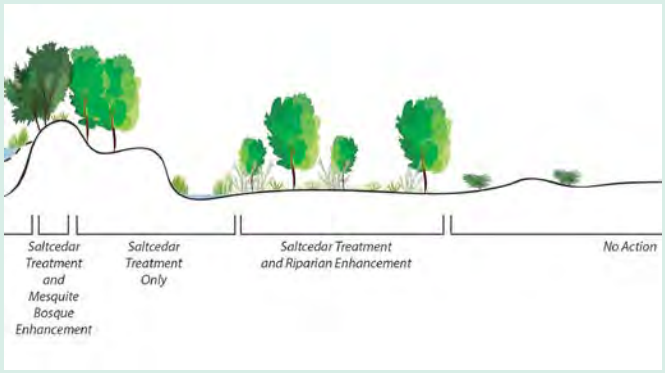
FINAL TECHNICAL REPORT ◦ MAY 2016

El Rio Vegetation Management Plan
Lower Gila River, Maricopa County, AZ
Volume 3: Vegetation Management Units and Implementation Elements



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Cover Graphics:

Upper left: Subset of the vegetation management unit map produced for the planning area (created by Stillwater Sciences).

Top right: View of wolfberry shrubs (*Lycium andersonii*) with bird nest in the El Rio planning reach that is representative of the "Saltcedar Treatment and Mesquite Bosque Enhancement" vegetation management unit proposed by the Plan (photo taken 2/27/2015 by Stillwater Sciences).

Bottom left: Partial illustration of anticipated vegetation conditions after implementation of the El Rio Vegetation Management Plan (created by Stillwater Sciences).

Bottom right: View of Fremont cottonwood (*Populus fremontii*) trees in the El Rio planning reach that are representative of the "Saltcedar Treatment and Riparian Enhancement" vegetation management unit proposed by the Plan (photo taken 6/29/2015 by Stillwater Sciences).

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym or abbreviation	Definition
%	percent
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
APHIS	U.S. Department of Agriculture's Animal and Health Inspection Service
ASLD	Arizona State Land Department
AZ	Arizona
BLM	Bureau of Land Management
District	Flood Control District of Maricopa County
e.g.	"for example"
ESA	Endangered Species Act
et al.	"and others"
etc.	"and other things of the same class"
FEMA	Federal Emergency Management Agency
GIS	geographic information system
i.e.	"that is"
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
No.	number
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
OHWM	ordinary high water mark
pers. comm.	personal communication
Plan	Vegetation Management Plan
RGP	Regional General Permit
spp.	species (plural)
SRP	Salt River Project
SHPO	State Historic Preservation Office
SWPP	Stormwater Pollution Prevention Plan
TAC	Technical Advisory Committee
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service

UNIT CONVERSION FACTORS

Most values presented in this report are reported in the U.S. Customary Unit System. This table presents conversion factors of the commonly used U.S. Customary system units to metric units.

U.S. Customary Units	Conversion	Metric Units
in (inches)	*x* 2.54	cm (centimeters)
	x 25.4	mm (millimeters)
	x 25,400	um (micrometers)
ft (feet)	*x* 0.3048	m (meters)
mi (mile)	*x* 1.609	km (kilometers)
ac (acres)	*x 0.4047*	ha (hectares)

1 INTRODUCTION

1.1 Document Purpose

This technical report has been prepared as the second step to inform and facilitate the development of a science-based Vegetation Management Plan (Plan) for the El Rio reach of the lower Gila River in Maricopa County. This report has been prepared by Stillwater Sciences for the Flood Control District of Maricopa County (District), with input from District staff and a technical advisory committee (TAC). Specific objectives of the Plan, and this technical report in particular, are to:

- Provide a framework for reducing the extent of flooding under the predicted 100-year flow event (*i.e.*, the modeled 100-year floodplain in Figure 1) through saltcedar management, while maintaining and enhancing riparian habitat assets.
- Identify appropriate, ecologically sustainable, and spatially-explicit management actions, such as saltcedar treatment, revegetation with native plant species, or no action, based on biological and hydrological factors, as well as the reasonableness of costs, local community expectations, and other key considerations.
- Develop monitoring methods to evaluate progress toward Plan objectives, to apply adaptive management to enhance the likelihood of achieving those objectives, and increase understanding of flood and ecosystem interactions.
- Prepare for anticipated changes to the system, such as climate change, land-use changes, and colonization by the tamarisk beetle (*Diorhabda elongata* complex).
- Prepare for implementation of rapid, active ecological restoration and other management strategies for threatened, endangered, and other native wildlife species potentially displaced by saltcedar treatment activities, and to enhance pollinator habitat.
- Provide consideration of proper implementation techniques, implementation costs, permitting requirements, short- and long-term maintenance needs, water use/savings, and wildfire control.

The first step in the development of the Plan was to compile and collect baseline ecological and hydrological data for the El Rio reach. This effort is documented in Volume 2: Data Collection and Analysis. Together, the two technical reports compose the Vegetation Management Plan that describes appropriate types of actions and their locations, and considers permitting requirements, mitigation strategies, maintenance needs, monitoring and adaptive management needs, funding opportunities, and implementation costs.

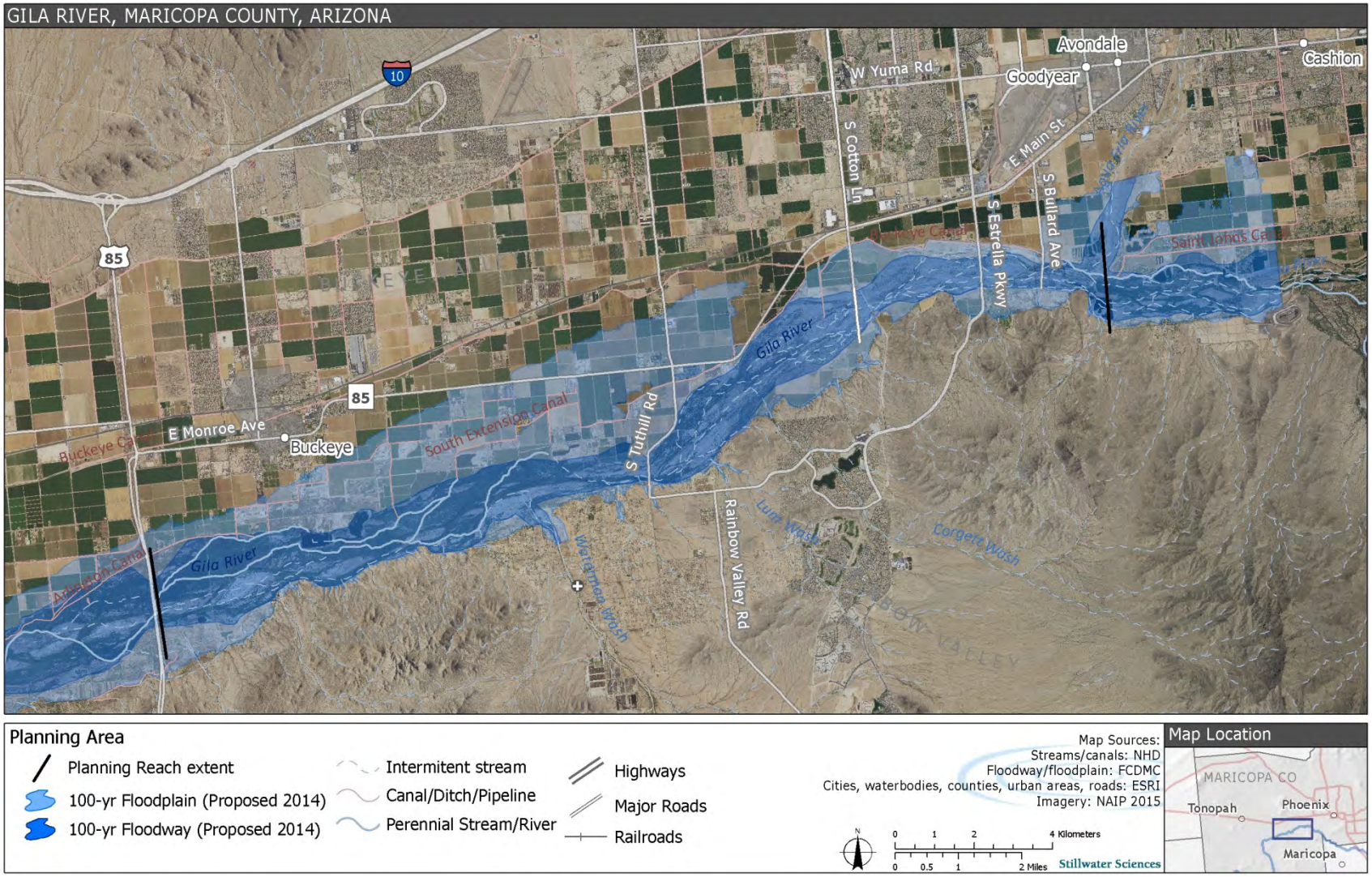


Figure 1. Location map of the planning area (source data from the District).

1.2 Planning Area

The El Rio reach of the lower Gila River, and the area addressed by the Plan, extends from the confluence of the Agua Fria River with the Gila River, downstream to Maricopa County Highway 85 bridge (Figure 1). This reach is approximately 17 miles long and 1 mile wide, and is referred to as the "planning area" throughout the Plan. The width of the planning area is defined by the extent of the 100-year floodway (Figure 1), which currently includes the non-developed corridor of the Gila River. The 100-year floodway typically defines the maximum amount of development encroachment allowed by the Federal Emergency Management Agency (FEMA) into the 100-year floodplain: development can occur within the 100-year floodplain so long as it and any associated mitigation does not result in changes to the floodway. The 100-year floodplain (also shown in Figure 1) is the area predicted to be inundated by a flow event that statistically has a one percent chance of occurring in any given year.

1.3 Overview of Findings and Recommendations from Volume 2

Volume 2 provides an assessment of ecohydrological conditions in the planning area and describes the implications of those conditions that informed the identification of the vegetation management actions and spatial units that are presented in this report. Volume 2 also introduced the planning area, the need for vegetation management, and the goals and objectives of the Plan: information that is not repeated in this report.

The salient findings and recommendations presented in Volume 2 are as follows:

- **Land uses**—Land ownership in the planning area is roughly split evenly between public and private entities (*i.e.*, 47% versus 53%), while many areas just outside the planning area are anticipated to be developed for residential and commercial uses in the future.
    - Most opportunities for Plan implementation will be found on the public-owned lands, of which the District, Bureau of Land Management (BLM), and Arizona Game and Fish Department (AGFD) collectively own about 3,990 acres. Much of the privately-owned land is anticipated to be used for gravel mining in the future. Conversion of portions of the floodway to open water features from gravel mining will potentially reduce flood risk and have implications on the types of vegetation management that are appropriate in and around gravel mining operations. As such, the Plan should incorporate flexibility in any recommended management action on and adjacent to the private lands. Additionally, implementation of the Plan should be done in coordination with planning recreational and scenic attractions for the community and adjacent residential developments.
    - Continue communication and coordination with other entities that have previously conducted vegetation-management-related activities in the planning area to ensure that future vegetation-management activities do not conflict with one another and, ideally, can be conducted in ways that save or share costs and increase mutual benefits.
- **Climate**—Predicted future increases in regional and local air temperatures, and the likely reduction in future water supply, will challenge local riparian habitat. Air temperature and drought tolerances for native plant species must be incorporated into the Plan when specifying appropriate species and locations for revegetation, but such specifications

must incorporate sufficient flexibility to address the implications of hotter and drier conditions in the future.

- **Flood hydrology and geomorphology**—The river corridor naturally experiences a wide variation of flows, punctuated episodically by short-duration but intensive high-flow events capable of dramatically repositioning the dominant channel and scouring large swaths of vegetation. Appropriate strategies for saltcedar treatment and native species revegetation within the flood reset zone (*i.e.*, that portion of the river corridor most frequently scoured during larger flood events) will be developed for the Plan. For example, to reduce the risk of future floods washing away plantings, revegetation within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation, even if it is saltcedar (see Section 3.7 Site Preparation). Similarly, conservation of saltcedar within some portions of the flood reset zone will likely be necessary to reduce the potential for unintended bank instability and geomorphic changes from saltcedar removal. Management actions conducted soon after flood scour (or fires) can take advantage of newly cleared areas where much of the saltcedar biomass has been removed and more cost-effectively treat remaining saltcedar and/or revegetate with native species to promote their establishment prior to re-colonization by saltcedar or other invasive plants.
- **Ecological flows—**Baseflows in the planning reach are supplemented by a number of stormwater, wastewater, and agricultural return-flow canals.
    - The outfalls of several of these water sources support some of the largest and most diverse stands of native riparian vegetation in the planning area. While these inputs could be used to prioritize where saltcedar removal and habitat enhancement occurs, since plantings would have a higher likelihood of being successful, the volume, timing, and constancy of these water sources are highly subject to change in light of land-use changes outside the planning area. As residential development replaces agriculture, agricultural return flows will decrease while stormwater and wastewater discharges, which can be high in salinity, will increase. Vegetation management actions that are potentially dependent on these water supplies will need to evaluate and likely monitor water supply changes in the future.
    - Another potential source of water in the planning area is the Salt River Project (SRP), which regulates upstream water supply. It is recommended that discussions with SRP, as well as Buckeye Water Conservation and Drainage District, take place regarding the possibility of purchasing agricultural water rights when the associated agricultural activity ends, and transferring the water for restoration purposes. Discussions with SRP should also include the potential for storing water in the flood pool behind Roosevelt Dam and then releasing that water at a time that would facilitate natural recruitment of native riparian vegetation.
- **Soils**—Soil texture, salinity, and alkalinity levels in the vast majority of the planning area are within the tolerance ranges of most native woody riparian, desert wash, and upland plant species that would be appropriate for revegetation, and should not preclude the natural recruitment of these species. Given general plant soil requirements and tolerance levels, suitable areas for active restoration of many native riparian trees and shrubs include those with soils having non-saline to very slightly saline conditions, while areas with soils having slightly saline to strongly saline conditions are better suited for desert shrub species. Additional soil sampling may be necessary at sites where there are visual signs of potentially high soil salinity or other unforeseen soil characteristics. Where this

is the case, planting plans will need to incorporate native species with appropriate soil condition tolerances (salinity and other soil condition tolerance levels of native species are provided in Volume 2, Appendix E).

