US Army Corps
of Engineers®
Los Angeles District

Prado Basin Ecosystem Restoration and Water Conservation Study

APPENDIX E

Monitoring and Adaptive Management Plan

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers, Los Angeles District (Corps), in partnership with the Orange County Water District (OCWD), has developed feasibility level plans for the Prado Basin Feasibility Study (PBFS) in Corona, California. The purpose of this ecosystem restoration project is to:

1. Improve hydraulic and fluvial geomorphic functions to promote habitat growth and wildlife connectivity to regionally significant core habitats at Prado Basin and associated main watercourses within the proposed project area.
2. Restore riparian and riparian associated habitats suitable to native species within the proposed project area.
3. Reduce presence and effects of non-native wildlife on habitat suitability and function for native wildlife species.

Native species that would benefit from this restoration include, but are not limited to, the federally endangered least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*), Santa Ana sucker (*Catostomus santaanae*) and Arroyo chub (*Gila orcuttii*), a species of special concern of the State.

This document outlines the feasibility level Monitoring and Adaptive Management Plan (MAMP) for the PBFS. The MAMP is focused on the ecosystem restoration measures identified for Alternative 3 as identified in the Integrated Feasibility Report (IFR), and describes the monitoring and adaptive management activities proposed and estimates their cost and duration.

The general purpose of the MAMP is to provide a systematic approach for improving resource management outcomes and a structured process for recommending decisions, with an emphasis on uncertainty about resources response to management actions and the value of reducing that uncertainty to improve management.

More specifically, the MAMP will:

- Establish the framework for effective monitoring, assessment of monitoring data, and decision making for implementation of adaptive management activities in the project focal areas.
- Provide the process for identifying adaptive management actions if monitoring demonstrates that restoration measures are not achieving established success criteria in the project focal areas.
- Establish decision criteria for vegetation and wildlife evaluation and modification of adaptive management activities.
- Establish decision criteria for the habitat or in-stream management measures evaluation and modification of adaptive management activities.

- Provide estimated cost and duration of the monitoring and adaptive management measures.

This plan will be reviewed and revised as needed during the Preconstruction, Engineering, and Design (PED) phase as specific design details are made available.

1.1 Statutory Basis for Monitoring and Adaptive Management

Section 2039 of WRDA 2007, as amended, specifies the information required to be included in monitoring plans for ecosystem restoration projects, and directs when non-federal operation and maintenance responsibilities of these projects may cease.

Section 2039 of WRDA 2007, as amended, directs the Secretary to ensure that, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The monitoring plan shall include a description of:

a. Types and number of restoration activities to be carried out;
b. Physical actions to be undertaken to achieve project objectives;
c. Functions and values that will result from the restoration plan;
d. Monitoring activities to be carried out;
e. Criteria for ecosystem restoration success;
f. Estimated cost and duration of the monitoring; and
g. A contingency plan (adaptive management plan) for taking corrective actions in cases in which the monitoring demonstrates that restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan.

This MAMP includes all elements required by Section 2039, as amended, and as described in the Corps' WRDA 2016 implementation guidance for section 1161, dated 19 October 2017 (Section 7.b), including:

- the rationale for monitoring (Section 2.2), including:
  - key project specific parameters to be measured (Section 2.3.2)
  - how the parameters relate to achieving the desired outcomes or making a decision about the next phase of the project (Sections 2.3.2, 6.1),
- the intended use(s) of the information obtained (Section 2.3.4)
- the nature of the monitoring including duration and/or periodicity (Sections 2.3.2, 2.3.3),
- the disposition of the information and analysis (Sections 2.3, 5.0)
- the cost of the MAMP (Section 7.0)
- the party responsible for carrying out the MAMP (Section 1.2)
- a project closeout plan (Section 6.4).
- a contingency (adaptive management) plan (Section 6.3)

1.2 Adaptive Management Team

The MAMP provides the framework and guidance for an Adaptive Management Team (AMT) to review and assess monitoring results and consider and recommend adaptive management actions when ecological success is not achieved and decision criteria are triggered. The AMT members shall work together to make recommendations relevant to implementing the MAMP. The AMT is composed of the Corps, the OCWD, and interested resource agencies. Although the Corps and OCWD have coordinated with the entities that will be invited to compose the AMT in development of the IFR, the AMT will be officially established during the PED.

The AMT focuses on the ecological function of the habitats through related management actions to maintain and provide functional riverine habitat for general species and special status (threatened and endangered species) within the project area. This MAMP provides a monitoring plan and identifies triggers upon which an adaptive management action may be implemented. The AMT shall review the monitoring results and advise on and recommend actions that are consistent with the project goals and reflect the current and future needs of the habitat and the species they support within the project area. The Corps shall have final determination on all adaptive management actions recommended.

The Corps is responsible for ensuring that monitoring data and assessments are properly used in the adaptive management decision-making process. If the Corps determines that adaptive management actions are needed, it will coordinate with the AMT on implementation of those actions. The Corps is also responsible for project documentation, reporting, and external communication.

The AMT shall meet at a minimum of once per year, as scheduled by the Corps and/or sponsor during the monitoring period, to review the results of monitoring and assess whether project objectives are being met. If objectives are not being met, the AMT may recommend that adaptive management actions be taken in response to monitoring results as compared to decision-making triggers.

The AMT may consider other related projects along the River and its tributaries in determining the appropriate adaptive management actions, and may consult with other recognized experts or stakeholders as appropriate, to achieve project goals.

