–5	Implement and evaluate use of cover crops to reduce weed/invasive plant cover, stabilize soil surface, or increase above-ground plant matter entering aquatic ecosystem. Implement and evaluate seeding treatments to restore cover of waterfowl food plants or to enhance abundance or diversity of native species, particularly for revegetation following treatment of naturalized invasive plants.
	Plant cover in revegetated seasonal wetland[d]	Absolute cover 50% in Years 2–5[d]	
	Native plant cover in areas treated to enhance or restore seasonal wetland or other natural vegetation	Absolute cover in Years 1–3 ≥ pre-treatment	
Waterfowl—Preserve waterfowl habitat quality in the proposed water storage area.	Annual median of daily abundance and species richness of waterfowl guilds (diving and dabbling ducks) during December–March[e]	Annual median of daily abundance below range of pre-Project (2015–2021) medians	Evaluate College Lake monitoring data, regional data, and other information sources (including technical experts) to identify potential causes of low abundance. Adjust timing or frequency of vegetation management to enhance habitat quality Take additional vegetation management actions to enhance habitat quality (See potential management actions for vegetation objective.) Adjust rate or timing of water diversions
		Annual median of daily species richness below range of pre-Project (2015–2021) medians	
Invasive Animal Species—Control invasive animal species pursuant to a plan approved by the appropriate regulatory agencies.	Species—Presence	Additional species detected	Determine source of invasive species and develop and implement measures to control spread from identified sources Adjust frequency, extent (partial or complete), or timing of lake draining Physically capture and remove invasive animals Revaluate invasive species control methods
	Species—# Individuals / unit area or sampling effort	Increasing trend in abundance	
Cultural Resources— Preserve significant archaeological and historical resources and sustain plants of cultural significance to the Amah Mutsun Tribe[e].	Observed condition of Sites CA-SCR-44/H and CA-SCR-150.	Visible evidence of erosion or other damage.	Work with qualified archaeologist to develop and implement a plan to protect the site(s) from further damage. Work with a qualified archaeologist to recover archaeological resources from the affected portion(s) of the site(s) if protective measures are infeasible.
	Cover of plants of cultural significance at sites revegetated, restored, or enhanced by implementing avoidance and	Post-treatment cover is less than pre-treatment cover at revegetation, restoration, and enhancement sites..	Reassess treatments Implement site-specific remedial measures Develop, apply and evaluate alternative treatments.

TABLE 4-1
SUMMARY OF PROPOSED MANAGEMENT OBJECTIVES, METRICS, AND TRIGGERS

Objective	Metric	Management Action Trigger	Potential Management Actions
	minimization measures or potential management actions[g]		
Research—Support research, including community science, focused on uncertainties affecting management[h]	Studies addressing uncertainties or data gaps (number)	0 studies initiated at College Lake in first 3 years of implementation	Identify opportunities to improve suitability of College Lake as a research site by improving: access (potentially with assistance of adjacent landowners), safety of researchers and equipment, and availability of supporting site and Project information. Make identified improvements. Conduct additional targeted outreach to potential researchers at local universities, colleges, and environmental non-governmental organizations.

Notes

a – "Lower" Salsipuedes Creek refers to the reach between the Pajaro River and Corralitos Creek; "upper" Salsipuedes Creek refers to the reach between Corralitos Creek and College Lake weir.

b – Based on Total Maximum Daily Load (TMDL) established for Pinto Lake and supporting assessments; intended to reduce likelihood of cyanobacteria blooms impairing water uses (State of California Regional Water Quality Control Board Central Coast Region Resolution No. R3-2020-0034; R. Ketley, A. Retinger, and M. Los Huertos [2013] Pinto Lake Total Maximum Daily Load (TMDL) Planning and Assessment, State Water Resources Control Board, Sacramento, California.

c – Here "significant" refers to statistical significance ($\alpha = 0.05$ or less); the vegetation monitoring described in Section 5.1.1.6, "Vegetation," is designed to distinguish substantial changes in cover as statistically significant. To be conservative (in this context, to err on the side of a Type I error), critical values will not be adjusted for multiple comparisons.