- **Groundwater**—Relative elevation above the low-flow, or baseflow, water surface in the river channel is a useful indicator of revegetation potential as native riparian plant species tend to occur in particular topographic positions relative to the river channel based largely on depth to groundwater and plant ecophysiological requirements and tolerances. Vegetation-transect surveys performed in support of Plan development found that native cottonwood and willow trees are most numerous upon surfaces within 2 to 10 feet above the low-flow channel water surface, and desert shrub vegetation is most numerous at relative elevations ranging from 5 to 18 feet. The location of the vegetation management units described in Chapter 2 were identified in part by these relative elevation/depth to groundwater preferences: areas under 7.5 feet were considered to be suitable for establishing native woody riparian trees, and areas above 7.5 feet were considered to be suitable for native desert shrub.
- **Vegetation—**Numerous considerations should be incorporated into the Plan:
    - Biocontrol of saltcedar by the tamarisk beetle will not be sufficient to reduce flood risk in the planning area within the timeframe desired because saltcedar defoliation and mortality from the beetle will not remove standing saltcedar biomass (*i.e.*, the remaining trunks and branches).
    - While removal of saltcedar will provide multiple benefits to the El Rio reach and surrounding lands, replacement of removed saltcedar with native vegetation will be necessary to mitigate lost habitat structure, reduce resprouting of saltcedar and establishment of secondary weeds, and offset impacts for regulatory compliance.
    - Recruitment potential of native trees, shrubs, and herbs is limited by water availability and high density of saltcedar cover, which together indicate that active planting will be needed to replace saltcedar with native species in most areas and instances.
    - The biophysical conditions (*e.g.*, relative elevations, soils types, and proximity to water supply) under which native plant species have been documented to occur should be used to help select sites for active revegetation, rather than just the current location of natives, which is likely to underestimate the area potentially suitable for revegetation.
    - The most appropriate vegetation types for revegetation in the planning area, based on existing species presence and regional vegetation types, are riparian cottonwood (*Populus fremontii*)/willow (*Salix* spp.), mesquite (*Prosopis* spp.) bosque, and native desert shrub. A mixture of these vegetation types, particularly where a multilayered canopy develops and a wide range of appropriate locally native tree, shrub, and herb species are incorporated, would enhance native vegetation and habitat diversity and quality for wildlife.
    - All existing native trees and shrubs, such as Fremont cottonwood, Goodding's willow, mesquite, palo verde (*Parkinsonia* spp.), creosote (*Larrea tridentata*), *etc.*, should be conserved, whenever feasible, and post-saltcedar-removal plantings should be planned to maximize native seed source and natural recruitment potential.
    - A variety of strategies will need to be developed that specifically optimize native plant revegetation, including: (1) developing a plan for managing standing dying/dead saltcedar following wildfire and tamarisk beetle colonization, (2)

protecting cottonwood and willow plantings from herbivory, (3) protecting remnant native vegetation from wildfires, (4) suppressing aggressive native plants such as arrowweed (*Pluchea sericia*) and seepweed (*Suaeda moquini*), and (5) planting highly competitive species, such as quailbush (*Atriplex lentiformis*), after less competitive desirable species, such as screwbean mesquite, have established.

- Consider creation of a variety of swales and other features that reduce depths to groundwater and increase access to surface water to facilitate expansion and long-term sustainment of diverse open water/marsh and riparian woodland habitats, including: (1) low-flow side channels and side-channel pools that can expand perennial aquatic and riparian habitat, (2) high-flow backwater channels and embayment areas to facilitate development of open water/marsh habitats adjacent to restored riparian woodland, (3) high-flow ephemeral channels, or inundation channels, to support upper terrace mesquite woodlands, and (4) channel-side benches or terraces to increase inundation of cottonwood/willow plantings.
- Flood-risk mitigation actives undertaken to improve the FEMA Community Rating System should be coordinated with riparian vegetation restoration plans to maximize their mutual benefits.

- **Wildlife**—Southwestern willow flycatcher (*Empidonax traillii extimus*), western yellow-billed cuckoo (*Coccyzus americanus*), and Yuma clapper rail (*Rallus longirostris yumanensis)*[1] are listed as threatened or endangered under the federal Endangered Species Act (ESA) and have been documented to occur or have potential to occur in the planning area. In addition, other migratory birds and native wildlife occur in the planning area.
  - The arrival of tamarisk beetle is anticipated to dramatically reduce the dense saltcedar cover that these birds and other wildlife species may currently use in the planning area. As such, it is necessary to quickly establish beetle-resilient native habitat for these species to use.
  - Saltcedar removal for vegetation management will similarly reduce the habitat available to these species. Therefore, replanting saltcedar-treatment areas with native vegetation types will be necessary to mitigate for the impacts of vegetation management.
  - To minimize the impacts of vegetation management, saltcedar removal and subsequent native revegetation should be conducted in phases, so that the amount of habitat removed is relatively small in any given year and there is time for native habitat to grow to sufficient height, complexity, and density to suitable provide habitat before additional saltcedar is removed.
  - Microscale (*i.e.*, approximately 3-foot resolution) habitat suitability models in the El Rio reach for southwestern willow flycatcher and western yellow-billed cuckoo can be used to specify the amount and location of suitable habitat that should be avoided be avoided during vegetation management or, if avoidance is not feasible, may be affected by vegetation management. The model parameters

[1] Recent taxonomic studies have led to the Yuma clapper rail being reclassified as Yuma Ridgway's rail (*R. obsoletus yumanensis*) (http://blog.aba.org/2014/07/2014-aou-check-list-supplement-is-out.html). However, in this report we retain use of the older name for consistency with prior studies and usage by regulatory agencies.

can also be used to define the structure that created habitat should be designed to achieve, and specify the amount and location of revegetation that may be necessary to mitigate for habitat loss, as well as help prioritize areas where habitat enhancement should be most beneficial to these species and facilitate regulatory compliance.

- Surveys for the listed bird species in the planning area (as well as other wildlife) can be used to: calibrate habitat suitability models; determine where suitable habitat occurs at vegetation management sites; identify measures that will be necessary to protect these species during vegetation management activities in suitable habitat area, such as pre-treatment surveys and avoiding certain work activities during the breeding season from early-May to late-September; and, if the surveys are repeated, document wildlife response to vegetation management and habitat enhancement.

2 VEGETATION MANAGEMENT UNITS AND ACTIONS

Vegetation management units are specific locations within the planning area where particular vegetation management actions, or combinations of actions, should be appropriate and sustainable, given the biophysical and land-use conditions in and around the planning area, and will promote the goals of the Plan—the removal of saltcedar, revegetation with appropriate locally native riparian and upland plant species, and, ultimately, flood-risk reduction throughout the El Rio reach. This chapter summarizes the methods used to identify the vegetation management units, presents the vegetation management unit maps, and describes generally the actions that would occur in different unit types.

2.1 Methods

The vegetation management units were identified in a geographic information system (GIS) based on data that were collected and described in Volume 2, and then reviewed and revised as needed based on interpretation of remote-sensing products and other knowledge of local conditions. In particular, the following GIS products were critical to the development of the vegetation management units:

- **Delineation of the flood reset zone** (Section 2.5.2 of Volume 2)—defined the portion of the Gila River floodway that is most likely to experience notable scour and deposition under future high flow events. This area should provide one of the most reliable sources of water for native riparian vegetation, since it is in close proximity to the river channel, but also presents greater risk of losing planted vegetation during a subsequent high flow event.
- **Soil salinity and texture** (Section 2.6 and Appendix B of Volume 2)—determined which species are likely to be appropriate to plant in particular areas (*e.g.*, those that can tolerate the soil salinity and texture conditions) and indicated where revegetation is likely to be more or less sustainable.
- **Relative elevation above the low-flow river channel** (Section 2.7 and Appendix C of Volume 2)—served as a proxy for groundwater depth and indicated general water supply availability. This information helped determine which species were likely to be appropriate to plant in particular areas (*e.g.*, those native species that have sufficient root growth rates and rooting depths to reach deeper groundwater levels during the driest part of the growing season).
- **Vegetation type** (Section 2.8 and Appendix D of Volume 2)—identified which areas should have sufficient existing native cover to facilitate natural recruitment, and which vegetation type is likely to be most appropriate to plant in any particular area.
- **Vegetation canopy height** (Section 2.8 and Appendix D of Volume 2)—provided an indication of areas that are currently productive (*i.e.*, are capable of supporting taller native woody species) and where native revegetation is likely to be more successful and sustainable. Vegetation canopy height also serves as an indicator of wildlife habitat availability. (Vegetation canopy height was derived and/or averaged across relatively broad areas and is not an indication of individual tree height.)

- **Habitat suitability of southwestern willow flycatcher and western yellow-billed cuckoo** (Sections 2.9.1 and 2.9.2, and Figures 13 and 14 in Volume 2)—indicated where existing biophysical conditions most likely provide suitable breeding habitat and, by extrapolation, where active revegetation with appropriate native species is most likely to create suitable habitat, and may be required as a part of regulatory compliance.

Table 1 summarizes how these GIS-based products were used to identify vegetation management unit types. The unit types are described in Section 2.2 below.

The map resulting from the GIS effort was reviewed to evaluate landscape position (*e.g.*, proximity to adjacent land uses and unit types, location on terraces, proximity to tributary washes, position relative to flood bottlenecks) and other conditions potentially influencing unit type suitability, such as natural recruitment potential, and revised accordingly. Many, but not all, of the individual vegetation management units have been reviewed in the field. They have also been incorporated into a hydraulic model (at the locations specified in Appendix A and the acres, heights, and densities indicated in Table 2) and determined to reduce (although not eliminate) flood risk to adjacent lands. It is important to note that land ownership or parcel boundaries were not used during the selection of vegetation management unit types or locations and, as such, units on private property in particular will be subject to change based on future uses of those lands. Section 2.2.9 describes some of the changes that may be appropriate given future land use conditions on private property.

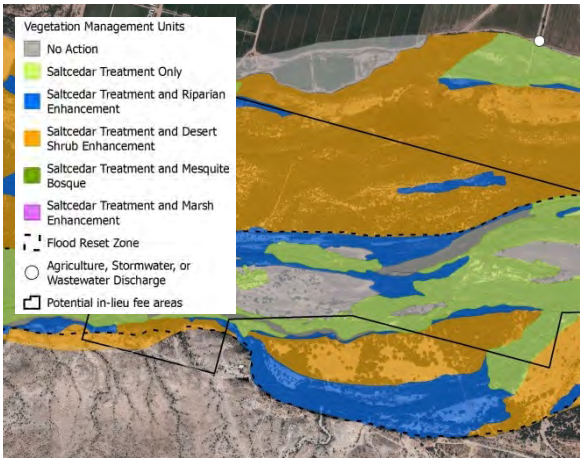
Table 1. GIS information used to identify vegetation management unit types.

Unit Type No.	Unit Type Name	Summary Description	Primary Existing Vegetation Types	GIS Assessment Criteria
1	No Action	• No saltcedar removal, habitat enhancement, or any other activity for flood-risk reduction • Monitored to determine if/when saltcedar removal may become necessary	• Cobble/gravel/sand • Saltcedar (low-density) • Agriculture • Canal/ditch • Developed • Water • Planted (mesquite) • Desert shrub • Mesquite	None
2	Saltcedar Treatment Only	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Native species expected to recruit and expand naturally; no planting or seeding	• Desert shrub • Marsh • Saltcedar/Mesquite • Saltcedar/Arrowweed • Saltcedar/Cottonwood • Saltcedar/Cottonwood/Willow • Saltcedar/Willow	• Canopy height used as an indication of unit productivity and potential for sustainable enhancement • Southwestern willow flycatcher habitat modeling used as an indication of where active planting may be required to enhance habitat and mitigate for impacts • Potential for natural recruitment assessed, using the following criteria: o Within 50 feet of water o Under 7.5 feet relative elevation o Canopy height above 15 feet o Non-saline soils
3	Saltcedar Treatment and Riparian Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Planting of native cottonwood, willow, and associated riparian species	• Saltcedar (medium- and high-density) • Disturbed • Marsh • Desert shrub	• Under 7.5 feet relative elevation • Canopy height used as an indication of vegetation productivity (whether native or not) in each unit and potential for sustainable native enhancement • Flood Reset Zone used to distinguish level of risk to enhancement investment • For areas outside Flood Reset Zone, influence from agricultural return flow used to identify appropriate locations

Unit Type No.	Unit Type Name	Summary Description	Primary Existing Vegetation Types	GIS Assessment Criteria
4	Saltcedar Treatment and Desert Shrub Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Planting of native desert shrub and associated upland species	• Saltcedar (medium- and high-density) • Disturbed • Desert shrub • Mesquite	• Primarily above 7.5 feet relative elevation • Flood Reset Zone used to distinguish level of risk to enhancement investment • Landscape position used to decide between this type and Unit Type 5, with flood-prone areas assigned as this type
5	Saltcedar Treatment and Mesquite Bosque Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Planting of native mesquite, palo verde, and associated mesquite bosque species	• Saltcedar (medium- and high-density) • Disturbed • Desert shrub • Mesquite	• Primarily outside Flood Reset Zone • Above 7.5 feet relative elevation • Landscape position used to decide between this type and Unit Type 4, with tributary terraces and non-flood-prone areas assigned as this type • Canopy height used as an indication of vegetation productivity (whether native or not) in each unit and potential for sustainable native enhancement
6	Saltcedar Treatment and Marsh Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Surface grading to create appropriate gradients and inundation depths • Planting of native cattails, tules, and associated marsh species	• Saltcedar (medium- and high-density) • Disturbed • Water	• Outside Flood Reset Zone • Within 50 feet of water's edge (includes water vegetation types, and upland vegetation types)
7	Bridge Clearance	• Vegetation clearing within 200 feet of the Highway 85 bridge, as required by Arizona Department of Transportation (ADOT)	• All except Water	• Within 200 feet of the Highway 85 bridge (clearance around other bridges in the planning area is not required)
8	Planned/ Completed Restoration	• Locations of previously implemented restoration projects and restoration projects planned for the foreseeable future from the project proponents	• Not applicable	• Not applicable

2.2 Vegetation Management Units

The vegetation management units for the 8,787-acre planning area are depicted in Appendix A and summarized in Table 2 (see map excerpt at right). Although the unit maps in Appendix A and the acres in Table 2 appear very precise, it is important to note that the level of specificity in unit boundaries is a reflection of the underlying GIS data. Unit boundaries should, in fact, be thought of as approximations and the extent and boundaries of activities actually undertaken as a part of the Plan will need to be determined based on site-specific field evaluations.



Excerpt of vegetation management unit maps (see Appendix A for complete map tiles)

Table 2. Vegetation management unit types recommended for the planning area.

Unit Type No.	Unit Type Name	Area Inside Flood Reset Zone (acres)	Area Outside Flood Reset Zone (acres)	Total Area (acres)	Percent of Planning Area	Anticipated Vegetation Height at Maturity (feet)	Anticipated Woody Plant Density at Maturity [A]
1	No Action [B]	1,924	1,119	3,043	35%	0–10	None–Moderate
2	Saltcedar Treatment Only [B]	395	214	609	7%	0–90	Sparse–Dense
3	Saltcedar Treatment and Riparian Enhancement	586	163	749	9%	40–90	Dense
4	Saltcedar Treatment and Desert Shrub Enhancement	1,470	2,163	3,633	41%	2–8	Sparse–Moderate
5	Saltcedar Treatment and Mesquite Bosque Enhancement	4	566	570	6%	20–40	Moderate–Dense
6	Saltcedar Treatment and Marsh Enhancement	14	63	77	1%	5–10	Sparse [C]
7	Bridge Clearance	4	20	24	<1%	0	None
8	Planned/ Completed Restoration [D]	6	76	82	1%	6–90	Sparse–Dense

Table footnotes:

[A] Sparse = >6 feet of space between woody plant canopies; Moderate = 0–6 feet of space between woody plant canopies; Dense = overlapping woody plant canopies (*i.e.*, woody plants present in overstory and understory).

[B] As described in more detail below, this unit type encompasses a variety of underlying vegetation conditions and, as a result, there is a greater range of potential vegetation heights and densities following vegetation management.
[C] This unit type would be enhanced primarily with herbaceous, rather than woody, plant species.
[D] As described in more detail below, this unit type could result in variable vegetation conditions depending upon the project goals and methods.

The activities that are anticipated to be appropriate for these units, and that form the basis for the unit type numbers and names, are summarized in the sections below. In total, the vegetation management units entail approximately 5,000 acres of saltcedar removal in the planning area, which would be implemented in numerous phases and individual projects. Most removed saltcedar would be replaced with native riparian, mesquite, desert shrub, or marsh vegetation communities. Figure 2 illustrates current vegetation conditions across a typical cross section in the planning area, and Figure 3 illustrates how those conditions are anticipated to change with implementation of the vegetation management units and maturity of native vegetation.