Recommendations for adaptive management should be based on:

- Monitoring data from previous years
- Consideration of current habitat conditions
- Consideration of current and potential threats to habitat establishment success
- Past and predicted response by target species

1.2.1 Team Structure

The Adaptive Management Team shall include representatives from the Corps, Los Angeles District and OCWD, the non-Federal sponsor.

U.S. Army Corps of Engineers: The Corps may be represented by the Project Ecologist as well as the Project Hydrology and Hydraulics (H&H) representative and the Project Geotechnical representative as needed. Other Corps attendees may include the Project Manager, the Project Environmental Coordinator, and/or Operations and Maintenance designees, as needed.

Orange County Water District: OCWD, as the non-Federal sponsor for the project, is responsible for Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRRR) activities once the Corps notifies OCWD of completion of the project or each functional element thereof. Prior to final project completion, the Corps will transfer responsibility of functional elements of the project to OCWD as they are completed.

The AMT shall also include representatives from resource agencies who would serve in an advisory capacity, to assist in evaluation of monitoring data and assessment of adaptive management needs. The following agencies shall be invited, and would participate in the AMT upon their acceptance:

- U.S. Fish and Wildlife Service, Palm Springs Office
- California Department of Fish and Wildlife, South Coast Region
- California Regional Water Quality Control Board, Santa Ana Region

Additional expertise may be provided by other entities and stakeholders with knowledge of the Santa Ana River ecosystem, hydrology, and wildlife species, at the discretion of the primary AMT participants.

Input from the AMT will be solicited during the selection of reference sites during PED, the refinement of success criteria, and the development of specific adaptive actions (as necessary).

2.0 MONITORING

An effective monitoring program will be required to determine if the project outcomes are consistent with original project goals and objectives. The power of a monitoring program developed to support adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management. A carefully designed monitoring program is the central component of the project adaptive management program as it supplies the information to assess whether the project is functioning as planned.

2.1 Project Objectives

The study objectives for the *ecosystem restoration* component of the PBFS include:

1. Improve hydraulic and fluvial geomorphic functions to promote habitat growth and wildlife connectivity to regionally significant core habitats at Prado Basin and associated main watercourses within the proposed project area.
2. Restore riparian and riparian associated habitats suitable to native species within the proposed project area.
3. Reduce presence and effects of non-native wildlife on habitat suitability and function for native wildlife species.

2.2 Rationale for Monitoring

Monitoring must be closely integrated with the adaptive management components because it is the key to the evaluation of adaptive management needs. Objectives must be considered to determine appropriate indicators to monitor. In order to be effective, monitoring must be able to distinguish between ecosystem responses that result from project implementation (i.e., management actions) and natural ecosystem variability. Achieving objectives will require monitoring that focuses on the target habitats and the hydrologic and geomorphic processes that support them.

2.3 Monitoring Plan

According to the Corps' implementation guidance, "Monitoring includes the systemic collection and analysis of data that provides information necessary to determine if the project is meeting its performance standards and to determine when ecological success has been achieved or whether adaptive management measures are necessary to ensure that the project will attain project benefits."

The following discussion outlines a monitoring plan that identifies performance measures along with desired outcomes and monitoring design in relation to specific objectives. A performance measure includes specific feature(s) to be monitored to determine project performance. Additional monitoring is identified as supporting information needs that will help to further understand the interrelationships of restoration features and external environmental variability and to corroborate project effects.

Decision-making triggers are related to each performance measure and desired outcome and identify the need to discuss potential implementation of adaptive management actions with the AMT. These criteria/triggers are identified in Section 2.3.2 and 6.1 respectively.

Overall, monitoring results will be used to evaluate the progress of habitat restoration toward meeting project objectives and to inform the need for adaptive management actions to ensure successful restoration is achieved.

2.3.1 Monitoring Period

Upon completion of construction of each phase or feature of the project, the non-federal sponsor will begin OMRRR and the Corps will initiate cost-shared monitoring for ecological success and adaptive management, which will continue until ecological success criteria are met. OCWD will be responsible for implementing the cost-shared monitoring tasks, as shown in Attachment A. Cost shared monitoring and adaptive management will continue for a period of up to 10 years, depending on the restoration measure, until restoration success is achieved. The monitoring and adaptive management period requirement would vary based on the data needs of the site specific monitoring programs to assess a particular measure and/or focal area.

Although Section 2039 of WRDA 2007, as amended, allows for up to ten years of cost-shared monitoring, this plan anticipates that five years of monitoring and adaptive management will likely be sufficient for successful establishment of native riparian vegetative cover and abatement and control of non-native wildlife. However, once the Corps determines that ecological success for a measure has been fully achieved, even if this occurs in less than five years, no further monitoring will be performed.

If performance criteria for project objectives have not been met within the first five years, as is expected, then cost-shared monitoring and adaptive management would continue within those areas until performance criteria are met or for a maximum of five additional years, whichever is less, resulting in no more than 10 years of cost-shared monitoring. If the success criteria cannot be met within the ten-year period of cost-shared monitoring allowed by law, any additional monitoring and management will be a non- Federal responsibility. Concurrent monitoring of one or more nearby reference sites with similar conditions to the desired restored habitat is recommended to differentiate changes at the restoration site that are attributable to the restoration activity versus normal environmental variability affecting the region.