d – From College Lake Integrated Resources Management Project – Revegetation Plan (provided as **Appendix E, "Revegetation Plan"**)

e – Species richness is the number of species.

f – Plants of cultural significance to the Amah Mutsun are identified in **Appendix G, "Plant Species List."**

g – Cover may be measured using transects as described in Section 5.1.1.6, "Vegetation," in **Appendix E, "Revegetation Plan,"** or using a "releve method" consistent with the releve protocol of the California Native Plant Society (CNPS 2020).

h – Community science is the involvement of the public in scientific research under the guidance of trained scientists and can involve collecting, categorizing, transcribing, or analyzing scientific data. Community science can provide educational and other benefits in addition to supporting scientific research.

4.1 Objectives

Objectives are desired outcomes or performance measures that serve to guide decision making and evaluations of success in fulfilling the Project's purpose. Important attributes of objectives include being:

- Specific
- Measurable
- Attainable
- Relevant
- Time-bound

The AMP's objectives must not conflict with the Project's objectives, permit requirements, or other constraints. Each AMP objective and the actions taken to attain it must not conflict with other AMP objectives.

4.2 Metrics

Metrics are monitored variables used to evaluate Project outcomes (e.g., progress towards a measurable objective, success). Important attributes for metrics include:

- Relevance—Metrics are related to the Project's objectives and have implications for management activities.
- Responsiveness—Metrics are capable of exhibiting changes in response to actions taken in the time frame required for adaptive management (e.g., within 0–5 years).
- Cost-effectiveness—Individually and collectively, measuring the metrics will involve a reasonable expenditure relative to other metrics that could effectively assess progress and inform management decisions.
- Reliability of interpretation—Changes in the metrics will reliably and clearly document the results of management actions (as opposed to other causes, such as environmental fluctuations) and will highlight the types of changes that are needed in the Project's implementation.
- Transparency/ease of communication—As a set, the metrics will tell a clear and concise story to a broad cross section of the interested public about the results of implementing the Project.

Table 4-1 presents the metrics for each of the Project's objectives, and Section 5.1, "Monitoring Framework," describes how these metrics will be monitored.

Monitoring of other variables may improve management by increasing understanding of the College Lake ecosystem. Studies that would address key uncertainties are discussed in Section 5.2, "Targeted Studies."

4.3 Triggers and Management Actions

Triggers are limiting values of metrics that trigger management actions (e.g., thresholds, decision criteria). The key attributes of an action trigger are its relationship to the objective and its relationship to potential management actions. Action triggers need to indicate risk of an undesirable outcome when there are still potential actions that could be taken to avoid or rectify the undesirable outcome. Natural variability complicates the selection of action triggers, and management responses when they are exceeded. **Table 4-1** presents the action triggers selected for each metric.

For most objectives, there are several different types of management actions that could be implemented, including:

- Evaluation
- Coordination/consultation
- Adjustments to operations and maintenance practices
- Remedial actions
- Collaboration on off-site actions (e.g., actions up or downstream of College Lake)

For each action trigger, **Table 4-1** presents potential management actions that may be implemented in response to the trigger being exceeded. These lists represent the range of potential management actions but do not necessarily include all potential actions. Although no sequencing of actions is indicated in **Table 4-1**, the initial action typically would be an evaluation or assessment of the situation which would inform the selection of subsequent actions.

CHAPTER 5

Monitoring and Targeted Studies

This chapter describes the monitoring that will be conducted to inform the Project's O&M activities. Topics for targeted studies (research or community science) that could support management by reducing key uncertainties will also be detailed in this chapter.

5.1 Monitoring Framework

For each objective of the AMP, the following sections concisely describe how O&M activities will be documented and how metrics will be monitored. The monitoring activities described below will be conducted by PV Water staff, its contractors, or both.

5.1.1 Monitoring of Metrics for Objectives

5.1.1.1 Flooding

The flooding metric is the water surface elevation of College Lake, and the action trigger is a water surface elevation above 62.5 feet NAVD88 when the weir height is above 60.1 feet NAVD88. Flooding that occurs naturally, when the weir is in its lowered position (60.1 feet NAVD88), is beyond the scope of the Project. Therefore, monitoring for the flooding objective will consist of weir height and water surface elevation at the weir recorded continuously.