Additional implementation considerations, details, and recommendations are provided in Chapter 3. These activities and details, like the unit extents and boundaries, will need to be evaluated and revised as necessary based on site-specific field evaluations of physical and biological conditions, land use, and other factors. Similarly, while vegetation management unit types and locations have been selected with consideration for future climate, water supply, tamarisk beetle, and land-use conditions in mind, there are bound to be changes within and near the planning area over the next several decades that will necessitate revisions to the vegetation management units. It is important to note that most of the privately owned property in the planning area is anticipated to be used for gravel mining, the demand for which will increase as the lands outside of the planning area are developed. In areas where gravel mining occurs and open-water features are created, vegetation management will be determined primarily by the mining operation's reclamation plan. Section 2.2.9 describes how vegetation management units may need to be changed given potential future gravel mining on private property.

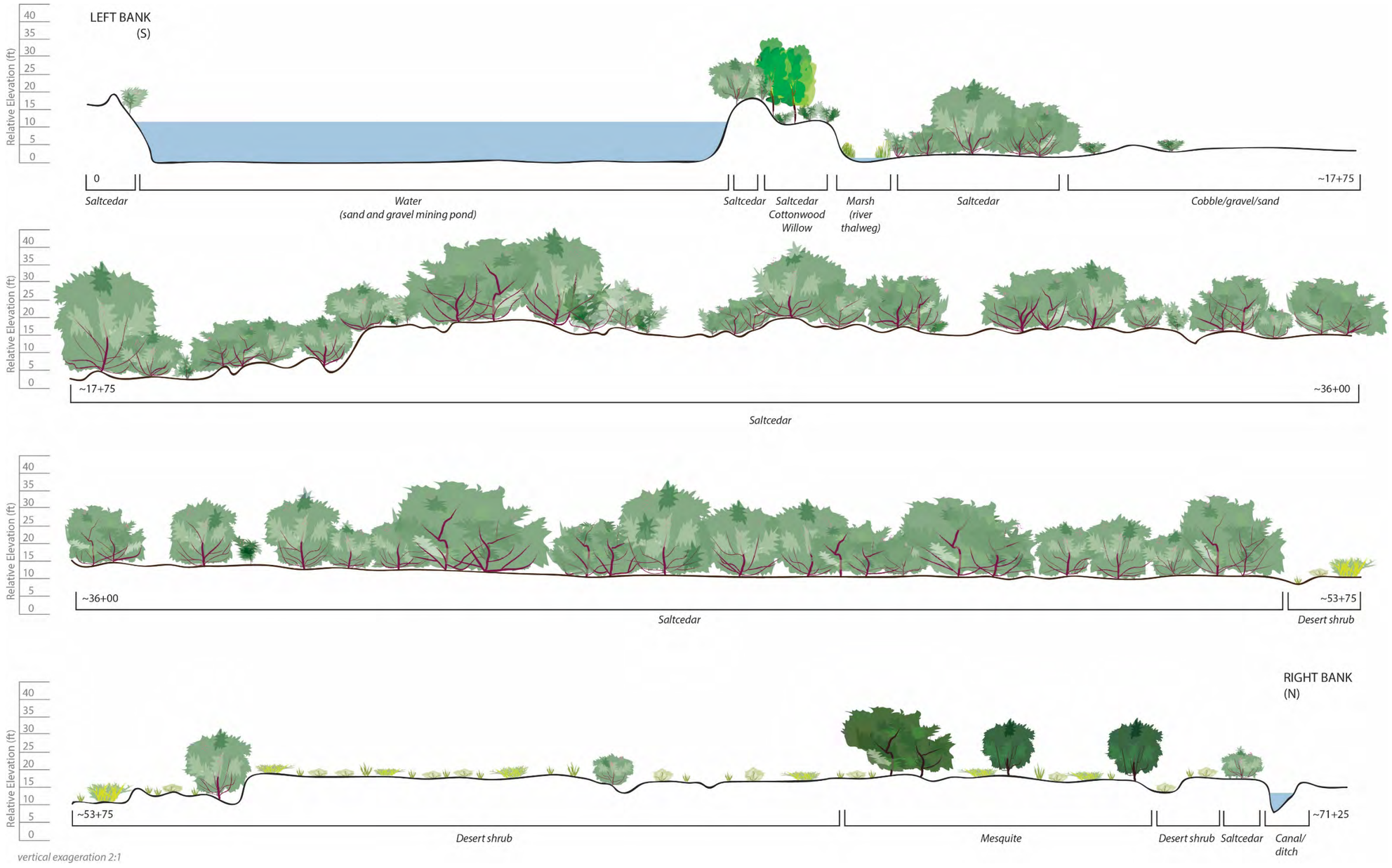


Figure 2. Illustration of current vegetation conditions across a typical cross section in the planning area.

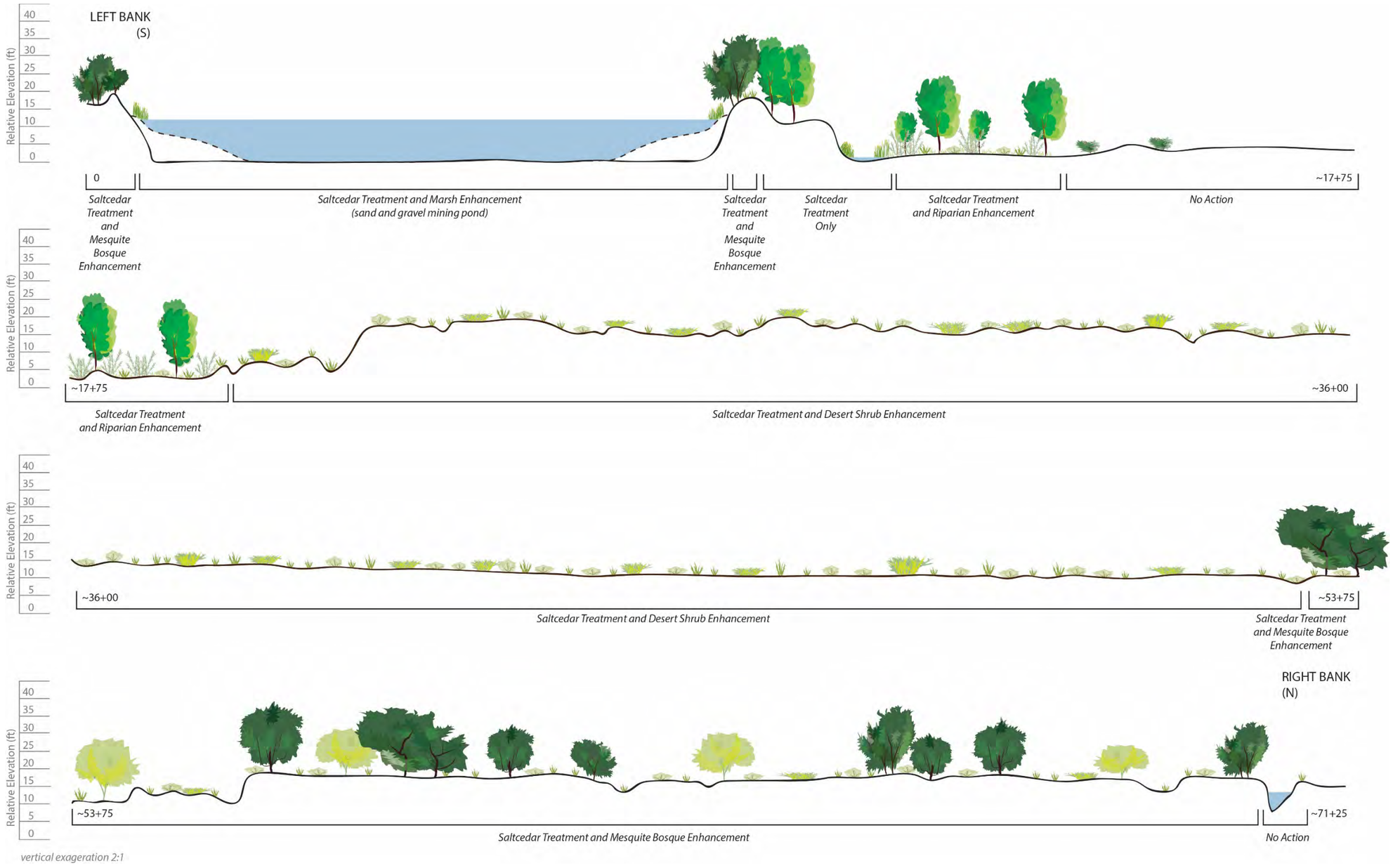


Figure 3. Illustration of anticipated vegetation conditions across the Figure 2 cross section with implementation of the Plan.

2.2.1 No Action

The "No Action" vegetation management (Type 1) units are those areas with little to no saltcedar present (see photos below). These units include several different mapped vegetation types, but primarily consist of areas that were mapped as cobble/gravel/sand, low density saltcedar, agriculture, water, canal/ditch, or developed in the 2015 vegetation map of the planning area (see Section 2.8 in Volume 2 for descriptions of vegetation map types). In some of these units, there is no saltcedar to remove. Where saltcedar is present, it occurs at sufficiently low density that removal would likely have little to no influence on flood-risk reduction. It is in such units—No Action units with low density saltcedar—that saltcedar treatment is anticipated to be efficiently accomplished by the tamarisk beetle once it colonizes the area. There are 3,042 acres of No Action units, which account for 35% of the planning area (see Table 2 and Appendix A), with the greatest concentration occurring in the upstream portion of the planning area, where there is relatively little vegetative cover due to lack of surface water and greater depths to groundwater. Figure 3 and the photos below illustrate anticipated typical conditions in No Action units following vegetation management.

Example views of No Action units in the planning area (Photos by Stillwater Sciences)

Although there is currently little to no saltcedar in most No Action units and, as a result, saltcedar removal to reduce flood-risk is not warranted, these areas need to be monitored to identify whether saltcedar is increasing in these units to such an extent that active removal becomes warranted. During development of the 2015 vegetation map of the planning area, parts previously mapped as cobble strand (the equivalent of cobble/gravel/sand) were found to be the primary locations of recent saltcedar recruitment. As such, and in light of the fact that tamarisk beetle may not colonize the planning area until 2018/2019, periodic monitoring of No Action units should be conducted to determine whether saltcedar treatment becomes needed in these units to reduce flood risk, and whether any active enhancement of native vegetation may be warranted (*i.e.,* if no native vegetation is naturally recruiting or if secondary weeds become problematic). If saltcedar treatment does become warranted in the future, the methods described above in Section 2.1 should be used to identify an appropriate alternative vegetation management unit type for the area.

In addition to the No Action units that have been identified based on lack of saltcedar cover, there are likely to be other areas where "no action" is determined to be appropriate and desirable based on site-specific conditions and individual project goals. In particular, No Action will be necessary for areas that are occupied by protected species (as determined by site surveys) or to provide sufficient buffers around occupied habitat to avoid affecting the species (necessary buffer sizes

vary by species and would likely need to be determined in coordination with USFWS). No Action units of conserved saltcedar may also be necessary to maintain the stability of the river bank at project locations, and reduce the potential for unintended geomorphic change (*e.g.*, Graf 1981). Conserved saltcedar can also provide a "hydraulic shield" from high flow events for downstream revegetation areas (see Section 3.7 for additional details). These same areas can also act as a buffer around native vegetation to maintain microclimate conditions during nearby saltcedar removal activities. There may also be areas where native vegetation is of sufficient density that no action is determined to be appropriate, but such areas will be few and small in the planning area (see Section 2.2.2 below).

2.2.2 Saltcedar Treatment Only

"Saltcedar Treatment Only" vegetation management (Type 2) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk (see Section 3.8 for a more detailed discussion of saltcedar removal methods), and there should be sufficient native vegetation and appropriate biophysical conditions for native species to naturally ("passively") recolonize the area once saltcedar is removed. This unit type offers one of the most efficient and sustainable opportunities to reduce flood risk, since saltcedar would be removed from the floodway, while simultaneously enhancing native habitats without the effort and expense of active seeding and planting. These units primarily include areas mapped as desert shrub, marsh, mesquite, saltcedar/arrowweed, saltcedar/cottonwood, saltcedar/cottonwood/willow, or saltcedar/willow in the 2015 vegetation map of the planning area and, as such, should have at least 10–30% cover of native species (see photo below), and were further screened to include only those areas thought to have good potential for natural recruitment of native species. Criteria indicating good natural recruitment potential included 10–30% cover of native species, close proximity to water, low relative elevation, non-saline soil, and high canopy height (see Table 1; Nissen *et al.* 2009, Sher *et al.* 2010). There are 609 acres of Saltcedar Treatment Only units accounting for 7% of the planning area (see Table 2 and Appendix A), with most occurring within the flood reset zone and in the downstream half of the planning area, where there is the greatest extent of native vegetation. Figure 3 and the photo below illustrate anticipated typical conditions in most Saltcedar Treatment Only units following vegetation management.

Example view of Saltcedar Treatment Only units in the planning area (Photo by Stillwater Sciences)

Despite the GIS screening conducted to identify Saltcedar Treatment Only units, there is still uncertainty over whether or not the amount of native cover in these units will be sufficient for native species to recruit and establish naturally after saltcedar is removed, particularly in light of the modified duration, extent, and magnitude of water availability in the planning area. As such, these units will need to be further evaluated for natural recruitment potential in the field. If a saltcedar removal only unit is found to have low or no natural recruitment potential, then it should be changed to one of the active enhancement unit types described below using the methods described in Section 2.1 and site-specific field evaluation. In addition, this evaluation should also include the potential for saltcedar removal to undermine river bank stability (see Section 3.3 for additional discussion).

Monitoring and maintenance of all saltcedar removal areas (regardless of vegetation management unit type) will be necessary to ensure long-term success and will likely be required for a minimum of five years following removal. Monitoring of all saltcedar removal areas should, at a minimum, evaluate the need for treatment of saltcedar resprouts or other problematic secondary weeds (*e.g.*, kochia [*Bassia scoparia*]) and how developing vegetation conditions may influence or conflict with flood risk reduction objectives. In Saltcedar Treatment Only units in particular, monitoring will also need to evaluate whether natural recruitment will be sufficient to replace removed saltcedar or whether active planting may be warranted. Monitoring and maintenance activities are described in more detail in Sections 3.11 and 3.12.

2.2.3 Saltcedar Treatment and Riparian Enhancement

"Saltcedar Treatment and Riparian Enhancement" vegetation management (Type 3) units are those areas where saltcedar should be removed and treated with herbicide, and then planted with appropriate native cottonwood, willow, and other associated riparian plants (Table 3). These units primarily include areas mapped as saltcedar or disturbed that are less than 7.5 feet in relative elevation from the low-flow river channel, or areas mapped as saltcedar/cottonwood, saltcedar/cottonwood/willow, or saltcedar/willow that have low potential for natural recruitment. The 7.5 feet relative elevation threshold for riparian plantings comes from the ecohydrological fieldwork and assessment conducted for the Plan (see Volume 2). This work determined that relative elevation above the low-flow water surface in the river channel is an appropriate proxy for depth to groundwater[2], which is more challenging to measure, and documented that native riparian trees are most numerous within 2 to 10 feet above the low-flow channel water surface. The use of the 7.5 feet relative-elevation threshold results in most of the Riparian Enhancement units being located within the flood reset zone. Outside of the river's flood reset zone, proximity to other water sources, such as agricultural return flows, was also used to identify units. As such, they include areas that are in need of habitat enhancement, unlikely to support natural/passive recruitment of native species (since there are little to no native species present in the unit to provide a seed source), and likely have the physical conditions necessary to support planted riparian vegetation with minimal levels of maintenance.