This monitoring plan includes the minimum monitoring actions necessary to evaluate success and to determine adaptive management needs. If multiple construction contracts or phases are required to implement all of the restoration elements associated with the recommended plan, monitoring and adaptive management would be initiated at the completion of each phase of construction.

2.3.2 Performance Measures and Monitoring Design

This section outlines the monitoring tasks needed to evaluate the success of restoration and the rationale for how these tasks relate to study objectives and desired outcomes. Desired outcomes are measured as described in Section 6.1, presented as decision-making triggers for adaptive management action.

Objective 1: Improve hydraulic and fluvial geomorphic functions to promote habitat growth and wildlife connectivity to regionally significant core habitats at Prado Basin and associated main watercourses within the proposed project area.

Performance Measure 1: Geomorphic conditions at Chino Creek

Desired Outcomes: Increase structure and diversity of in-channel form and microhabitats in the Chino Creek focal area.

Monitoring Design and Rationale: A reference site will be identified on the Santa Ana River or other site of similar hydrologic character and gradient during PED phase. Desirable geomorphic conditions at the reference site will be identified for establishment of geomorphic success criteria for the Chino Creek channel. Conditions that will be assessed may include stream gradient, channel form, channel sinuosity, channel dimensions (depth and width), substrate composition, and substrate distribution. Specific numerical targets will be developed with regards to desired geomorphic conditions of the reference site, as they exist at the time of the PED phase. The reference site location, as well as the final geomorphic condition success criteria, will be developed in coordination with the AMT. Once established, three monitoring stations will be identified at the reference site for monitoring channel cross-sections in order to establish the final numerical targets for success criteria.

Prior to construction, monitoring locations will be developed within the existing alignment of the Chino Creek channel. Cross-sections at each monitoring location will be evaluated for the desired geomorphic conditions based on the reference site and will serve as the baseline for the new Chino Creek channel alignment.

Following construction completion, three permanent monitoring stations will be established for monitoring channel cross-sections at the new Chino Creek channel. Geomorphology and in-channel habitat elements would be monitored to match the desirable geomorphic conditions and success criteria established based on the reference site. Monitoring of these cross-sections will be performed annually for a period of five years, and results of monitoring will be compared to the baseline assessment of the original Chino Creek alignment to document the habitat improvement achieved by the new channel alignment.

Monitoring of these geomorphic features is necessary to determine the successful establishment of a stable, native arid southwestern stream channel. Changes to geomorphic processes will affect the vegetation component of target habitats, which would also impact wildlife movement through the project area. If vegetative cover and structure criteria are not being met, data from monitoring of geomorphic and hydrologic processes may provide additional information on the underlying causes of failure.

Decision-making triggers can be found in Section 6.1.1.

Objective 2: Restore riparian and riparian associated habitats suitable to native species within the proposed project area.

Performance Measure 2: Vegetative community, cover, and structure

Desired Outcomes:

1. Increase percent cover of native riparian and riparian-associated habitat, including but not limited to: riparian woodland, riparian scrub, and transitional riparian habitats.
2. Maintain appropriate structural diversity of native riparian habitats to support survival and reproductive requirements for riparian obligate species and to support regional wildlife movement.
3. Increase percent native vegetative cover over water to reduce water temperatures to support native fish such as the Santa Ana sucker and Arroyo chub.
4. Decrease percent cover of non-native invasive vegetative species that out-compete natives.

Monitoring Design and Rationale: Permanent quantitative vegetation monitoring stations will be established for assessing vegetation communities at each of the native planting locations, as well as within each of the invasive plant management areas and in the riparian habitat surrounding the Chino Creek channel feature. Baseline condition information will be gathered at each monitoring station prior to construction to provide a basis of comparison, and these stations will be monitored annually for five years post-construction as part of adaptive management, and would continue to be monitored long-term as part of operation and maintenance. In addition, during the initial year of monitoring, data from reference sites will be collected for comparison. Reference sites will be chosen in coordination with the AMT from within the Prado Basin. A reference site for each habitat type restored will be identified (i.e. riparian woodland, riparian scrub, and transitional riparian). Analysis of hyperspectral imagery mapping would be performed prior to construction (i.e. baseline condition) and during 2 of 5 monitoring years. As drone mapping technology improves in the future, monitoring methods may be adjusted in coordination with the AMT to incorporate drone mapping in place of on the ground monitoring.

Monitoring of vegetation (including percent cover, structural diversity, cover over water,

and percent cover of invasives) will indicate if target habitats have been successfully restored. Results of monitoring for vegetation communities would also indicate whether habitat components necessary to provide habitat connectivity and support increased wildlife movement have been successfully established.

Decision-making triggers can be found in Section 6.1.2.

Objective 3: Reduce presence and effects of non-native wildlife on habitat suitability and function for native wildlife species.

Performance measure 3: Non-native wildlife species populations

Desired Outcomes:

1. Reduce brown-headed cowbird population and vireo nest parasitism to support increased function of riparian habitats and use by endangered vireos and flycatcher.

Monitoring Design and Rationale: Monitoring of cowbirds will indicate if restored habitats are providing the expected benefits, as their presence may inhibit use and occupation of target habitats by native species. Results of this monitoring will inform whether adaptive management actions related to the cowbird trapping measure are needed.