5.1.1.2 Fish passage

The fish passage metrics are passage-related attributes (chamber depths, leap heights, water velocities, and water depth at critical riffles), the number of tagged smolts detected and smolts trapped at the College Lake Weir, and the relative abundance of Age 0 (young-of the year) steelhead in Casserly Creek. These metrics will be monitored and related information collected by:

- Evaluating passage efficiency at and downstream of the weir in Salsipuedes Creek Conducting juvenile steelhead population surveys in the Casserly Creek watershed
- Tagging juvenile steelhead with passive integrated transponder (PIT) tags
- Operating PIT-tag detection arrays
- Trapping outmigrants
-

The methodology for this monitoring is described in detail in **Appendix C, "Steelhead Monitoring Plan."**

If for the five years after Project operations begin, this monitoring has indicated successful fish passage through College Lake, in coordination with NMFS, PV Water may reduce the frequency or simplify the methods of this monitoring.

5.1.1.3 Water Storage

The water storage metrics are for sediment and debris affecting water storage and Project operations. These will be monitored annually by visual inspections of all ditches and the lakebed. During these inspections, the locations of any flow obstructions and the typical depth reduction in predefined subdivisions of the ditch system will be recorded, as will the location and approximate area and depth of all sediment deposits on the lakebed that are greater than both 1,000 square feet in area and three inches in depth. Additional assessment methods may be considered to support the visual inspections where appropriate (e.g., surveying of elevations, installing staff plates).

5.1.1.4 Water Quality

The water quality metrics are for the water column temperature gradient and concentrations of total phosphorus, chlorophyll-a and microcystins. These metrics will be monitored through PV Water's water quality monitoring program. **Appendix B, "Water Quality Monitoring Plan,"** provides a detailed description of the water quality monitoring program, including sampling locations, water quality constituents analyzed and methods. During Project implementation, PV Water will adapt and add to its existing water quality monitoring program by monitoring:

- Cyanotoxins and algae (taxonomic group and density) in the grab samples collected from College Lake
- Depth, water temperature, dissolved oxygen, specific conductance, pH, chlorophyll-a, and phycocayanin continuously at two locations in College Lake
- Monthly profiles of water temperature, dissolved oxygen, specific conductance, chlorophyll-a, and water clarity (Secchi depth) at the two sample locations

5.1.1.5 Farming

The farming metrics is for the acreage of cultivation of land between 59 feet and 63 feet elevation NAVD88 by year, for average, dry, or very dry water years. Farmed acreage will be recorded annually, including the crop(s) grown on each field, and adding this information as attributes to the geographic information system (GIS) data for the vegetation map of College Lake (see "Vegetation Type Mapping" in Section 5.1.1.5, "Vegetation," below). From this information and elevation data, GIS software will be used to calculate the acreage cultivated between 59 feet and 63 feet elevation NAVD88 in average, dry, or very dry water years, and the frequency of cultivation of all areas of agricultural land at 59–63 feet elevation NAVD88 during average, dry, or very dry years.

5.1.1.6 Vegetation

The vegetation metrics are for the acreage of seasonal wetlands and the cover of waterfowl food plants within them, and for the location, area, and abundance of woody riparian plants and invasive plants. These metrics will be monitored through site assessments, vegetation type mapping from aerial imagery, and plant cover in seasonal wetlands along permanently marked transects. These monitoring methods are described below.

Site Assessment

As part of an annual site assessment, the presence, cover, and area infested by invasive species will be visually estimated and recorded, as will the presence, typical height, density, and area with seedlings/saplings of woody riparian plants. Invasive plants are species in the California Invasive Plant Council's (Cal IPC's) database (Cal IPC 2021) with a rating of "High." The estimated absolute cover of these species will be recorded in one of several categories. For woody riparian plants, typical height will be recorded to the nearest quarter foot, and density will be recorded in one of several categories. Ideally, assessment data will be recorded into a digital form and the perimeter of the invasive plant infestation or area with woody plant recruitment will be mapped in the field.