Example views of Saltcedar Treatment and Riparian Enhancement unit before management (top, from the planning area) and hypothetically after (bottom, from the San Pedro River) (Photos by Stillwater Sciences)

[2] The relationship between relative elevation and depth to groundwater, however, apparently shifts in the upper half of the El Rio reach between approximately the crossings of the Tuthill Rd and Bullard Ave. bridges, where the depth to groundwater is seemingly greater based on a general lack of vegetation. For this reason, riparian enhancement units were not identified in this portion of the planning area, as there is insufficient water supply to sustain the tree and shrub species included in riparian enhancement vegetation.

Table 3. Riparian Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments [B]
Trees			
Fremont cottonwood	*Populus fremontii*	Pole cutting	Foundation species
Goodding's willow	*Salix gooddingii*	Pole cutting	Foundation species; attracts pollinators
Shrubs			
Seep willow	*Baccharis salicifolia*	Pole cutting	High salinity tolerance; attracts pollinators
Emory baccharis	*Baccharis emoryi*	Nursery container or seed	Attracts pollinators
Spiny hackberry	*Celtis ehrenbergiana*	Nursery container/seed	Attracts pollinators
Burrobush	*Hymenoclea monogyra*	Nursery container/seed	
Coyote willow	*Salix exigua*	Pole cutting	Under-represented in the planning area; attracts pollinators
Herbs/Forbs/Vines			
Missouri gourd	*Cucurbita foetidissima*	Nursery container/ plug or seed	Attracts pollinators
Sacred thorn-apple	*Datura wrightii*	Nursery container/ plug or seed	Attracts pollinators
Desert saltgrass	*Distichlis spicata*	Nursery container/plug	High salinity tolerance
Fringed twinevine	*Funastrum cynanchoides*	Nursery container/plug	Monarch butterfly host plant
Alkali muhly	*Muhlenbergia asperfolia*	Nursery container/plug	High salinity tolerance
Alkali sacaton	*Sporobolus airoides*	Nursery container/ plug or seed	High salinity tolerance

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.
[B] Pollinator and monarch butterfly host plants are based on NAPPC and Pollinator Partnership (no date) and The Xeres Society and NRCS (2012). Salinity tolerances are based on NRCS (2002).

There are 749 acres of Riparian Enhancement units, which account for 7% of the planning area (see Table 2 and Appendix A). Characteristic native plant species that may be appropriate for planting at Riparian Enhancement units, depending on site-specific conditions and project goals, are listed in Table 3 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos above illustrate anticipated typical conditions in Riparian Enhancement units following vegetation management.

Riparian habitat in the planning area could support southwestern willow flycatcher and is identified as critical habitat for western yellow-billed cuckoo – protection for both of these species is provided under the ESA. These birds, as well as other migratory birds (which are protected under the federal Migratory Bird Treaty Act), now use saltcedar for nesting in the absence of native trees and shrubs. As such, saltcedar that is removed in areas that could provide habitat for these birds will need to be replaced with equivalently tall and dense native vegetation

to mitigate for any habitat loss. As a result, and because both southwestern willow flycatcher and western yellow-billed cuckoo require tall, complex, and dense riparian vegetation that is close to water, Riparian Enhancement units will not contribute to the flood risk reduction objectives of the Plan. Due to their close proximity to water, however, they are the most appropriate locations to efficiently and effectively contribute to the Plan's habitat mitigation and enhancement objectives. While there will be some temporal loss of habitat between saltcedar removal and the establishment of sufficiently tall and dense native vegetation, the incremental, phased implementation of the Plan through multiple smaller project is anticipated to minimize this loss.

Given the importance of Riparian Enhancement units in mitigating habitat loss from saltcedar removal and enhancing habitat for southwestern willow flycatcher and western yellow-billed cuckoo, it may be desirable to increase the extent of the planning area outside of the flood reset zone that can sustain the associated cottonwood/willow vegetation. This could be done by excavating swales and channel features that increase the extent and frequency of flood inundation and/or decrease the depth to groundwater, thereby increasing the water supply for Riparian Enhancement plantings, as well as potential marsh vegetation. Such features include: (1) low-flow side channels and side-channel pools; (2) high-flow backwater channels and embayment areas; (3) high flow ephemeral channels; and (4) channel-side benches or terraces. These features have not been incorporated into the vegetation management units, as it will require additional site-specific assessment (see Section 3.3) to determine where such excavation would be feasible and appropriate. The location of such features could be further informed by flycatcher and cuckoo microscale habitat suitability models to identify where such features would be optimally located for those species.

The native riparian plants that provide nesting habitat for these bird species and additional wildlife require nearly constant access to water and are precluded from much of the planning area as a result of reduced water availability. As a result, much of the planning area that is likely to be suitable for Riparian Enhancement is within close proximity to the low-flow river channel and within the flood reset zone. To reduce the risk of future floods washing away plantings, Riparian Enhancement units within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation, even if it is saltcedar (see Section 3.7). This hydraulic shield may also preserve microclimate conditions in surrounding areas and benefit young native recruits (*e.g.*, by functioning as a "nurse tree"), and maintain river bank stability. In addition, Riparian Enhancement plantings within the flood reset zone should consist primarily of pole cuttings, which are less expensive than container plantings, to minimize loss of investment. It is anticipated that revegetation in Riparian Enhancement units will require three to five years to become sufficiently established to withstand typical high flow events.

Outside of the flood reset zone, native riparian vegetation occurs almost exclusively along or at the downstream end of agricultural return flow and stormwater canals, where there is sufficient water availability. These features were used, in part, to identify Riparian Enhancement units, but are also subject to change as land use around the planning area changes. Therefore, the long-term reliability of agricultural return flow frequency, duration, and magnitude should be evaluated for Riparian Enhancement units outside of the flood reset zone. Without such flows, these units, as well as some of those within the flood reset zone, would require one to three years of irrigation for planting roots to reach groundwater (see Section 3.7).

2.2.4 Saltcedar Treatment and Desert Shrub Enhancement

Example views of Saltcedar Treatment and Desert Shrub Enhancement unit before management (top) and hypothetically after (bottom) (both photos from the planning area) (Photos by Stillwater Sciences)

"Saltcedar Treatment and Desert Shrub Enhancement" vegetation management (Type 4) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with appropriate native desert shrub and associated upland species (Table 4). These units primarily include areas mapped as disturbed and saltcedar that are above 7.5 feet in relative elevation from the low-flow river channel (as such, these areas are farther from groundwater and more geomorphically stable than Riparian Enhancement units), or areas mapped as desert shrub that have low potential for natural recruitment. Replacement of saltcedar with native desert shrubs will reduce flood risk, since desert shrubs do not impede high flows to the extent that saltcedar does, and discourage the establishment of secondary weeds if they are planted densely enough. In light of these benefits and the limited water availability in the planning area (which will likely be exacerbated in the future), replacement of removed saltcedar with native desert shrub vegetation is anticipated to be the most appropriate and sustainable enhancement habitat type for much of the planning area.

There are 3,634 acres of Desert Shrub Enhancement units, which account for 41% of the planning area (see Table 2). Native species that may be appropriate for planting at Desert Shrub Enhancement units, depending on site-specific conditions and project goals, are listed in Table 4 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos above illustrate anticipated typical conditions in Desert Shrub Enhancement units following vegetation management.

Desert shrub vegetation in the planning area is very sparse, with open area surrounding nearly every shrub. Mimicking this low density in Desert Shrub Enhancement units would maximize the flood-risk reduction benefits of this unit type, but sparse plantings, particularly after saltcedar removal may have disturbed the ground surface, may facilitate the establishment of problematic secondary weeds. When seeded very densely, native shrubs can be effective at reducing saltcedar resprouting and preventing the establishing of secondary weeds, as demonstrated by the District's Buck Fire restoration area within the planning area. Initial plantings at high densities and allowing densities to reach a natural equilibrium may be one approach to balancing these trade-offs. The trade-offs between low- and high-density planting of native shrubs and occasional trees should be evaluated on a site-by-site basis to develop an appropriate balance between flood-risk reduction, secondary weed establishment, and habitat mitigation.

As with riparian plantings, Desert Shrub Enhancement that is conducted within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation (see Section 3.7)

to reduce the risk of future floods washing away the plantings. Fortunately, planting of some desert shrub species, and *Atriplex* species in particular, can be efficiently conducted by seeding, which can reduce the costs associated with Desert Shrub Enhancement units.

Table 4. Desert Shrub Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments
Shrubs			
Fourwing saltbush	*Atriplex canescens*	Seed	High salinity tolerance
Quailbush	*Atriplex lentiformis*	Seed	High salinity tolerance
Spiny hackberry	*Celtis ehrenbergiana*	Nursery container or seed	Attracts pollinators
Sweetbush	*Bebbia juncea*	Nursery container or seed	Attracts pollinators
Brittlebush	*Encelia farinosa*	Nursery container or seed	Attracts pollinators
Rabbitbrush	*Ericameria nauseosa*	Nursery container or seed	Attracts pollinators
Burrobush	*Hymenoclea monogyra*	Nursery container or seed	
Creosote bush	*Larrea tridentata*	Nursery container or seed	Attracts pollinators
Sandpaper plant	*Petalonyx thurberi*	Nursery container or seed	
Wirelettuce	*Stephanomeria pauciflora*	Nursery container or seed	
Herbs/Forbs/Vines			
Desert sand verbena	*Abronia villosa*	Seed	Attracts pollinators
Needlegrass	*Achnatherum* spp.	Seed	
Mojave milkweed	*Asclepias nyctaginfolia*	Seed	Monarch butterfly host plant
Grama grass	*Bouteloua* spp.	Seed	
East Mojave buckwheat	*Eriogonum fasciculatum*	Seed	Attracts pollinators
Salt heliotrope	*Heliotropium curassavicum*	Seed	Attracts pollinators
Mojave lupine	*Lupinus sparsiflorus*	Seed	Attracts pollinators
Adonis blazingstar	*Mentzelia multiflora*	Seed	Attracts pollinators
Parry's beardtongue	*Penstemon parryi*	Seed	Attracts pollinators
Desert senna	*Senna covesii*	Seed	Attracts pollinators
Globemallow	*Sphaeralcea ambigua*	Seed	Attracts pollinators
Trees (very sparse; only a minor component of this unit)			
Desert willow	*Chilopsis linearis*	Nursery container	Plant only a very few plants per acre; attracts pollinators
Mexican paloverde	*Parkinsonia aculeata*	Nursery container	Plant only a very few plants per acre; attracts pollinators
Blue paloverde	*Parkinsonia florida*	Nursery container	Plant only a very few plants per acre; attracts pollinators

Table footnotes:

[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.

Although replacement of saltcedar with desert shrub vegetation will result in a notable change in vegetation and associated habitat structure (in many areas, Desert Shrub Enhancement units will be much more sparsely planted and with shorter plants than the saltcedar that is there now; see Figures 2 and 3) across much of the planning area, it is important to note that very few of the Desert Shrub Enhancement units currently provide suitable habitat for the three listed bird species with potential to occur in the planning area. (Microscale habitat suitability models for southwestern willow flycatcher and western yellow-billed cuckoo could be used to refine some of the Desert Shrub Enhancement units to further exclude potential habitat for these species.) As a result, loss of nesting habitat for migratory birds is expected to be the primary impact associated with conversion of saltcedar with desert shrubs. Desert Shrub Enhancement units present a trade-off between flood-risk reduction and loss of habitat structure, but the intent of replacing saltcedar with these shrubs (*in lieu* of leaving bare ground or only seeding of grasses and herbs) is to help mitigate for some of that habitat loss (particularly if trees are incorporated at low density in some areas), improve habitat for native pollinators, and improve foraging habitat for birds and other native wildlife, as well as prevent establishment of secondary weeds, and increase the extent of a native vegetation type that will be sustainable in the planning area as temperatures increase and water supply decreases.

2.2.5 Saltcedar Treatment and Mesquite Bosque Enhancement

"Saltcedar Treatment and Mesquite Bosque Enhancement" vegetation management (Type 5) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with appropriate native mesquite bosque species (Table 5). These units include areas currently mapped as desert shrub, disturbed, mesquite, and saltcedar that are primarily outside the flood reset zone, and above 7.5 feet in relative elevation above the low-flow river channel (as such, these areas are farther from groundwater and more geomorphically stable than Riparian Enhancement units).

Example views of Saltcedar Treatment and Mesquite Bosque Enhancement unit before management (top, from the planning area) and hypothetically after (bottom, from the San Pedro River) (Photos by Stillwater Sciences)

Mesquite bosque is a characteristic vegetation type of Sonoran Desert washes and rivers that tolerates more xeric conditions than cottonwood and willows, but it has been declining throughout southern Arizona, including almost all of the Gila and Salt rivers (Foldi 2014). The size and structure of mesquite trees (*Prosopis* spp.) is similar enough to that of saltcedar that this unit type will not contribute to the flood-risk reduction goal of the Plan, unless planted mesquite trees are spaced sufficiently apart. However, mesquite provides habitat for many native wildlife species, including cavity-nesting avian species and arboreal reptile species (Rice et al. 1984), so this enhancement type would help mitigate habitat loss from saltcedar removal for some species (although not necessarily for southwestern willow

flycatcher or Yuma clapper rail). Additionally, Mesquite Bosque Enhancement may improve native plant and wildlife diversity in the planning area.

Table 5. Mesquite Bosque Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments/Notes
Trees			
Western honey mesquite	*Prosopis glandulosa*	Nursery container or seed	Attracts pollinators
Screwbean mesquite	*Prosopis pubescens*	Nursery container or seed	Fairly tolerant of saline soils; low presence in planning area
Velvet mesquite	*Prosopis velutina*	Nursery container or seed	Attracts pollinators
Spiny hackberry	*Celtis ehrenbergiana*	Nursery container or seed	Attracts pollinators
Desert willow	*Chilopsis linearis*	Nursery container or seed	Plant only very few plants per acre
Mexican paloverde	*Parkinsonia aculeata*	Nursery container or seed	Plant only very few plants per acre; attracts pollinators
Blue paloverde	*Parkinsonia florida*	Nursery container or seed	Plant only very few plants per acre; attracts pollinators
Yellow paloverde	*Parkinsonia microphylla*	Nursery container or seed	Plant only very few plants per acre; attracts pollinators
Shrubs			
Catclaw acacia	*Acacia greggii*	Nursery container or seed	Attracts pollinators
Fourwing saltbush	*Atriplex canescens*	Seed	High salinity tolerance
Quailbush	*Atriplex lentiformis*	Seed	High salinity tolerance
Brittlebush	*Encelia farinosa*	Nursery container or seed	Attracts pollinators
Creosote bush	*Larrea tridentata*	Nursery container or seed	Attracts pollinators
Wolfberry	*Lycium* spp.	Nursery container or seed	Attracts pollinators
Herbs/Forbs/Vines			
Desert saltgrass	*Distichlis spicata*	Nursery container/plug	High salinity tolerance
Basin wildrye	*Leymus cinereus*	Nursery container/ plug or seed	
Vine mesquite	*Panicum obtusum*	Nursery container/ plug or seed	
Big galleta	*Pleuraphis rigida*	Nursery container/ plug or seed	
Desert senna	*Senna covesii*	Seed	Attracts pollinators
Alkali sacaton	*Sporobolus airoides*	Nursery container/ plug or seed	High salinity tolerance
Tobosa grass	*Hilaria mutica*	Nursery container/ plug or seed	

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.