Cowbirds would be monitored and counted annually for five years at each trapping location as part of the cowbird trapping effort, and the capture rate of non-target species would be documented. Parasitism of vireo nests by cowbirds would also be monitored at baseline and Year 1, Year 3, and Year 5.

Decision-making triggers can be found in Section 6.1.3.

2.3.3 Monitoring Procedures

The following monitoring procedures will provide the information and data necessary to meet the success criteria and objectives for the project.

Geomorphic conditions: To assess the overall stream health and available habitat for native fish and wildlife movement, a California Stream Bio-assessment Worksheet (CDFG 1999) will be completed annually for 5 years at permanent monitoring stations within the restored channel area of Chino Creek. This assessment is meant to rapidly assess the stream and to give it a habitat value score based on the physical characteristics of the site. Some of the physical factors that are assessed include the stream gradient, substrate composition, organic material in the stream (woody debris and leaf litter), and vegetative cover above the stream. Additional desirable geomorphic conditions may be assessed that are not included in the worksheet, based on the outcome of reference site

condition assessments described in Section 2.3.2.

In-stream characteristics will also be recorded during this time by taking channel cross-sections at each of the three permanent monitoring stations. Methods involve placing a transect line perpendicular to flow at the up and downstream extents of 100 meter monitoring sites. Substrate composition and size (silt, sand, gravel, cobble, boulder, sandbars, and emergent vegetation), channel width, channel depth, mid-column current velocity, and riffle/pool microhabitat depths and velocities will be measured at 1.0 meter intervals along each transect line.

Vegetation: Quantitative vegetation transect monitoring will occur annually for five years at each of the native planting and invasive plant management locations, as well as in the riparian restoration area surrounding the Chino Creek channel. Transects will also be utilized at each of the reference sites described in Objective 2. At each location, the final number of transects utilized will be determined during the refinement of the MAMP during PED. The final number of transects at each location will be determined based on the size of the feature and the type of habitat being restored, with consideration given to the number of transects required to capture natural variability within the reference sites for each habitat type. For cost-estimating purposes, we estimated that Chino Creek and Mill Creek would require five transects, while features in the SARM upstream and downstream focal areas would require ten transects. Sampling will occur during spring months, at the peak of growing season, and will consist of permanent field monitoring plots along one or more transects either perpendicular to the stream centerline or parallel to the floodplain slope and hydraulic gradient. Plots will be located randomly within each focal area, and the distance between plots and along transects will be dependent on the conditions and variability in the focal area. Monitoring will measure percent cover of native and non-native plant species, structural diversity, and percent cover over water. Photograph stations are also important for documenting vegetation conditions. All plots and photograph stations will be documented via Global Positioning System (GPS) coordinates to reoccupy in each year of sampling.

General observations, such as fitness and health of plantings, native plant species recruitment, plant composition and structure, and signs of drought stress would be noted during the surveys.

Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified.

Analysis of hyperspectral imagery mapping from OCWD would be performed during 2 of 5 monitoring years. This analysis would ensure comprehensive assessment of non-native cover in the project area and identify problem areas that may require adaptive management.

Cowbird Monitoring: Cowbirds would be monitored and counted annually for five years as part of the cowbird trapping effort. Cowbird numbers would be recorded based on the number of cowbirds trapped at each trapping location. In addition, data would be collected on the number of

non-target species trapped, and their location. Parasitism of vireo nests by cowbirds would also be monitored at baseline and at Year 1, Year 3, and Year 5, during the nesting season. Regular monitoring across the focal areas would help identify which locations would most benefit from adaptive management of cowbird trapping.

2.3.4 Use of Monitoring Results and Analysis

Results of the monitoring will be assessed in comparison to project objectives and decision-making triggers to evaluate whether the project is functioning as planned and whether adaptive management actions are needed to achieve project objectives. The results of the monitoring will be provided to the AMT who will evaluate and compare data to project objectives and decision making triggers.

The AMT will use the monitoring results to assess habitat responses to management, evaluate overall project performance, and make recommendations for adaptive management actions as appropriate. If monitoring results, as compared to desired outcomes and decision making triggers, show that project objectives are not being met, the AMT will evaluate causes of failure and recommend implementation of adaptive management actions, as identified in Section 6.2, to remedy the underlying problems.

As data is gathered through monitoring, more information will also be available to address uncertainties and fill information gaps. Uncertainties such as effective operational regimes, restoration design needs, benefits generated by restored features, and accuracy of hydrologic and sediment modeling can be evaluated to inform adaptive management actions and future restoration needs.

3.0 PROJECT ADAPTIVE MANAGEMENT PLANNING

The MAMP outlines how the results of the project-specific monitoring program would be used to adaptively manage the project, including specification of conditions that will define project success. The MAMP reflects a level of detail consistent with the feasibility study phase. The primary intent was to develop monitoring and adaptive management actions appropriate to assess and achieve the project's restoration goals and objectives. The specified management actions, as well as expected timelines for achieving successful establishment and self-sustaining maturity of restored habitat features, were used to develop an estimation of the adaptive management program costs and duration for the project.

The following section outlines restoration actions that will be undertaken to achieve the project objectives and lists sources of uncertainty that may impact the need for adaptive management actions. Subsequent sections describe assessment of monitoring results, data management, and decision-making on the implementation of adaptive management.

The level of detail in this plan is based on currently available data and information developed during plan formulation as part of the feasibility study. Uncertainties may remain concerning the exact project features, monitoring elements, and adaptive management opportunities. Components of the MAMP, including costs, were similarly estimated using currently available information. Uncertainties will be addressed in the PED phase, and the MAMP may be amended to incorporated additional detail as part of the design phase.