Vegetation Type Mapping

Annually, aerial imagery from that year will be used to review the College Lake vegetation map. Based on that review, and any related field verification, the boundaries, vegetation type, and other attributes of polygons in the geographic information system (GIS) data will be updated as necessary. If new vegetation types develop by changes in dominant species or vegetation structure (including extent of bare ground), they will be added to the classification system of the vegetation map.

Five years after Project operations have begun, if boundaries of vegetation types have been stable, the frequency of this monitoring may be reduced.

Seasonal Wetland Plant Cover

Permanently marked transects will be used to monitor changes in the cover and species composition of seasonal wetland vegetation at elevations of 59–63 feet NAVD88. The purpose of this monitoring is to document changes in species composition of seasonal wetland vegetation because of its importance for wildlife, particularly waterfowl. (Changes in the acreage of seasonal wetland would be documented through mapping from aerial imagery as described above.)

In two or three fields, six 100-meter-long, permanently marked, transects will be randomly located approximately parallel to the elevation contours (12–18 transects total)[18]. Plant cover

[18] Based on the variance among transects in unpublished data collected by Jerry Bush and John Pritchard at College Lake in 2014–2016, and 2016, this size sample for a field should detect a change in cover of 20 percent between years at a high level of significance ($\alpha = 0.05$ [95% "significance"]) with moderate power ($\beta = 0.20$ [80 % "power"]), and should detect smaller differences between years overall (i.e., for all fields combined) at a high level of significance and moderate level of power.

by species will be recorded along the transects. Also, photographs of the transects will be taken and the typical height and qualitative seed production information will be recorded for high-value waterfowl food plants. High-value waterfowl food plants are:

- Smartweed (*Persicaria lapathifolia*)
- Fat-hen (*Atriplex prostrata*)
- Swamp timothy (*Crypsis schoenoides*)
- Barnyard grass (*Echinochloa crus-galli*)

The methodology for monitoring seasonal wetland vegetation is fully described in **Appendix F, "Seasonal Wetland Monitoring Methodology."**

If for five years after Project operations begin, the cover of waterfowl food plants has been comparable to or greater than that documented by pre-project monitoring, or has remained stable, the frequency of this monitoring may be reduced or the monitoring discontinued.

5.1.1.7 Waterfowl and Other Birds

PV Water has been monitoring bird use of College Lake since 2014, and will continue to monitor bird use of the lake using comparable methods.

Since 2014, PV Water has been collecting waterfowl, shorebird, wading bird, raptor, and nesting bird data at College Lake during winter and spring. This monitoring consists of bi-weekly to monthly early morning site visits to established observation points around the lake for waterfowl/bird counts. The primary goal of the baseline survey is to develop a understanding of when and how College Lake is used by migratory waterfowl, shorebirds, and wading birds as well as resident nesting bird populations.

As the lake drains and spring-migrant shorebirds are passing through the region, the frequency of site visits is typically increased. The ephemeral dry-out period mudflat conditions that attract migrating shorebirds to College Lake can last just a few weeks, so more frequent visits are required to characterize shorebird use. Migrating and locally nesting herons, egrets, and cormorants also congregate in large numbers during spring lake-draining period to feed on stranded aquatic species. In addition, spring raptor nesting activity is mapped and monitored, while landbird species are noted and reported when encountered, they are not the focus of the survey efforts. Observation points for lake-full surveys have been located to maximize coverage of the flooded lakebed with minimal overlap.

Since 2017, PV Water has also been collecting waterfowl, shorebird, wading bird, raptor, and nesting bird data at College Lake during summer and fall because bird observations had not been previously recorded during the crop growing season. Once the lake is drained in the spring, monthly site visits are conducted. A different set of observation points are used during summer–fall when the lake is fully drained and thus more accessible, and observations are also

made along four permanent transects. Active agricultural fields, drainage ditches, and accessible parts of the PV Water riparian parcel are surveyed during summer and fall visits.

During lake-full site visits, monitoring is typically conducted by a team of two or three observers, depending on site conditions and availability of personnel. Dry-season surveys are conducted by one or two people and transects are walked. Observers note all bird species identified in the field and for each species record the number of birds observed. These data are compiled in a spreadsheet for analysis and uploaded to the website eBird for public access[19]. Breeding activity and nesting birds are also noted and these observations are contributed to the Santa Cruz Bird Club's Breeding Bird Census.