There are 571 acres of Mesquite Bosque Enhancement units, which account for 6% of the planning area (see Table 2 and Appendix A). These are distributed throughout the planning area, and are generally outside of the flood reset zone and on terrace surfaces at the confluence of tributary washes, where they are anticipated to have less influence on flood conveyance. Native species that may be appropriate for planting at Mesquite Bosque Enhancement units, depending on site-specific conditions and project goals, are listed in Table 5 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos above illustrate anticipated typical conditions in Mesquite Bosque Enhancement units following vegetation management.

As with desert shrubs, mesquite vegetation in the planning area is generally sparse, with open area surrounding most trees and shrubs. Mimicking this low density in Mesquite Bosque Enhancement units would not achieve the density and cover of most of the saltcedar that it replaces, but appears to be a naturally sustainable density for the planning area. Sparse plantings, particularly after saltcedar removal may have disturbed the ground surface, may facilitate the establishment of problematic secondary weeds. To reduce this potential, Mesquite Bosque Enhancement units should include denser seeding or planting of understory shrub and herbaceous plants, which do not impede high flows to the extent that saltcedar or native trees do. Patches of densely planted mesquite trees within these units could also be used to balance flood risks with secondary weed risks and would also improve habitat patchiness/diversity. The trade-offs between low- and high-density planting of mesquite bosque vegetation should be evaluated on a site-by-site basis to develop an appropriate balance between flood-risk reduction, suppression of secondary weed establishment, habitat mitigation, and native plant and wildlife diversity. In addition, in light of the extensive woodland habitat requirements of the western yellow-billed cuckoo, mitigation for saltcedar loss should be planned in consideration of the slow growth of mesquite trees and the density of restored mesquite bosque suitable for foraging preferred by the cuckoo.

2.2.6 Saltcedar Treatment and Marsh Enhancement

"Saltcedar Treatment and Marsh Enhancement" vegetation management (Type 6) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with native cattails, tules, and associated marsh species (Table 6). These units primarily include areas mapped as saltcedar, disturbed, and non-Gila River channel water that are outside the flood reset zone but within 50 feet of water. As such, these units are exclusively located along the shores of inundated gravel mining pits and will require shoreline grading and/or fill along the margins of the ponds to achieve suitable water supply and inundation conditions for marsh plants. Although the greatest extent of existing marsh vegetation occurs within the low-flow river channel, these areas were considered to be inappropriate for active enhancement, since they are highly likely to be scoured and altered under high flow events. Rather, these areas are primarily categorized as Saltcedar Treatment Only units.

There are 77 acres of Marsh Enhancement units, which account for 1% of the planning area (see Table 2 and Appendix A). Native species that may be appropriate for planting at Marsh Enhancement units, depending on site-specific conditions and project goals, are listed in Table 6 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos below illustrate anticipated typical conditions in Marsh Enhancement units following vegetation management.

Although they will require relatively expensive earthwork, Marsh Enhancement units have the potential to provide multiple benefits. All of the sand and gravel mining-pit ponds in the planning area are within the 100-year floodplain, and the shorelines of mining-pit ponds in the planning area are primarily vegetated with saltcedar. As such, saltcedar removal in these units should contribute to flood-risk reduction, and native marsh plants that would replace the saltcedar do not impede flood flows to the degree that saltcedar does. The flood-risk reduction benefits of Marsh Enhancement are limited primarily by the small extent of these units. The potential for Marsh Enhancement may increase in extent; however, as a result of future gravel mining and associated creation of open water features on private property in the planning area (see Section 2.2.9).

Example views of a Saltcedar Treatment and Marsh Enhancement unit before management (top) and hypothetically after (bottom) (both, from the planning area) (Photos by Stillwater Sciences)

Enhanced marsh vegetation may also help improve water quality, by sequestering some pollutants that would otherwise reach the water table or river, particularly if a diverse assemblage of vegetation is used (Weller et al. 2015). The habitat that is created at Marsh Enhancement units—shallowly inundated shorelines with dense cover of cattails and tules—is likely to directly benefit Yuma clapper rail, which has been observed in the planning area (Wilcox and Wade 2014) and uses marsh habitat. If dense shrub vegetation is included in Marsh Enhancement units then they could also directly benefit southwestern willow flycatcher (if present) due to the proximity to water. Lastly, marsh habitat enhancement at the mining pits near Buckeye would contribute to public recreational and educational uses that are being planned in that area.

To maximize these benefits, and minimize potential conflicts between wildlife habitat and human uses, several design considerations should be included for Marsh Enhancement units. Where feasible, the creation of marsh "islands" within the mining-pit ponds should be constructed to protect created marsh habitat from human disturbance, and the wildlife that uses the habitat from predators. Relatively shallow areas within the mining-pit ponds should be used to limit the amount of fill and costs needed to create islands, but such areas would need to be an adequate distance from the shore to limit predator access to the island. Any constructed island, as well as shoreline grading or fill placement along the shore should be carefully designed to ensure appropriate inundation depths and duration to support native marsh species. To further enhance the created marsh habitat, low density plantings of riparian trees and shrubs should be planted along the upland boundary of the marsh, where/if there are relatively short distances to groundwater to support such species. Native trees and shrubs would also enhance the public access experience, and should be planned and planted accordingly (*i.e.,* with the knowledge that the shade provided by trees and tall shrubs is likely to attract more concentrated use). Most marsh species should be initially planted from container stock/plugs, but relatively low planting densities may be appropriate since these species should spread rapidly under appropriate inundation conditions.

Table 6. Marsh Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments/Notes
Herbs/Forbs/Vines			
Cosmopolitan bulrush	*Bolboschoenus* (formerly *Scirpus*) *maritimus*	Nursery container/plug	
Common spikerush	*Eleocharis palustris*	Nursery container/plug	
Rushes	*Juncus* species	Nursery container/plug	
Hardstem bulrush	*Schoenoplectus* (formerly *Scirpus*) *acutus*	Nursery container/plug	High salinity tolerance
Chairmaker's bulrush	*Schoenoplectus americanus*	Nursery container/plug	High salinity tolerance
California bulrush	*Schoenoplectus californicus*	Nursery container/plug	High salinity tolerance
Southern cattail	*Typha domingensis*	Seed	
Broadleaf cattail	*Typha latifolia*	Seed	
Shrubs			
Seep willow	*Baccharis salicifolia*	Pole cutting	High salinity tolerance; attracts pollinators
Coyote willow	*Salix exigua*	Pole cutting	Under-represented in the planning area; attracts pollinators
Trees			
Fremont cottonwood	*Populus fremontii*	Pole cutting	Plant only very few plants per acre
Goodding willow	*Salix gooddingii*	Pole cutting	Plant only very few plants per acre; attracts pollinators

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.

Given the benefits of Marsh Enhancement for Yuma clapper rail and, potentially, southwestern willow flycatcher, it may be desirable to increase the extent of the planning area that can sustain marsh vegetation. As with Riparian Enhancement units, this could be done by excavating swales that support open water, the location of which could be informed by habitat suitability modeling. Given the potential for additional sand and gravel mining in the planning area, and resulting open water features, however, it will likely be more cost efficient for Marsh Enhancement to be incorporated into future gravel mining reclamation plans (see City of Buckeye 2015), since the open water features created by mining can sustain marsh vegetation and are at low risk of being scoured by flood flows. See Section 2.2.9 for additional discussion of potential conditions under altered land use conditions on private property in the planning area.

2.2.7 Bridge Clearance

The "Bridge Clearance" vegetation management (Type 7) unit represents the required vegetation clearing within 200 feet of the Highway 85 bridge that has been routinely conducted by ADOT (most recently in late 2015; see photo at right). This management action applies to all vegetation types, except water. No other bridges in the planning area appear to warrant vegetation clearing. There are 24 acres of the Bridge Clearance unit, which account for less than 1% of the planning area (see Table 2 and Appendix A).

View of the Bridge Clearance unit near the Highway 85 bridge in the planning area (Photo by Stillwater Sciences)

2.2.8 Planned/Completed Restoration

"Planned/Completed Restoration" vegetation management (Type 8) units are completed or planned restoration projects. The locations of three project sites are shown as "Restoration Unit" areas on map tiles 1 and 6 presented in Appendix A. In total, there are 83 acres of Planned/Completed Restoration units, which account for 1% of the planning area (see Table 2 and Appendix A).

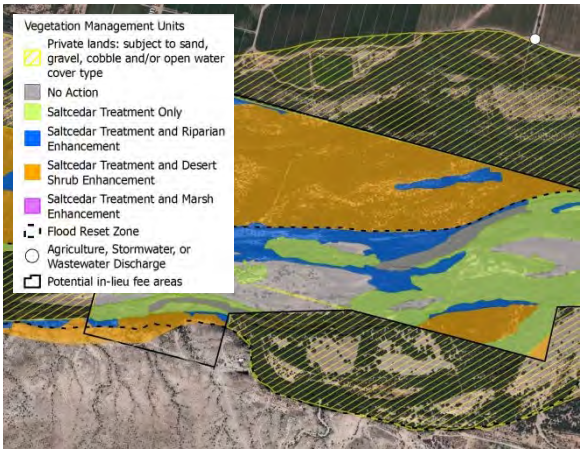
The three Planned/Completed Restoration unit sites include the District's completed 7-acre El Rio Educational Research and Development Project site located along the south side of the river on West Vineyard Avenue near the Bullard Avenue bridge (see top photo at right), the District's completed Buck Fire Revegetation Project located along the northside of the river near the end of Miller Road (see bottom photo at right), and the City of Buckeye's proposed 40-acre vegetation restoration and public access improvement project located adjacent to the Buck Fire project site. The District's El Rio Educational Research and Development Project entailed removal of saltcedar and strategic plantings of native, mixed-density plots, consisting primarily of velvet mesquite, to determine how many plants are necessary to suppress regrowth of saltcedar. The District's 35-acre Buck Fire Revegetation Project entailed replacement of burned saltcedar with native desert shrub vegetation, consisting primarily of saltbush varieties (*Atriplex* spp.). The City of

View of the El Rio Educational Research and Development Project site (top) and the District's Buck Fire Revegetation Project (bottom) in the planning area (Photos by Stillwater Sciences)

Buckeye's restoration plan for their 40-acre parcel has proposed implementation in 2016 to entail removal of the dense saltcedar stands followed by planting of native vegetation appropriate for that higher floodplain surface (City of Buckeye, pers. comm., 2015).

2.2.9 Vegetation management units under altered land use conditions

As mentioned previously, the vegetation management units described above were based on biophysical suitability and developed without consideration for property boundaries and ownership type. While an area is biophysically suitable for a particular vegetation management unit type regardless of ownership, that may change if the property owner alters the land use of the area. Approximately half of the planning area is privately owned and anticipated to be used for sand and gravel mining. Due to the anticipated development surrounding the planning area, it is expected that much, if not all, of this land will be mined in the future. Following mining, the vegetation management units described above, depicted in Appendix A, and summarized in Table 2, are unlikely to be appropriate for the resulting biophysical conditions. While post-mining conditions may result in additional sand, gravel, cobble, and/or open water features, where No Action, Saltcedar Treatment Only, and Marsh Enhancement units may be most appropriate, they are otherwise very uncertain. Given this uncertainty, an alternative view of the vegetation management units is summarized in Table 7 and depicted in maps presented in Appendix B, with privately owned parcels removed from vegetation management consideration (see map excerpt above).



Excerpt of vegetation management units under altered land use conditions maps (see Appendix B for complete map tiles)

The total areas of each of the vegetation management units presented above in Table 2 are reduced when excluding the privately owned parcels in the planning area (see Table 7). The greatest differences would occur with the No Action and Desert Shrub Enhancement units, with a reduction of approximately 1,439 and 1,768 acres, respectively. Though, both of these units would still account for the greatest proportion of the planning area. The Saltcedar Treatment Only and other "enhancement" units would be proportionally less reduced.

It does remain possible that areas eventually mined will be reclaimed according to their reclamation plan, which could very well include actions similar to those described for the Desert Shrub, Mesquite Bosque, and Marsh enhancement units (see City of Buckeye 2015).

Table 7. Vegetation management unit types under altered land use conditions.

Unit Type No.	Unit Type Name	Area Inside Flood Reset Zone (acres)	Area Outside Flood Reset Zone (acres)	Total Area (acres)	Percent of Entire Planning Area	Total Area Percent of Planning Area not Including Private Lands
1	No Action	1,311	293	1,604	18%	34%
2	Saltcedar Treatment Only	272	22	294	3%	6%
3	Saltcedar Treatment and Riparian Enhancement	439	57	496	6%	11%
4	Saltcedar Treatment and Desert Shrub Enhancement	691	1,174	1,865	21%	40%
5	Saltcedar Treatment and Mesquite Bosque Enhancement	3	282	285	3%	6%
6	Saltcedar Treatment and Marsh Enhancement	14	4	18	<1%	<1%
7	Bridge Clearance	3	18	21	<1%	<1%
8	Planned/ Completed Restoration	6	76	82	1%	2%
9	Private Lands (subject to sand, gravel, cobble and/or open water cover types) [A]	1,666	2,457	4,123	47%	--

Table footnotes:
[A] Parcel information provided by the District. The quantities provided here and the parcel boundaries depicted in the maps presented in Appendix B should be considered approximate.

3 VEGETATION MANAGEMENT ACTION IMPLEMENTATION ELEMENTS

3.1 Implementation Phasing

The Vegetation Management Plan will ultimately be implemented as a series of projects by a variety of project proponents, and result in a mosaic of implemented units. Concerted effort by the District and its partners to implement the Plan will occur over decades, and is primarily dependent on acquiring landowner permission (see Section 3.2), funding (see Section 3.5), and permits (see Section 3.6). Very generally, implementation of the Plan is anticipated to occur over a series of phases, as illustrated in Figure 4, some of which may co-occur and will be repeated as landowner permission and funding are secured for more and more units.