3.1 Management and Restoration Actions

The PDT performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objectives. Many alternatives were considered, evaluated, and screened in producing a final array of alternatives. The Corps subsequently identified a NER Plan.

The Recommended Plan, is referred to as Plan 9 or Alternative 3, also known as the Proposed Action Alternative. The Recommended Plan is described in detail in Section 7.0 of the Integrated Feasibility Report (IFR). The restoration actions have been divided into four focal areas, as described below. See Figure 1-3 of the IFR.

1- **Santa Ana River Upstream** focal area includes the existing channel of the Santa Ana River from the Hamner Avenue crossing. This represents the river reach upstream of Prado Dam where there are no physical barriers to ecological restoration or connectivity of the active river channel and the adjacent floodplain that provides riparian forest and associated habitats that rely on the river and floodplain for their character and ecological functions, primarily because of overbank flows in the floodplain and the river's contribution to the

shallow water table in the alluvial aquifer.

2- **Santa Ana River Downstream** focal area includes the existing channel of the Santa Ana River from the Prado Dam downstream to the upstream limit of the engineered flood control channel of the Santa Ana River near the crossing of Yorba Linda Boulevard. This reach is referred to as Reach 9 of the Santa Ana River Mainstem Project (SARM) which is a component of the SARM project area for flood damage reduction. The focal area includes the mainstem of the Santa Ana River through Reach 9, along with the associated floodplains within the boundaries of the bank stabilization features of SARM.
3- **Chino Creek** focal area was defined based on the restoration opportunities presented by the active channel of Chino Creek, which is perennial due to the upstream flow contributions that include discharge of treated wastewater from active municipal treatment plants. Open areas along Chino Creek provide restoration opportunities for the creek channel and adjacent riparian habitats from Pine Avenue downstream to Euclid Avenue. Restoration in this focal area would provide connectivity to Prado Regional Park and to the downstream reach of Chino Creek that is influenced by operation of Prado Dam.
4- **Mill Creek** focal area extends along the minor valley of the Mill Creek tributary of Prado Basin from an area due west of the OCWD constructed wetlands to Chino Corona Road to the north. While Mill Creek is an ephemeral stream, the focal area provides opportunities for restoration of vegetation for riparian habitats and provides connectivity to the existing habitat in the lower part of the basin south of this focal area.

Table 1. Recommended Plan Features

Measure	Chino Creek Channel Restoration	Native Plantings	Invasive Plant Management	Cowbird Trapping
Description	Construction of a new shallow channel along the west side of Chino Creek; channel would promote riparian habitat growth	Plantings would include seeding, pole stalking, and planting of nursery-grown plants at areas with reduced vegetation cover	Removal of invasive plants and planting and management of native species to promote native vegetation re-establishment	Trapping and implementation of other population control measures to provide control for non-native cowbird species
Implementation Locations	Chino Creek Focal Area	SARM Upstream, Mill Creek Focal Area, Chino Creek Focal Area	All Focal Areas	SARM Upstream, Mill Creek Focal Area, Chino Creek Focal Area

3.2 Sources of Uncertainty

Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any large-scale ecosystem restoration project. Below is a list of uncertainties associated with restoration of the aquatic and riverine habitats included in the project.

- Correct engineering and design to fully address project objectives
- Correct operational regime to fully achieve project objectives
- Ability of CHAP (Combined Habitat Assessment Protocol) method to predict project benefits
- Ability of hydrologic models to predict project impacts/benefits
- Imprecise relationships between management actions and corresponding outcomes
- Future availability of water for restored habitats due to extreme drought or other climate change issues
- Other factors which are not completely within the Corps' or Sponsor's control or ability to predict, such as high flow events that may occur before the restored habitat has fully established, vandalism, fire, or upstream watershed changes that may affect the project area.

4.0 RATIONALE FOR ADAPTIVE MANAGEMENT

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties listed above. Given these uncertainties, adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to desired project outcomes. The adaptive management program for the project will use the results of continued project monitoring to manage restoration actions in order to achieve the previously stated project objectives. Adaptive management establishes the critical feedback of information from project monitoring to inform project management and promote learning through reduced uncertainty.

Implementation of the MAMP will provide flexibility to account for changing environmental conditions and new information and will allow project success to be measured, though it will not alleviate all uncertainty. The MAMP provides a mechanism to evaluate the effectiveness of the restoration measures implemented in this project and to implement adaptive changes, if required, to realize project objectives.

5.0 ASSESSMENT

The assessment phase of the adaptive management framework describes the process by which the results of the monitoring efforts will be compared to the project performance measures, which reflect the objectives of the restoration action.

The results of the monitoring program will be assessed annually through the AMT. Monitoring results will be compared to the desired project outcomes as set forth by the project performance measures. This assessment process will measure the progress of the project in relation to the stated project objectives.

The AMT will compare monitoring results to decision-making triggers to evaluate project effectiveness and consider if adaptive management actions are needed.

The assessments will indicate if the habitat responses to management actions are undesirable (e.g., are moving away from restoration goals) or if the responses have met the success criteria for the project. Assessments will also inform the AMT if other factors are influencing the response that may warrant further research.