If eight years after Project operations have begun, abundance and species richness of waterfowl guilds (diving and dabbling ducks) remains comparable to or becomes greater than that documented by pre-project monitoring, the frequency of this monitoring may be reduced or the monitoring discontinued.

5.1.1.8 Invasive Animal Species

The invasive animal species metrics are for species presence and their abundance (number of individuals per unit area or sampling effort). At permanently marked sites, invasive animals will be monitored in conjunction with their removal. This removal-monitoring will be conducted in late summer–early fall when College Lake has been drawn down and wetted areas are confined to drainage channels. For each species of invasive animal, life stage, number, and location will be recorded for all animals removed. From this information, densities of invasive species captured per unit effort will be calculated. The methods for this combined monitoring and removal are described in greater detail in **Appendix D, "Invasive Species Management Plan."**

5.1.1.9 Cultural Resources

The cultural resources metrics are for the condition of Sites CA-SCR-44/H and CA-SCR-150 (e.g., evidence of erosion). Consistent with Mitigation Measure CUL-1i, the condition of these sites will be determined by a qualified archaeologist who will prepare a technical memorandum of the inspection with photographs. During the first two years of Project operation, the sites will be inspected quarterly, and during the third through fifth years, the sites will be inspected semi-annually. If after five years, no erosion or other impacts to these sites have been observed, this monitoring may be discontinued.

5.1.1.10 Research

The research metric is the number of studies addressing uncertainties or potentially informing adaptive management of O&M of the Project in addition to monitoring of metrics for the objectives. A description of each study conducted at College Lake will be included in the annual

[19] All survey data collected, to date, can be found in the "College Lake, Santa Cruz County, CA, US" eBird Hotspot: https://ebird.org/hotspot/L281754?yr=all&m=&rank=mrec

memorandum described in Section 6.2, "Reporting," and copies of study data sets and other work products will be archived.

5.1.2 Documenting Management Actions

Records will be kept documenting all O&M conducted by PV Water at College Lake. Documenting O&M activities is an important component of monitoring. These records will be summarized annually to support decision making.

5.2 Targeted Studies

Data on College Lake's habitats, ecosystems processes (e.g., hydraulics), and species have been sufficient for the planning and analyses conducted for the Basin Management Plan Update Programmatic Environmental Impact Report and College Lake Integrated Resources Management Project Draft Environmental Impact Report (PV Water 2014, 2017), Project permitting, and this AMP. However, some information that would assist future management is not available or not well understood. Therefore, focused (targeted) studies will be encouraged and facilitated (e.g., by providing access or supporting information) to reduce uncertainties and further inform adaptive management of the Project's O&M.

Section 3.4, "Anticipated Changes in Inundation and Land Use Changes and Related Uncertainties," described several uncertainties in the response of organisms to the Project's implementation. Most of these uncertainties will be reduced through monitoring that is already or will be implemented by PV Water (see Section 5.1.1, Monitoring of Metrics for Objectives"). However, the planned monitoring will not document the response of the aquatic food web to implementation of the Project, and the planned monitoring does not directly compare the effectiveness and consequences of alternative management practices on waterfowl or other organisms, which would require a much greater level of effort.

In addition to uncertainties about organism responses to Project implementation, several potential areas of investigation have been identified during development of this AMP, including:

- **Presence of red-legged frog**—PV Water has committed to implementing multiple measures to avoid and minimize impacts to red-legged frogs, a species federally listed as endangered; however, the presence of red-legged frogs at College Lake has not been confirmed. Surveys confirming the presence or determining the absence of red-legged frog would guide refinements of avoidance and minimization measures and improved management practices.

- **Causes of Inter-Annual Changes in Waterfowl Use**—waterfowl abundance at College Lake varies considerably from year to year, and a better understanding of the causes of this variation would aid interpretation of monitoring data, particularly if monitoring documents substantial increases or decreases in waterfowl use of the lake. Studies of regional waterfowl use, effects of human activities (including active agricultural use of Project lakebed margins and hazing), and spatial patterns of waterfowl use in different arms of the

lake will help in evaluating whether potential changes in waterfowl use of College Lake are independent of or in response to Project O&M.