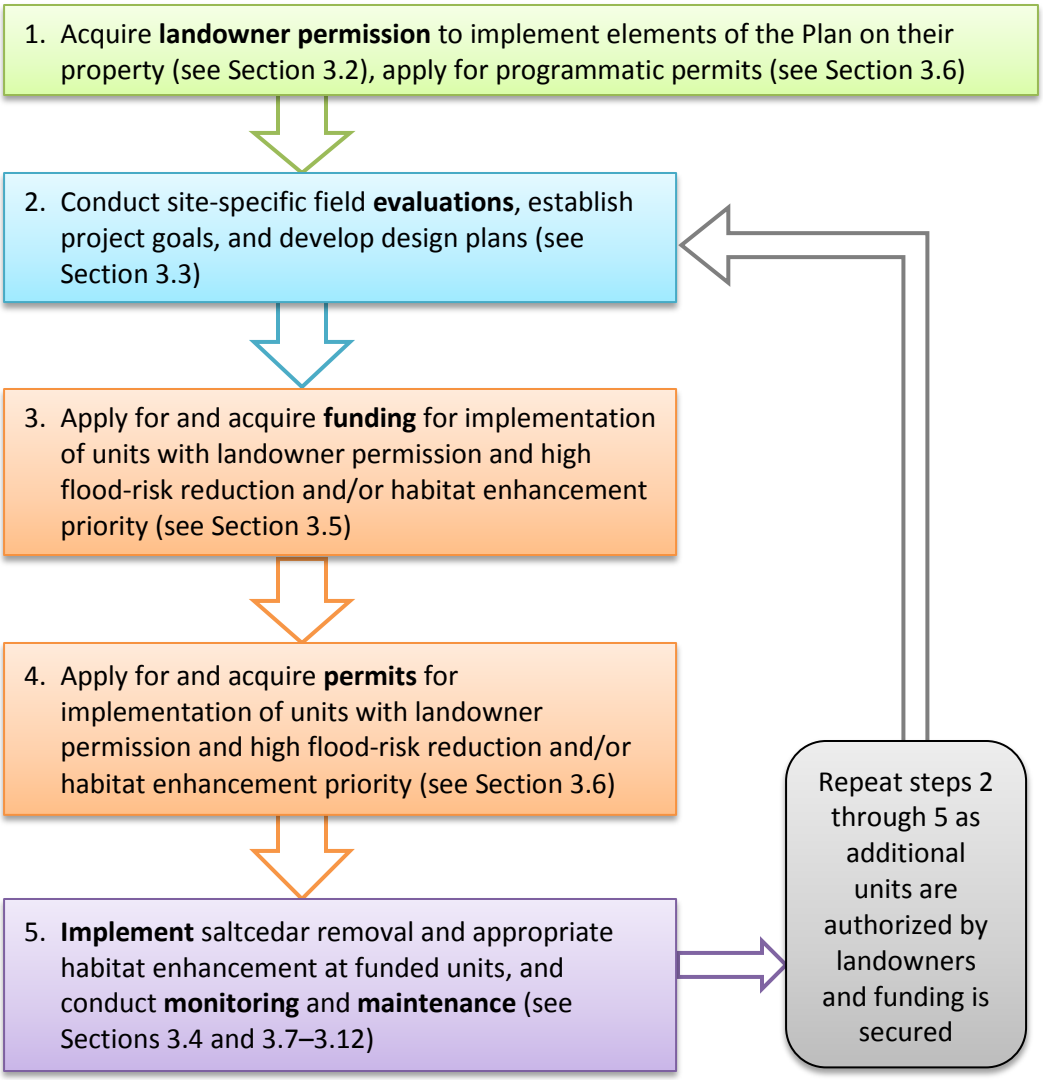


Figure 4. Conceptual phases of Plan implementation.

3.2 Landowner Permission

The District, many private landowners, BLM (whose lands in the planning area are controlled by the U.S, Fish and Wildlife Service's [USFWS] Division of Realty), Arizona State Land Department (ASLD), AGFD, and Maricopa County Parks and Recreation Department all own and manage land in the planning area (see Figure 3 and Appendix A in Volume 2). Vegetation management actions will only occur where landowner permission has been granted. Outside of the District's owned, leased, or easement areas, the District will conduct landowner outreach efforts to identify willing landowners. Landowners are anticipated to provide critical input to the design and implementation of Plan actions, based on a combination of what is agreeable to the landowner, will not conflict with landowner objectives or uses of the land, and will be feasible and appropriate given landowner knowledge of the area.

District and other publically owned lands present priorities for Plan implementation. Plan implementation is consistent with the objectives of many of these lands, such as off-setting impacts to endangered species, and habitat enhancement would be protected from long-term land use change. This would meet the requirements of some funding sources and/or permits that lands where saltcedar removal and/or habitat enhancement occur be placed under conservation easement or otherwise protected. Acquiring permission from federal and state landowners may trigger the need for additional permits, such as a Special Use Permit, and approvals.

Most of the privately owned property in the planning area is anticipated to be used for gravel mining, where long-term vegetation management will be determined primarily by the mining operation's reclamation plan. Such reclamation plans offer opportunities to incorporate the habitat enhancement prescribed in the Plan as well as enhance recreational and scenic attractions for future adjacent communities. For example, the City of Buckeye has developed draft reclamation guidelines for sand and gravel mining operations in the vicinity of the city to promote the environmental, recreational and economic assets of the Gila River for the City, and balance sand and gravel mining, developments, the environmental, and resident quality of life (City of Buckeye 2015).

3.3 Site Assessment and Design

The vegetation management units were identified primarily by mapping, with limited ground-truthing of some areas. As such, any units that are planned for implementation will first need to be evaluated in the field for site-scale opportunities, constraints, and overall feasibility and sustainability. Site assessment is also an essential component of successful project planning (*e.g.,* Dreesen and Fenchel 2009, Sher *et al.* 2010).

For Saltcedar Treatment Only units, site assessment needs to include, at a minimum, the information necessary to select the most appropriate and feasible saltcedar treatment methods, such as:

- Saltcedar age, density, and cover
- Access routes and accessibility issues for heavy equipment and long-term monitoring and maintenance activities, including landowner access and geographic barriers
- Site topography, ditches, and other features

- Presence, cover, density, and diversity of native vegetation that should be avoided during mechanical and/or herbicide treatment and may contribute to natural revegetation of the site following saltcedar removal[3] (see Section 3.8 for more detail on removal methods)
- Presence, cover, and diversity of other noxious weeds to determine risk of secondary weed establishment and need for measures to reduce their spread
- Site land-use history, including flood, fire, herbivory, and potential for hazardous materials to occur (modified from Dreesen and Fenchel 2009, Sher et al. 2010)
- An evaluation of channel stability in the project area, as well as upstream, downstream, and across the channel, to understand potential geomorphic consequences of saltcedar removal

It may also be prudent or required to conduct pre-treatment surveys for endangered species and/or their habitat, as well as other native wildlife. Such baseline surveys can determine whether saltcedar removal needs to be avoided during any particular time periods, determine whether other protective measures may be needed to avoid impacts to wildlife, identity the habitat elements that are most critical to the wildlife community of the El Rio ecosystem and how saltcedar removal affects that community, and provide a way to evaluate project success. Evaluating areas of saltcedar removal will be important during permitting; regulatory agencies will need information on presence of endangered species and/or suitable habitat for those species, and may use site assessment results to determine potential future conditions.

Site assessment may reveal that Saltcedar Treatment Only is not appropriate for that location (*e.g.*, there is not sufficient native vegetation to naturally recolonize the site after saltcedar removal), and that subsequent habitat enhancement will be necessary. The relatively high number of acres of habitat enhancement units (see Table 2) indicates that, with the exception of a few areas, most units in the planning area are not anticipated to support natural recruitment sufficient to adequately revegetate saltcedar treatments sites and, as such, that habitat enhancement will be necessary.

In units where habitat enhancement will occur, site assessment should also include the following elements to determine which vegetation type will be most appropriate and sustainable at each site:

- Hydrology/water availability, including surface flow patterns, depths to groundwater (which can be measured with relatively inexpensive shallow monitoring wells), and water chemistry
- Existing and historical (to the extent feasible) presence and distribution of native plants to guide planting palettes.
- Potential for excavation or grading to improve water availability and make the site more conducive to revegetation success
- Sampling for soil conditions (*e.g.*, texture, salinity, nutrients), to determine the need for soil amendments

[3] Nissen *et al.* (2009) and Sher *et al.* (2010) recommend criteria for determining natural recruitment potential of a site, including: 10% native cover at mesic sites with favorable hydrology; 25% native cover at arid sites; saltcedar treatment method and intensity; and amount of livestock grazing and/or recreation.

- Evaluation of channel stability and channel dynamics, to understand risk to habitat enhancement areas and identify the need for a "hydraulic shield" of conserved saltcedar (see Section 3.7) or other measures that may be necessary to reduce the risk of habitat enhancement plantings being scoured or damaged from high flow events
- Potential for installing irrigation infrastructure
- Need for fencing or other protective measures to prevent herbivory, damage, and vandalism (modified from Dreesen and Fenchel 2009, Sher *et al.* 2010)

Based on this evaluation, it may be prudent to continue with implementation as planned, or to reassign the unit to a different category (*e.g.,* to No Action, if implementation is infeasible). Ultimately, the site assessment should generate the information and understanding necessary to develop realistic project objectives, and select appropriate saltcedar treatment methods and species for revegetation, given the project budget and timeline. For example, soil sampling may indicate the presence of saline soils and the need to revise the planting palette to focus on species that can tolerate such soils (see species tables [Tables 3–6 and Appendix E] in Chapter 2 for notes on more saline soil-tolerant species).

The results of the site assessment will need to be incorporated into site-specific designs for the unit(s). For Saltcedar Treatment Only units, no plans may be necessary, other than delineating areas that may need to be avoided and/or specifying the saltcedar removal or herbicide application methods that may be necessary. Where habitat enhancement occurs, site-specific designs may need to also include: design plans for any excavation or earthwork; plan-view planting plans with associated planting specifications, such as species, propagule type (*e.g.,* seed or container stock size), planting density, and any specific instructions for soil amendments or planting methods; irrigation design and specifications; and/or design plans for any public access or recreational improvements. In addition to being vital to the correct implementation of activities in a unit, project designs, particularly at the conceptual or 30% design level, will be helpful in developing the description of the project that will be necessary for funding and permit applications (see Sections 3.5 and 3.6).

3.4 Site Prioritization

As illustrated in Section 3.1, the Plan cannot be implemented in one contiguous effort because landowner permission, permits, and funding are not in place to do so, and it would potentially result in large-scale habitat loss. The following criteria should be considered to identify locations in the planning area that are the highest priority for vegetation management:

- **On District-owned land.** Until additional landowner outreach can be conducted and permission for vegetation management granted, District-owned land will be the highest priority for implementing vegetation management activities.
- **Outside of the Gila River ordinary high water mark (OHWM) and suitable habitat for endangered species**. Until the necessary surveys are conducted and permits acquired, it will be necessary to implement vegetation management activities in areas where they will not conflict with federal, state, and local regulations. This criterion conflicts with the District-owned land criterion, however, as all District-owned land is expected to be within the OHWM of the river. As such, all relevant permits will be required (see Section 3.6).

- **In the downstream half of the planning area.** Saltcedar stand density is greater in the downstream half of the planning area. Also, groundwater depths are shallower and water supply greater in this portion of the planning area and, as a result, habitat enhancement activities will have a greater likelihood of being successful and sustainable in the long-term.
- **Where there are benefits to the public.** Vegetation management projects that improve aesthetics and recreational and education opportunities for the public will have additional benefit, relative to cost, and help increase public support for vegetation management.
- **Where suitable habitat for endangered species is lacking but could be sustainably supported.** This would ensure that conflicts with endangered species are avoided, and will be critical to offsetting impacts to endangered species habitat elsewhere by creating habitat where there is none. Such habitat creation will also provide resiliency against the impacts to habitat that are anticipated with the arrival of the tamarisk beetle. Evaluating this criterion will require reach- and/or site-scale habitat surveys.
- **Where riparian and mesquite bosque habitat can be created and/or enhanced.** Both of these habitat types will be effective at off-setting the loss of habitat structure that is anticipated from the tamarisk beetle as well as the temporal loss of habitat from saltcedar removal projects.
- **Where saltcedar removal and/or habitat enhancement can be done most efficiently.** There may be areas that present opportunities for conducting vegetation management activities more efficiently than others. For example, some areas may be more readily accessed by the equipment necessary for vegetation, or have water rights and/or infrastructure for irrigation.

Conversely, the following areas should be de-prioritized for vegetation management:

- **Where there is existing suitable habitat for endangered species.** Areas of relatively high native vegetation cover or saltcedar that provide suitable habitat conditions for southwestern willow flycatcher, western yellow-billed cuckoo, or Yuma clapper rail should be de-prioritized as these areas may be supporting these species and can provide refuge while saltcedar removal occurs elsewhere and habitat enhancement plantings develop. Evaluating this criterion will require reach- and/or site-scale habitat surveys.
- **Where there is little to no saltcedar present.** These areas will not contribute to the flood risk reduction goal and the current absences of saltcedar or other vegetation suggests that conditions will not be conducive to the establishment and growth of habitat enhancement plantings.

These criteria will be used to identify an initial pilot project site for implementing and testing the concepts included in the Plan. The pilot project will be an important opportunity to test the feasibility and effectiveness of saltcedar removal methods and habitat enhancement types. In addition, the pilot project, and similar efforts, will be helpful in demonstrating to permitting agencies, funders, and the public how native species respond and habitat enhancement performs in mitigating for habitat loss.

3.5 Funding Sources and Cost Estimates

Implementation of the Plan will require substantial funding given the size of the planning area (8,787 acres) and the costs associated with saltcedar removal, revegetation, and maintenance. The availability of funding is anticipated to be a primary control on the amount of vegetation management that is conducted, and the timeframe in which it occurs. Examples of potential funding sources for implementation of the Plan, that fund invasive species removal and/or habitat enhancement activities in the planning area region, are listed in Table 8.

Table 8. Examples of funding sources for implementation of the Plan.

Funding Group/Agency	Eligible Applicants	General Deadline	Typical Funding Amount	Website
Arizona State Forestry Invasive Plant Grants	Units of local government, non-profit organizations, and public educational institutions; individuals may also apply if they work with one of these groups	November	$10,000–20,000	https://azsf.az.gov/grants/forest-health/ipg https://azsf.az.gov/invasive-plant-grants
Arizona Water Protection Fund	Any person, organization, local/state/tribal agency, or political subdivision of Arizona may submit an application. Federal agencies are not eligible to receive funding from the Arizona Water Protection Fund; however, funding can be awarded to projects on federal lands.	May	Variable	http://www.azwpf.gov/
Conservation Stewardship Program (NRCS)	Individuals, legal entities, joint operations or Indian tribes.		Up to $200,000	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/csp/
Environmental Quality Incentives Program (NRCS)	Agricultural producers and owners of non-industrial private forestland and Tribes.		Up to $450,000	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/
Environmental Solutions for Communities (National Fish and Wildlife Foundation)	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, educational institutions (eligible for BLM, U.S. Forest Service [USFS] and USFWS funds only), Indian tribes, and BLM field units (eligible for BLM funds only)	December	$25,000–100,000	http://www.nfwf.org/environmentalsolutions/Pages/2016RFP.aspxM
Five Star and Urban Waters Restoration Grant Program	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, Indian tribes and educational institutions	February	$20,000–50,000	http://www.nfwf.org/fivestar/Pages/home.aspx

Funding Group/Agency	Eligible Applicants	General Deadline	Typical Funding Amount	Website
Heritage Fund Program (AGFD)	Federal government, any federal department or agency; Indian tribes; all departments, agencies, boards, commissions and political subdivisions of the state of Arizona; counties; school districts; charter schools; cities; towns; and all municipal corporations.	September	$500–200,000	http://azgfdportal.az.gov/Wildlife/HeritageFund/Program
Landscape Conservation Cooperative Network (Bureau of Reclamation, USFWS)	Variable	Variable	$10,000–100,000	http://lccnetwork.org/
North American Wetland Conservation Act Small Grants (USFWS)	Non-profit organizations, state and local governments	November	up to $75,000	http://www.fws.gov/birds/grants/north-american-wetland-conservation-act/small-grants.php
Partners for Fish and Wildlife (USFWS)	Private, city, and county (*i.e.*, not federal or state) landowners	Anytime	Variable	http://www.fws.gov/partners/index.html
Walton Family Foundation Freshwater Conservation Initiative	Any; interested organizations must first send a brief letter of inquiry; only solicited proposals are accepted. Letter should describe the organization, the proposed project, relevance to the initiative, and an estimate of the funds that would be requested	Anytime	Variable	http://www.waltonfamilyfoundation.org/grants/grant-proposals
Water Bank Program (NRCS)	Landowner of eligible land for which enrollment is sought for at least two years preceding the date of the agreement	February	Variable by crop type	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=stelprdb1047790

Table 9 is a compilation of the estimated cost per acre for various activities that may be conducted as a part of the Plan. These costs are based on a variety of applicable sources and reflect wide ranges in cost as a result of differences in project conditions, methods, timeframes, year the work was undertaken, *etc*. No efforts were made to normalize these compiled costs for conditions that may be encountered during the implementation of the Plan, other than to exclude distinguishable, irrelevant activities and costs.