5.1 Database Management

Database management is an important component of the monitoring plan and the overall adaptive management program. As part of the AMT, individuals with responsibility for data management activities (data managers) in support of an adaptive management program will be identified from the Corps and OCWD. The data managers should collaborate with the AMT in developing a data management plan to support the adaptive management program. The data management plan should describe how and where data will be archived, data standards, data upload process and format, quality assurance and quality control procedures, metadata standards, and public data release. Storage of all data will be handled by the Corps. Data analysis and reporting will be the responsibility of OCWD, who will provide reports for the AMT to facilitate evaluation of adaptive management needs.

5.2 Documentation and Reporting

The Corps and OCWD will document the monitoring results, assessments, and the results of the AMT deliberations. OCWD will produce annual reports that will measure progress towards meeting project objectives as characterized by the performance measures. Results of assessments will be used to evaluate adaptive management needs and inform decision-making.

6.0 DECISION MAKING

Decisions on the implementation of adaptive management actions are informed by the assessment of monitoring results. The information generated by the monitoring plan will be used by the Corps and OCWD in consultation with the other AMT members to guide decisions on adaptive management actions that may be needed to ensure that the ecosystem restoration project achieves success. Final decisions on implementation of adaptive management actions are made by the Corps.

6.1 Decision Criteria

Decision criteria, also referred to as adaptive management triggers, are used to determine if and when adaptive management opportunities should be implemented. They can be qualitative or quantitative based on the nature of the performance measure and the level of information necessary to make a decision. Desired outcomes can be based on reference sites, predicted values, or comparison to historic conditions. Several decision criteria are identified below, based on the project objectives and performance measures. More specific decision criteria based on hydrology, geomorphology, and vegetation dynamics may be developed during the PED phase of the project.

If assessments show that any of these triggers are met, the Corps would consult with the AMT to discuss which adaptive management action, as described in Section 6.2, is warranted. Investigations may be required to determine the cause of failure in order to inform which of the adaptive management actions identified should be implemented, if needed.

6.1.1 Geomorphic conditions triggers:

Desired Outcomes:

1) Chino Creek should achieve geomorphic and in-channel habitat diversity within 3-years post construction, based on a comparison to the desirable geomorphic conditions identified at the reference site.

   Trigger: Geomorphic and in-channel habitat elements do not achieve diversity within 3 years post-construction, as compared to reference sites. Monitoring results showing trends of channel incision, uniform depth, lack of sinuosity and or lack of riffle-pool-run complexes. Since in-channel habitat is subject to significant variation, specific thresholds for success will be developed in coordination with the AMT during PED, based on actual desirable conditions that exist at the reference site at the time of evaluation.

Desirable geomorphic conditions would be evaluated using reference sites on the Santa Ana River or other sites of similar hydrologic character and gradient to guide quantitative thresholds for channel form and substrates.

Geomorphic conditions may not achieve the target composition due to natural events or design. Flood events may wash gravel and cobble substrates out of the project area.

Adaptive management actions that may be implemented to address problematic conditions and achieve project objectives are outlined in Section 6.2.

6.1.2 Vegetative community, cover, and structure triggers:

Desired Outcomes:

1. Increase percent cover of native riparian and riparian-associated habitat, including but not limited to: riparian woodland, riparian scrub, and transitional riparian habitats.
   Trigger: Within 250 feet of the river channel, 50% cover of native riparian habitats (including herbaceous, shrub and canopy layer) is not achieved (based on locations of restoration of each habitat) within 3 years. 75% cover of native riparian habitat is not achieved (based on locations of restoration of each habitat) within 5 years.
   Trigger: Farther than 250 feet from the river channel, 35% cover of native riparian habitats (including herbaceous, shrub and canopy layer) is not achieved (based on locations of restoration of each habitat) within 3 years. 50% cover of native riparian habitat is not achieved (based on locations of restoration of each habitat) within 5 years.
2. Maintain appropriate structural diversity of native riparian habitats to support survival and reproductive requirements for riparian obligate and other species and to support regional wildlife movement.
   Trigger: Suitable structural diversity is not achieved within 5 years. If canopy cover exceeds 60% and/or shrub cover does not exceed 50%, then adaptive management action may be needed.
   Trigger: Wildlife monitoring shows trends of decreasing use or movement by common native riparian obligate species and/or target or special status species, as compared to previous studies conducted by USGS and existing regional wildlife movement and use patterns.
3. Increase percent native vegetative cover over water to reduce water temperatures to support native fish such as the Santa Ana sucker and Arroyo chub.
   Trigger: Percent cover of riparian vegetation over water along the bank does not achieve 25% within 3 years, 40% within 5 years.
4. Decrease percent cover of non-native invasive vegetative species that out-compete natives.
   Trigger: For Native Planting sites and the riparian area surrounding the Chino Creek channel, non-native percent cover does not remain below 5%. The percent cover of problematic non-native species is intended to be maintained at 0% during the MAMP period through routine maintenance efforts. Problematic non-native species include arundo, castor bean, tamarisk, and perennial pepperweed.
   Trigger: Within the Invasive Plant Management areas, non-native percent cover does not achieve less than 10% after 3 years. Non- native percent cover does not achieve less than 5% after 5 years.

Riparian vegetation may not achieve the target percent cover or structural conditions (needed to support habitat and connectivity) due to improper geomorphic conditions. Such conditions may include excessive distance to groundwater, sedimentation, channel incision, or scour of soils. These conditions may be created naturally, such as during storm events, or may be the consequence of design. Lack of water due to drought may affect the establishment and persistence of vegetation, and subsequently the percent cover. Plantings may fail due to predation or trampling.