- **Plant species growing at College Lake**—the species composition of vegetation is relevant to several AMP objectives; however, there is not a complete list of the plants growing at College Lake. A complete list (an inventory) that distinguishes native from non-native species, identifies those species that are ethnobotanical resources and those that are invasive would inform management and support attainment of management objectives.

- **Pre-contact vegetation**—the vegetation of College Lake prior to the alterations that followed European contact (including among other changes the introduction of European plant species and changes to hydrology) could provide guidance for management to promote native plants at College Lake. This information on the historical ecology of College Lake does not currently exist but could be provided by compilation of historical records and field investigations of plant materials in sediments.

- **Vegetation response to management treatments—**if management actions need to be taken in response to changes, then studies of the effectiveness of alternative actions could guide management. While the monitoring described in Section 5.1.1.6, "Vegetation," would provide some evidence of vegetation response to a treatment, a targeted study could better inform decisions regarding alternative treatments.

These investigations of these topics and other useful information obtained through targeted studies by colleges and universities, government agencies, and non-governmental organizations (NGOs). In some cases, community science studies led by academic, agency, or NGO investigators may be appropriate.

Although not required for implementation of the AMP and not being undertaken ore funded by PV Water, PV Water will encourage and facilitate studies by others that provide this data, or otherwise inform Project O&M, and are compatible with ongoing Project O&M and agricultural activities.

CHAPTER 6

Reporting and Plan Updates

This chapter describes the evaluations by PV Water staff, reporting, and updating of the Plan that will be components of adaptive management of O&M of the Project.

6.1 PV Water Evaluations

PV Water staff will annually review summaries of monitoring data, PV Water O&M activities, and evaluate practices. Based on this review, monitoring and management practices will be discussed, and decisions to change practices for the subsequent year will be made if necessary. This evaluation may be supported by technical experts, regulatory agencies, land owners, or other stakeholders.

6.2 Reporting

6.2.1 Adaptive Management Reporting

Each year a memorandum will be produced that summarizes monitoring and O&M conducted by PV Water, if action triggers were exceeded, and if so, what management actions were taken or planned in response. This memorandum also will document any changes in monitoring and O&M practices implemented for other reasons (e.g., changes in regulations or technology), new information that may affect O&M, and revisions to the AMP, if any. Monitoring results will be an important basis not only for adaptive management decisions, but also for revising the AMP. Annual monitoring reports and reports on targeted studies completed that year will be attachments to the memorandum. Annual memoranda will be publicly available.

6.2.2 Other Reporting

In addition to monitoring and reporting to support and document operations, maintenance, and other management actions, PV Water will conduct monitoring and provide annual compliance reporting as required by the Project's permits and other authorizations.

6.3 Plan Updates

All planning documents eventually become dated and require revision so they can continue to provide practical direction for management. A common and unfortunate situation is that the revision of planning documents is neglected because the revision process is too involved and

too cumbersome. To address this problem, this AMP incorporates simple procedures for making revisions to the Plan.

Revisions to the AMP in response to new information may be made annually by PV Water with input from the Committee. New information necessitating revisions to keep the AMP current may include:

- Feedback generated by adaptive management
- Scientific research that directs improved techniques for resource management
- Changes in land use or management of adjacent lands
- New regulatory requirements

Beginning in the first year of Project operations, this information will be summarized annually in the adaptive management memorandum described in 6.2.1, "Adaptive Management Reporting." A draft of this memorandum will be shared with the Committee and will contain any proposed changes to the AMP. Proposed changes will be discussed with the Committee and the input of Committee members solicited prior to the memorandum, and any changes to the AMP it contains, being finalized.

At 5-year intervals, changes to the AMP made in the 5 annual adaptive management memoranda will be compiled in an updated version of AMP document for ease of reference. It is anticipated that the after the first 5-years of Project O&M, monitoring results and documented management activities will have provided a sound basis for evaluating and where appropriate, revising, all objectives, monitoring methods (including monitoring frequency), metrics, action triggers, and potential management actions.

CHAPTER 7

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