Table 9. Estimated costs per acre of various Plan implementation activities.

Activity	Cost per Acre	Cost Basis
Saltcedar Clearing and Grubbing	$442	Selective clearing of medium brush and trees, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$690	Clearing and grubbing for river enhancement from Stantec's 2015 Apache del Bosque project cost estimates
	$950	Mechanical removal of saltcedar, with biomass left on site, from bids received by Maricopa County in 2014
	$1,000	Clearing and grubbing of typical desert scrub landscape areas, from various District projects
	$1,208	Selective clearing of heavy wet brush and trees, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$1,640	Clearing and grubbing from the 2008 Tres Rios Restoration Project Phase 2 pricing schedule
	$1,960	Saltcedar removal/mulching, with biomass left on site, from the Gila Watershed Partnership's 2015 upper Gila River restoration project
	$2,450	Clearing and grubbing of saltcedar from the 2007 El Rio R&D pricing table
	$2,600	Mechanical removal of saltcedar, with biomass left on site, from bids received by Maricopa County in 2014
	$3,600	Clearing and grubbing of dense vegetation from Stantec's 2015 Buck Fire project cost estimates
	$3,614	Clearing and grubbing of saltcedar from the Buck Fire 2008 O&M costs pricing table
	$6,000	Clearing and chipping of mesquite bosque-type vegetation, from various District projects
	$7,475	Mechanical removal of saltcedar, with biomass left on site, from bids received by Maricopa County in 2014
	$9,512	Selective tree and shrub removal using dozer and brush rake, with bio-mass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$9,514	Selective tree and shrub removal using tractor with a rotary mower, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$9,882	Complete clear and grub of medium trees, to 10" diameter, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$3,909	***Average***
Grading/ Hauling	$5,000	General estimate for relatively minor site grading
	$2,060	Hauling excavated or borrow material from the 2010 Tres Rios Restoration Phase 3 Project

Activity	Cost per Acre	Cost Basis
Native Planting/ Revegetation [A]	$120	Seeding of saltbush and alkali sacaton at 13.6 pounds per acre from Bosque del Apache National Wildlife Refuge (Taylor and McDaniel 2004)
	$464	Planting of mesquite bosque from bids received by Maricopa County in 2014
	$900	Pole plantings, 100 per acre, from Bosque del Apache National Wildlife Refuge (Taylor and McDaniel 2004)
	$2,266	*Atriplex* plantings from the 2015 El Rio Enhancements Alternatives Valuation Report
	$2,316	Planting costs from the El Rio 2007 R&D pricing table
	$2,700	Tallpot container plantings on 3-foot centers from Bosque del Apache National Wildlife Refuge (Taylor and McDaniel 2004)
	$3,000	Native desert hydroseeding, including soil prep, amendments, and a final mulch cover, from various District projects
	$3,860	Planting and hydroseeding from the 2008 Buck Fire pricing table
	$4,500	Planting on levees from Stantec 2015 unit cost estimates
	$5,121	Cost of planting in coarse soils from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$6,000	Riparian habitat mitigation costs from 2003from the Pima County Office of Sustainability and Conservation
	$7,000	Mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$7,035	Wetland marsh plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$7,575	Mesquite bosque planting costs from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$8,000	Revegetation costs from 1990 from the Pima County Office of Sustainability and Conservation
	$9,400	Hydroseeding, pole planting, planting nursery plants, graded to from basins and furros, water from irrigation district and groundwater (Maricopa County Chicken Ranch) from 1991 from the Pima County Office of Sustainability and Conservation
	$9,586	Wetland and riparian forest plantings from the Tres Rios Restoration Project Phase 2 2008 pricing schedule
	$10,000	"Marginal" habitat mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$10,915	Wetland plantings from the Tres Rios Restoration Project Phase 2 2008 pricing schedule
	$11,215	Protect in place, diversion and control of water, clear and grubbing, vegetation removal, excavation and debris removal (Tres Rios Phase III Environmental Restoration Project from the 2010 Project Direct Summary)
	$11,609	Cost of cottonwood and willow plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$12,400	Mesquite bosque tall-pot plantings at approximately 90 trees/acre, with no irrigation system, from various District projects

Activity	Cost per Acre	Cost Basis
Native Planting/ Revegetation (cont.) [A]	$12,500	Fencing, irrigation system installation, hydroseeding, planting, nursery stock, 1-year maintenance contract (Southeast Mesa Detention Basin) from 1998 from the Flood Control District of Maricopa County
	$15,500	Site revegetation, monitoring, water, and maintenance from 2003 from the Pima County Office of Sustainability and Conservation for Santa Cruz River restoration; includes in-kind assistance (fencing and other activities, volunteer assistance) and low-cost measures (seeding, no irrigation)
	$18,783	Cost of plantings from the El Rio 2007 R&D pricing table
	$20,000	"Good" habitat mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$25,000	Mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$25,000	Site revegetation, half was hydroseeding (Maricopa County) from 1990 from the Pima County Office of Sustainability and Conservation
	$26,100	Revegetation, irrigation system (Town of Gilbert Riparian Preserve) from 2003 from the Pima County Office of Sustainability and Conservation
	$37,500	Irrigation installation, roadway, and landscaping (Pima County project) from 2003 from the Pima County Office of Sustainability and Conservation
	$75,000	Mitigation costs from Stantec based on 2015 prices from AGFD
	$12,624	***Average***
Hydroseeding	$1,500	Assuming low seed application rate and lower mulch cover (H. Cooper, pers. comm., 2015)
	$2,000	Cost of hydroseeding on levee slopes from 2015 from Stantec
	$3,500	Assuming high seed application rate and high mulch cover (H. Cooper, pers. comm., 2015)
	$4,356	Costs of hydroseeding on levee slopes from bids received by Maricopa County in 2014
	$4,027	Costs of hydroseeding upland flood terrace from the Tres Rios Restoration Project Phase 2 2008 pricing schedule
	$3,077	***Average***
Herbicide Application/ Maintenance	$1,125	Herbicide application after biomass removal of saltcedar based on 2014 bids received by Maricopa County
	$1,202	Six months of maintenance from the El Rio R&D 2007 pricing table
	$1,500	Herbicide application after biomass removal of arundo from 2013 from southern California
	$1,950	Maintenance, management, on-going monitoring costs from 2003 from the Pima County Office of Sustainability and Conservation
	$1,444	***Average***

Activity	Cost per Acre	Cost Basis
Monitoring	$25	General estimate for pedestrian surveys for saltcedar growth/ resprouting
	$792	General estimate for protocol-level surveys for endangered birds
	$600	General estimate for vegetation monitoring and associated reporting
	$472	***Average***

Table footnotes:
[A] The District already maintains a native plant nursery which will provide most of the plants, cuttings, and seeds needed for revegetation, therefore, costs associated with nursery development, operations, and maintenance are not included here.

In Table 10, the acres of vegetation management unit types from Tables 2 and 7 are multiplied by the costs per acre of relevant activities from Table 9, to provide a cost comparison of different unit types and a very coarse cost estimate for implementing the entire Plan under both current and altered land use conditions, over a 5-year period. A 5-year time period was used to ensure that saltcedar resprout treatment and routine monitoring (*i.e.*, to determine need for saltcedar resprout treatment and document revegetation success), which are typically needed or required for 3 to 5 years, were incorporated in the cost estimate. Costs associated with permitting are provided in Appendix C. Costs associated with additional monitoring (*e.g.*, post-project wildlife surveys to document species response to vegetation management) and site maintenance other than saltcedar resprout treatment are not incorporated in the costs in Table 10, as the need for and cost of such activities would be site and/or project-specific.

It is important to note, as described in Section 3.1 above, that Plan implementation will not proceed in a continuous and comprehensive manner for the entire area, but rather as a phased mosaic of individual projects implemented opportunistically as conditions permit (see Figure 4). This aspect of Plan implementation will have considerable bearing on the ultimate cost of implementation, but there is too much uncertainty in implementation phasing to incorporate such phasing into cost estimates at this time.

Table 10. Estimated cost of Plan implementation over 5 years.

Unit Type	Acres	Acres Under Altered Land Use	Relevant Activities	Activity Cost / Acre / Year	Number of Years to Implement	Estimated Cost	Estimated Cost under Altered Land Use Condition
No Action	3,042	1,603	Monitoring [A]	$498	5 years	$4,190,670 [A]	$2,016,900 [B]
Saltcedar Treatment Only	609	294	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$2,415,903	$1,166,298
			Herbicide application/ maintenance	$1,444	4 years	$3,517,584	$1,698,144
			Monitoring	$498	5 years	$1,516,410	$732,060
			Subtotal over 5 year period	*$5,909 per acre*		$7,449,897	$3,596,502
Saltcedar Treatment and Riparian Enhancement	749	496	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$2,971,283	$1,967,632
			Cottonwood and willow plantings [C]	$14,609	1 year	$10,942,141	$7,246,064
			Herbicide application/ maintenance	$1,444	4 years	$4,326,224	$2,864,896
			Monitoring	$498	5 years	$1,865,010	$1,235,040
			Subtotal over 5 year period	*$20,518 per acre*		$20,104,658	$13,313,632
Saltcedar Treatment and Desert Shrub Enhancement	3,634	1,865	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$14,416,078	$7,398,455
			Planting and hydroseeding [D]	$4,315	1 year	$15,680,710	$8,047,475
			Herbicide application/ maintenance	$1,444	4 years	$20,989,984	$10,772,240
			Monitoring	$498	5 years	$9,048,660	$4,643,850
			Subtotal over 5 year period	*$10,224 per acre*		$60,135,432	$30,862,020
Saltcedar Treatment and Mesquite Bosque Enhancement	571	284	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$2,265,157	$1,126,628
			Mesquite bosque plantings [E]	$15,400	1 year	$8,793,400	$4,373,600
			Herbicide application/ maintenance	$1,444	4 years	$3,298,096	$1,640,384
			Monitoring	$498	5 years	$1,421,790	$707,160
			Subtotal over 5 year period	*$21,309 per acre*		$15,778,443	$7,847,772

Unit Type	Acres	Acres Under Altered Land Use	Relevant Activities	Activity Cost / Acre / Year	Number of Years to Implement	Estimated Cost	Estimated Cost under Altered Land Use Condition
Saltcedar Treatment and Marsh Enhancement	77	17	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$305,459	$67,439
			Grading/fill [F]	$5,000	1 year	$385,000	$85,000
			Wetland marsh plantings [G]	$7,035	1 year	$541,695	$119,595
			Herbicide application/ maintenance	$1,444	4 years	$444,752	$98,192
			Monitoring	$498	5 years	$191,730	$42,330
			Subtotal over 5 year period	*$17,944per acre*		$1,868,636	$412,556
***Grand Total* (5-year cost for entire planning area)**						$109,527,736	$58,049,382

Table footnotes:

[A] Cost based on a total of 1,683 acres, which is the amount of No Action area throughout the entire planning area that is vegetated and would, thus, mostly likely need monitoring to determine if saltcedar treatment and/or habitat enhancement becomes necessary over time. Cost per acre is general estimate for pedestrian surveys for saltcedar growth/resprouting.

[B] Cost based on a total of 810 acres, which is the amount of No Action area in the planning area not including private parcels that is vegetated and would, thus, mostly likely need monitoring to determine if saltcedar treatment and/or habitat enhancement becomes necessary over time. Cost per acre is general estimate for pedestrian surveys for saltcedar growth/resprouting.

[C] Cost of cottonwood and willow plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report plus initial hydroseeding based on various District projects; cost includes materials from a nursery (*i.e.*, container stock).

[D] Cost of planting and hydroseeding from the Buck Fire pricing table (from 2008, adjusted for inflation); cost includes materials from a nursery (*i.e.*, container stock and seed).

[E] Cost of mesquite bosque planting from various District project, assuming initial hydroseeding and tall-pot plantings at approximately 90 plants/acre; cost includes materials from a nursery (*i.e.*, container stock).

[F] Cost of relatively minor grading from various District projects.

[G] Cost of wetland marsh plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report; cost includes materials from a nursery (*i.e.*, container stock and seed).

3.6 Permitting and Regulatory Compliance

This section summarizes the permits and regulatory compliance documentation that is likely to be required for implementation of the Plan. Additional permitting and compliance information is provided in Appendix C.

Permitting refers to the processes and authorizations necessary for a proposed project to comply with relevant federal, state, and local laws or regulations. These regulations give authority to particular agencies to implement the regulation and are intended to ensure that a proposed project's potential impacts on the environment are avoided, minimized, and/or mitigated. There are a number of regulations that would apply to, and regulatory agencies that would be involved in, the permitting of Plan actions (with the exception of No Action units, which would not require any permits) due to the facts that the planning area includes a river, wetlands, and is known to support federally endangered species and their habitat. In addition, implementation of the Plan involves actions, such as mechanized equipment within the ordinary high water mark of the Gila River, which would trigger the need to comply with certain environmental regulations.

Table 11 lists the regulations that are relevant to Plan implementation, the agency with authority for the regulation, the way(s) in which a regulation is likely to be triggered by the Plan activities, and the documentation that must be prepared to be issued a permit or demonstrate compliance with the regulation. These permits and required documentation are discussed in greater detail in Appendix C. An important basis for the permitting of the Plan or individual portions of the Plan will be the type of permit that is acquired from the U.S. Army Corps of Engineers (USACE) for Section 404 permitting. One option is a Regional General Permit (RGP)[4] that would cover implementation of the Plan, regardless of the project proponent. Another option is that individual project proponents apply for an Individual Permit or coverage under a Nationwide Permit, such as No. 27 for habitat restoration, for implementing individual portions of the Plan. The pros and cons of both approaches are discussed in Appendix C. Unless otherwise noted, the permits listed in Table 11 would be required regardless of whether a project occurs on private or public property, and whether it is federally funded or not.

There are many factors that influence the schedule and timeline for preparing and acquiring the permits listed in Table 11, which are described in more detail in Appendix C. In general, individual project permitting via a Nationwide Permit from USACE should take approximately 10 to 14 months, including drafting of the project description and associated maps, site assessment for threatened and endangered species habitat, delineation of USACE jurisdiction, USACE review and comments, consultation with USFWS (including preparation of a Biological Assessment [BA]) and SHPO (including a cultural resources survey report) for the project site, and acquisition of other required permits. Permitting via a RGP from USACE should take approximately one to six months, with most of the time spent addressing USFWS and SHPO requirements.

[4] There are RGPs for nonnative invasive plant removal, but currently none for Arizona. The District is currently working to have an RGP established that would cover at least Maricopa County.

Table 11. Summary of the permits that may be required to implement the Plan.