Invasive infestation may occur due to upstream inputs of seed/source material. It is expected that invasives will be adequately controlled through O&M procedures. However, if invasive infestation control is found to be ineffective, the Corps may recommend adjustments to invasive control methods utilized under O&M.

Adaptive management actions that may be implemented to address problematic conditions and achieve project objectives are outlined in Section 6.2.

6.1.3 Non-native wildlife species populations triggers:

Desired Outcomes:

2) Reduce brown-headed cowbird population and nest parasitism to support use and occupation of riparian habitats by federally listed vireos and other songbirds. While the adaptive triggers below will be used for the routine management of cowbird trapping, the overall success metric for this measure is to achieve an average nest parasitism rate no greater than 6% across five years.

   Triggers: Cowbird trapping will be adaptively managed based on several factors, including:
   a. Nest parasitism rates of least Bell's vireo
   b. Number of non-target species trapped
   c. Number of cowbirds trapped

If any of the triggers a-c reach unacceptable levels, input from the AMT and best-professional judgment will be utilized to determine if the locations of the traps should be adjusted, with the goal of ensuring that an average nest parasitism rate for least Bell's vireo of 6% is achieved.

6.2 Potential Adaptive Management Measures

The results of monitoring will be used by the AMT to evaluate project status and adaptive management needs. Identified adaptive management actions for this project are described below. Prior to implementing adaptive management measures, the Corps and OCWD shall assess whether supplemental environmental analysis is required.

Performance Measure 1: In-stream hydrologic, geomorphic, and topographic conditions

Adjusting diversion channel in Chino Creek: If geomorphic monitoring triggers are not being met in the Chino Creek focal area, a new diversion channel may need to be cut to remedy channel incision.

Performance Measure 2: Vegetative community, cover, and structure

Irrigation/Supplemental Water: Irrigation and/or supplemental water may be needed if triggers for vegetative cover and/or structure are met. Assessment of monitoring results may show that drought conditions are causing poor establishment, native recruitment, or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and successful restoration of target vegetation communities.

Invasives Control: It is expected that invasives will be adequately controlled through O&M procedures. However, if monitoring results show that triggers for invasives are met, the Corps may recommend adjustments to invasive control methods, level of effort, and/or frequency of treatments under O&M.

Replanting: Replanting may be needed if triggers for vegetative cover and/or structure are met. Monitoring results should be used to assess the underlying cause of inadequate cover, which may require that additional adaptive management actions be implemented to support successful replanting. For instance, monitoring results may show that channel incision has prevented successful establishment of vegetative communities. Adaptive management would include actions to remedy the incision (i.e., re-grading), which would be required for successful replanting.

Plant Protection: Plant protection may be needed if triggers for vegetative cover and/or structure are met. Monitoring results may show that plantings are failing due to predation or trampling from recreational use or homeless encampments. Adaptive management actions would include measures such as plant cages or protective fencing that could be installed to protect plantings.

Fence Repair/Augmentation: Fence repair or augmentation may be needed if triggers for wildlife use and movement are met. Under O&M, the Corps may recommend augmentations to fencing (height, length, or depth) in the Chino Creek focal area, in response to wildlife movement patterns.

Performance Measure 3: Non-native wildlife and non-native aquatic species populations

Cowbird trapping: It is expected that cowbirds will be adequately controlled through O&M procedures. However, if monitoring results show that triggers for invasive wildlife are met, the Corps may recommend adjustments to cowbird control methods, level of effort, and/or trap locations under O&M. The cowbird trapping program will routinely be implemented in an adaptive fashion, adjusting the number and location of cowbird traps based on the numbers of cowbirds trapped, the number of non-target species trapped, and the vireo nest parasitism rates. Given the flexibility and adaptive nature of the cowbird trapping plan, additional cowbird trapping adaptive management is not anticipated to be necessary.

6.3 Conclusion of Monitoring for Project Features

Ecological success of a project feature will be confirmed when desired outcomes have been achieved, as measured by meeting or exceeding the 5-year achievement thresholds identified in the triggers in Section 6.1. Once ecological success has been documented by the District Engineer in consultation with the Federal and State resources agencies, and a determination has been made by the Division Commander that ecological success has been achieved, no further monitoring will be required. Ecological success will be documented through an evaluation of the predicted outcomes as measured against the actual results.

When monitoring has shown that project objectives and success criteria have been met, regular inspection and maintenance by OCWD would occur over the 50-year life of the project.

7.0 COSTS FOR IMPLEMENTATION OF MONITORING AND ADAPTIVE MANAGEMENT PROGRAMS

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data, methods, and comparable projects (Attachment B). The potential adaptive management actions as described in Section 6.2 and potential expected frequency of need were used as a basis for cost estimating. Costs were estimated based on the overall area of monitoring over 4 focal areas. Because uncertainties remain as to detailed designs and adaptive management needs and opportunities, the estimated costs may be refined in PED during the development of the detailed monitoring and adaptive management plans for each project phase/feature. The current total estimate for implementing the monitoring plan is approximately $505,000 for the Recommended Plan.

Attachment A

Monitoring Tasks

Prado Basin Feasibility Study
Monitoring and Adaptive Management Plan
Monitoring Tasks

Objective	Activity	Frequency	Agency	Remarks
1	Improve hydraulic and fluvial geomorphic functions to promote habitat growth and wildlife connectivity to regionally significant core habitats at Prado Basin and associated main watercourses within the proposed project area.			
	Geomorphology monitoring	Annually for 5 years	OCWD	This applies to the Chino Creek channel restoration.
2	Restore riparian and riparian associated habitats suitable to native species within the proposed project area.			
	Reference Site Monitoring	Year 1	OCWD	At each target habitat type
	Quantitative Vegetation Monitoring	Annually for 5 years	OCWD	Within native planting and non-native removal areas
	Imagery Mapping	baseline & year 2 & 5	OCWD	assume use of OCWD imagery
3	Reduce presence and effects of non-native wildlife on habitat suitability and function for native wildlife species.			
	Nest Parasitism Monitoring	Annually	OCWD	

Attachment B

Monitoring & Adaptive Management Cost

Table 1. Monitoring Costs

Monitoring	Tasks	Frequency	Cost Assumptions	Cost
Geomorphology Monitoring	Survey of geomorphic conditions of restored Chino Creek. Stream gradient; channel form, dimensions, and dynamics; substrate composition and distribution.	Baseline & Year 5	Assume a river walk level of effort survey (incorporates transects for channel form, dimensions, vegetation, etc. and data gathering). Assume 2 person team over 2 days. 1 person over 2 weeks for post processing and analysis.	$84,000
Vegetation Monitoring	Habitat Details: Assume monitoring of projec area and 1 reference site, including transects for percent cover of natives, non-natives, structural diversity, canopy cover over water using transect/plot monitoring and data analysis. Assume inventories of general wildlife, and observations of damage to habitat would be recorded. Assume monitoring of all parameters would be done concurrently during each monitoring event.	Baseline + first 5 years	Monitoring: Assume 2 biologists, approximately 10 transects/day. Assume 10 transects each in the SARM Upstream and SARM Downstream focal areas, assume 5 transects each in Chino Creek and Mill Creek focal areas. Assume 3 reference sites, one for each habitat type, with 5 transects each. Total 40 transects - 7 days. Analysis: Assumes 1 biologist over 20 days to analyze transect data and compile tables, short memo report.	$162,000
	Assume use of OCWD imagery	Baseline + two events over first 5 years	Mapping: Assume $20K labor cost per event for processing and some analysis; 3 events.	$60,000
Cowbird Monitoring	Nest Parasitism Monitoring: Assume cowbirds monitored and counted annually through the general wildlife inventories and protocol wildlife surveys (see above). From cowbird trapping implemented through the project, obtain data on the number of cowbirds trapped, other unintended species trapped, and their location would be collected during project implementation. Assume nest parasitism would be monitored annually for vireo and flycatcher during protocol surveys and for other avian species at a lower level of effort with this monitoring measure.	Annually for 5 years	Nest Parasitism Monitoring: Assume 2 biologists over 5 days each in SARM U/S and D/S focal areas and 2 days each in both Chino and Mill Creek focal areas during nesting season.	$84,000
			TOTAL COST	**$390,000**

Table 2. Adaptive Management Costs

Monitoring	Tasks	Frequency	Cost Assumptions	Cost
Adjusting the Chino Creek Diversion Channel	Entails cutting a new diversion channel based on field observations at Chino Creek focal area.	Annually for 5 years	Assume $5,000 per year.	$25,000
Irrigation and Supplemental Water	Assume 10% of planted acres will need supplemental water (approximately 40 acres), spread across five years	Annually for 5 years	Assume water truck is $1500/day; assume 2 acres per day; assume 20 total days	$30,000
Re-Planting or Supplemental Planting	Assume this action will be performed within treatment (planted or non-native removal) areas in all focal areas. Assume that natural recruitment with invasives control will be the primary means of vegetation re-establishment. Assume first year will be under warranty from contractor. Assume that 4 acres may require replanting per year for years 2 and years 3 (8 total acres).	Years 2 & 3	Cost of vegetation estimated at $7500 per planted acre	$60,000
			TOTAL COST	**$115,000**

Attachment C

Adaptive Management Tasks Associated with Alternatives 2 and 4

Alternatives 2 and 4 include a sediment management measure associated with ecosystem restoration. Implementation of this sediment management measure could result in potential impacts to groundwater best managed in an adaptive management framework in coordination with the management of the feature for expected ecological benefits. While not part of the recommended plan, these adaptive groundwater management measures are described here for consistency, as this monitoring would inform the adaptive management of both vegetation for ecosystem restoration purposes, as well as groundwater for mitigation purposes.

Monitoring:

Depth to groundwater would be monitored twice annually (wet season and dry season) using installed piezometers pre-construction to gather baseline information, as well as post construction for five years.

Adaptive Management:

If post-construction depth to groundwater monitoring data indicates a significant increase in depth to groundwater, the following adaptive measures would be implemented.

1. The lower ½ of the transition channel and the upper ¾ of the sediment trap would be adaptively managed for groundwater by installing additional plugs and still basins similar to those planned for the lower portion of the sediment trap and outlet channel. Groundwater monitoring would continue following installation of this feature.
2. If adaptive measure 1 does not result in the restoration of expected depth to groundwater, gravity fed surface or sub-surface irrigation fields will be installed to provide appropriate water for riparian vegetation in areas where groundwater depths remain too deep.