Regulation (Permit)	Agency [A]	Triggers for Regulation	Required Documentation
Clean Water Act Section 404 (Nationwide Permit or Regional General Permit)	USACE	Working below the ordinary high water mark of a river and/or within adjacent wetlands	• Regional General Permit request letter (if RGP is available) • Individual or Nationwide Permit application (if RGP is not available) • Project description • Delineation of USACE-jurisdictional waters, including wetlands • All of the documentation listed below
ESA Section 7 (Biological Opinion)	USFWS	Potential to affect a federally listed species or its habitat	• Biological Assessment, which may necessitate a habitat assessment, habitat suitability modeling, and/or protocol-level surveys for endangered species.
National Environmental Policy Act (Record of Decision)	USACE	Potential for a federal action, permit, or funding to result in significant impacts to environmental resources [B]	• Environmental Impact Statement or Environmental Assessment • Waived for Nationwide Permit and RGP
National Historic Preservation Act Section 106 (SHPO Concurrence)	SHPO	Potential to affect historic and culturally significant resources	• Cultural resources report, which may necessitate cultural resource surveys and/or construction monitoring
Clean Water Act Section 401 (State Water Quality Certification)	ADEQ	Need for a 404 permit from USACE	• 401 Certification application
AZ Pollutant Discharge Elimination System (Stormwater Construction General Permit)	ADEQ	Construction activities disturbing one or more acres of land	• Notice of Intent (NOI) • Stormwater Pollution Prevention Plan (SWPPP)
Pesticide General Permit	ADEQ	Herbicide use	• Pesticide General Permit application
Floodplain Regulations for Maricopa County (Floodplain Use Permit)	District or local municipality	Construction of buildings, earthwork and other improvements within designated floodplains	• Floodplain Use Permit application • Floodplain development checklist • "No-rise" engineering analysis

Table footnotes:
[A] USACE=U.S. Army Corps of Engineers, ADEQ = Arizona Department of Environmental Quality, USFWS=U.S. Fish and Wildlife Service, SHPO=Arizona State Historic Preservation Office.
[B] If a project is not on federal property, federally funded, and a federal permit is not required, then compliance with the National Environmental Policy Act (NEPA) is not required.

These schedules assume that the project description would not change materially during the course of the permitting phase or after permits have been acquired. If such changes occur, permitting can take much longer. It is likely that consultation with USFWS will be the "critical path" item under any permitting scenario, as the consultation process can take up to 135 days (this review period is fairly standard for USFWS but can take longer depending on agency priorities and/or the level of controversy surrounding the project). In addition, consultation with USFWS may require that season-specific surveys for endangered species be conducted, which can greatly influence the permitting schedule.

Development of an RGP could take two to three years, but could streamline the subsequent approval of covered projects to one to six months. This schedule includes negotiations with USACE for RGP development, terms, and conditions; preparation of a National Environmental Policy Act (NEPA) compliance document and circulation for public review; consultation with USFWS and SHPO; and acquisition of other program-level permits. Once an RGP is in place, USACE would be made aware of individual project implementation with a project-specific summary letter, site-specific delineation of USACE jurisdiction, and a site-specific biological resources assessment, if necessary. The RGP would need to be renewed every five years, but with much less effort than the original RGP.

As noted above, consultation with USFWS and/or adequately addressing potential impacts of Plan implementation on endangered species is likely to be one of the most critical and time-consuming aspects of permitting. Habitat suitability modeling of the planning area for southwestern willow flycatcher and western yellow-billed cuckoo could greatly facilitate the USFWS consultation process (the relatively small patches of marsh habitat that can be utilized by Yuma clapper rail can be identified from vegetation maps and, as such, habitat suitability modeling is not considered to be warranted at this time). Habitat models for each species incorporating factors such as vegetation composition and structure (*e.g*., canopy height), landscape context, topography, and distance to water can be used to evaluate the current baseline quantity (acreage) and quality of suitable habitat for each species, predict potential loss of habitat due to saltcedar removal and potential gain of habitat resulting from habitat enhancement. The model results would be improved through model calibration using occupancy data for these species in the El Rio reach, although such data are currently limited. In addition preliminary model results could be used to prioritize which portions of the planning area should be included in species-specific surveys to obtain more data for calibration or validation of the models.

Consultation with SHPO has the potential to be similarly arduous to that with USFWS, but it is anticipated that much of the planning area has low potential for cultural resources because of the extent of historical flooding and associated scour and deposition in the Gila River floodway.

3.7 Site Preparation

Implementation sites would need to be prepared in accordance with any site-specific plans (see Section 3.6). In general, little site preparation should be necessary for Saltcedar Treatment Only units, other than establishing access routes and staging areas for equipment and supplies, and fencing or flagging areas that need to be avoided.

Staging areas for equipment and materials should be located in developed and/or unvegetated areas, to the extent feasible, and far enough away from the wetted river channel or other waterbodies to avoid risk of contamination if a spill or fuel leak occurs.

Existing paved and unpaved roads should be used for access to the extent practical. Where it is necessary to establish new access routes to provide vehicle access for transporting crews, equipment, and materials, native vegetation should be avoided to the extent feasible. Ideally new access routes can be established by removing saltcedar on the way to the project site, and with little to no surface grading, as this increases the risk of secondary weed infestations. Access routes should be planned for long-term access for maintenance and monitoring, but may need to be fenced to prevent unauthorized access and damage.

Where habitat enhancement occurs, a number of other site preparation activities may also be necessary to ensure the long-term success and sustainability of the enhancement effort. Saltcedar biomass will need to be mulched, burned, or otherwise removed, and secondary weed management may be necessary (Sher *et al.* 2010). Soil surface manipulations may be needed to prepare the seedbed, including the addition of soil amendments, and site fencing may be needed if there are risks of herbivory (Sher *et al.* 2010).

Where habitat enhancement occurs within the flood reset zone, it may be prudent to conserve upstream vegetation, even if it is saltcedar, to provide a hydraulic shield from high flow events for the downstream enhancement area (see Figure 5 below for an example). The goal of the shield would be to buffer new plantings in downstream or laterally adjacent enhancement areas from the scouring effects of high flows. The "hydraulic shield" may also reduce negative effects from saltcedar removal by maintaining microclimate conditions and protecting existing habitat that is occupied by a protected species. Once enhanced areas are sufficiently established and can withstand moderate to high flow events, the saltcedar in the hydraulic shield could then be removed, if it is has not already been colonized or killed off by tamarisk beetle. It is anticipated that revegetated areas in Riparian Enhancement units will require three to five years to become sufficiently established to withstand typical high flow events. It may also be prudent to preserve all or some saltcedar along regularly inundated streambanks to prevent streambank erosion and other unintended morphological changes following saltcedar removal (Nissen *et al.* 2009).

Grading or excavation, where determined to be appropriate and desired, would be designed to create planting surfaces or off-channel features that would allow the roots of planted trees and shrubs to reach groundwater more quickly, and increase their survival and long-term establishment. Such areas may also provide surface moisture conditions that are suitable for southwestern willow flycatcher nesting habitat. Identification of these areas will have been confirmed by local groundwater and soil sampling during site assessment and design. In these areas, a small to mid-sized excavator would be used to dig trench- or swale-like features prior to revegetation. Such features would typically be less than 3 feet deep (as measured below the ground surface), 100 feet long (as measured parallel to the river), and 25 feet wide (as measured perpendicular to the river), but large enough to support an adequate planting zone. Unless otherwise required, excavated material should remain on-site and be spread out around the grading area to create natural-looking topography and reduce costs. Earthwork could occur concurrently with saltcedar removal, in order to expedite implementation.

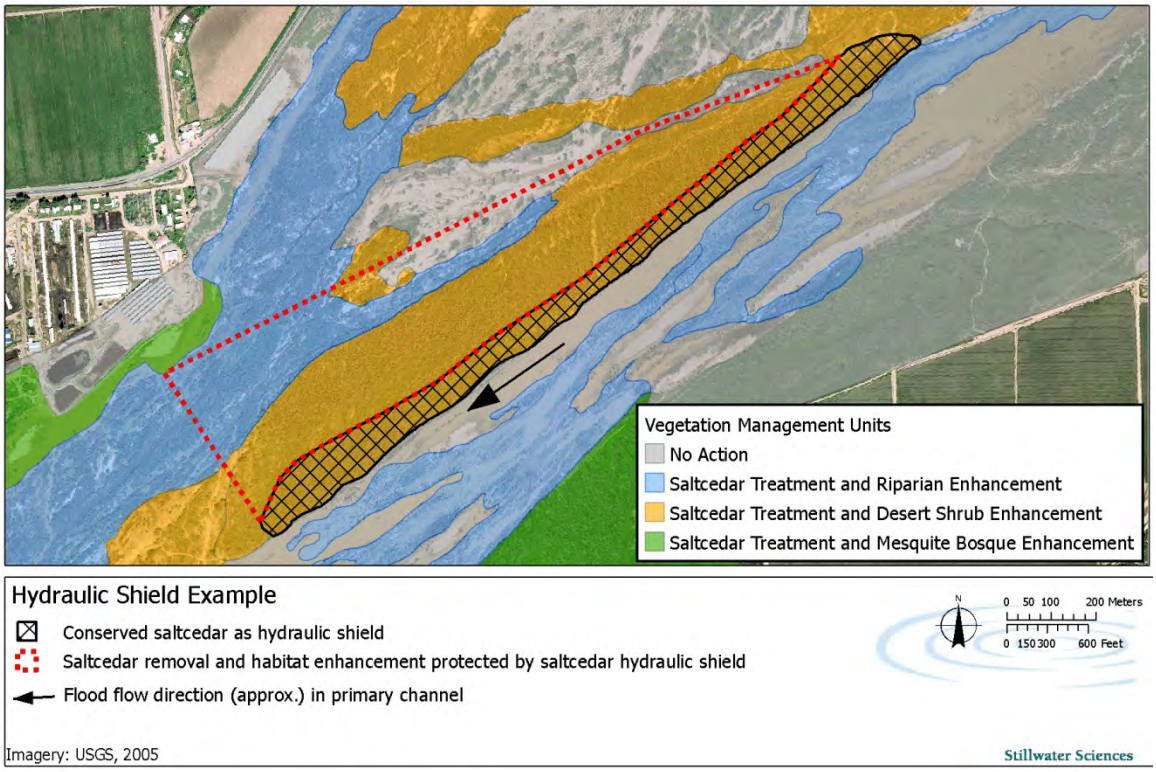


Figure 5. Conceptual example of saltcedar stands conserved along the geomorphically active river channel to provide a "hydraulic shield" for enhancement activities within the flood reset zone.

Ideally plantings will be installed directly into the capillary fringe of the water table and during the onset of either winter or early spring after buds form but before they open to minimize the amount of irrigation that may be necessary. In fact, where cuttings or container stock of perennial species are planted into the water table, or plantings are annual species or dependent only on seasonally available water, planting during the rainy season may preclude the need for irrigation altogether. Where that is not the case, enhancement sites, particularly where grading to reduce the distance to groundwater is not appropriate or feasible, may require at least 3 years of irrigation to allow plants to establish a sufficient root structure and canopy to be self-sufficient. There are a number of considerations in determining appropriate irrigation methods for a site, which is made more challenging in the planning areas since pumping water from the river channel for irrigation is not likely to be allowed. Such considerations include (but are not limited to): accessibility for water trucks (which may be the most cost effective approach if only an initial watering will be needed); proximity to the flood reset zone, where irrigation infrastructure could be scoured away or damaged during high flow events; risk of theft or vandalism; need for an electrical supply to power irrigation pumps or timers. Where irrigation is needed but ultimately determined to be infeasible, the planting palette should be revised to a more xeric vegetation community or habitat enhancement should be relocated someplace more conducive to long-term plant establishment. Dreesen and Fenchel (2009) provide a comparison of various irrigation methods, and Sher *et al.* (2010) provide recommendations for irrigation magnitude and frequency, for revegetation following saltcedar removal.

If not already established or conducted during the site assessment (see Section 3.3), baseline surveys should be conducted as part of site preparation. A wildlife inventory and/or endangered species surveys can help determine if saltcedar removal needs to be avoided during any particular time periods, determine whether other protective measures may be needed to avoid impacts to wildlife, identity habitat elements most critical to the wildlife community of the El Rio ecosystem and how saltcedar removal affects that community, and provide a way to evaluate project success. An additional component of site preparation should include the establishment of long-term vegetation monitoring plots that can be used to identify any naturally recruiting species, particularly secondary weeds, as well as quantify vegetation and habitat development following habitat enhancement.

3.8 Saltcedar Removal and Treatment Methods

In the long-term, the tamarisk beetle is a biological control agent that is likely to act as a cost-effective way of reducing the current extent of saltcedar and limiting re-infestation in the future after it has naturally entered[5] the El Rio reach. While the tamarisk beetle is expected to cause mortality of much of the saltcedar in the planning area, it will not remove the remaining standing biomass, which will continue to contribute to flood risk. As such, biomass removal by chipping or burning will still be necessary in some portions of the planning area to reduce flood risk sufficiently.

In the short-term, however, removal of saltcedar via manual, mechanical, and chemical methods is needed to reduce flood risk and to provide sufficient space for the revegetation of native trees and shrubs. Revegetation using native species will be necessary to replace habitat losses from saltcedar removal and to promote the re-establishment of native plant species. There are many methods for removing and treating saltcedar (*e.g.*, Tamarisk Coalition 2008). Because one of the primary objectives of saltcedar removal in the planning area is to reduce flood risk, biomass removal is an essential component. As such, foliar application of herbicides without any associated biomass removal, which can be one of the most cost-efficient means of saltcedar treatment (Parker *et al.* 2005), is not discussed in detail here. In addition, to effectively bring about saltcedar mortality, foliar treated trees must be left in place for at least two years (Tamarisk Coalition 2008); this precludes the flood-risk reduction benefits of treatment and increases fire risk. In addition, controlled burns are not recommended for standing/living saltcedar biomass removal since the plant regrows vigorously after fires and there would be fire risks to native vegetation and nearby land uses (Nissen *et al.* 2009). Incidental wildfires, however, as well as floods, present an opportunity for cost-effective foliar herbicide application on resprouts after most of the saltcedar biomass has been removed by the wildfire or flood.

[5] Per the U.S. Department of Agriculture's (USDA) Animal and Health Inspection Service (APHIS), any unauthorized human-assisted movement of the tamarisk beetle, particularly into designated critical habitat of southwestern willow flycatcher and western yellow-billed cuckoo (the latter of which includes the El Rio reach), may constitute a violation of the ESA, which could result in criminal punishment and/or fines, as well as the Plant Protection Act, which could result in criminal penalties and/or fines of up to $250,000 (APHIS 2010).

Mechanical saltcedar biomass removal followed by immediate herbicide application to the cut stumps, and subsequent foliar herbicide application to regrowth, is likely to be the best value in terms of cost versus efficacy, for the planning area, most of which can be accessed by the heavy equipment necessary for mechanical removal (*i.e.*, there are not very many steep slopes or banks) (see photos below). Mechanical removal may include root crown removal or above-ground biomass removal. Manual (*i.e.*, hand) removal may be necessary where equipment access is limited or where native vegetation needs to be avoided (although some mechanical methods are able to work around native vegetation successfully – see photo at right). The focus on these methods does not mean, however, that other or additional methods may not be appropriate for particular sites and conditions. Parker *et al.* (2005) and Tamarisk Coalition (2008) both provide comparisons of various saltcedar removal methods. Regardless of the method used, costs are high (see Section 3.5) and revegetation is likely to be necessary for sustained, long-term control of saltcedar. As such, sites with the greatest potential for natural recruitment and/or revegetation success, as well as potential for flood-risk reduction, should be prioritized for saltcedar removal (Parker *et al.* 2005). Herbicide application or mechanical methods may also be needed to control secondary weeds that often increase following treatment of saltcedar, such as Russian thistle (*Salsola tragus*) (see Section 3.11).

Examples of mechanical removal of saltcedar, placement of mulched biomass, and preservation of native riparian trees (top), and herbicide treatment on a cut saltcedar stump (bottom) (both views from the upper Gila River near Safford, AZ) (Photos by Stillwater Sciences)

Root crown removal is the extraction of saltcedar trees and their root crown by either root plowing and raking or by extraction of the entire plant and is approximately 85% effective (Tamarisk Coalition 2008). This approach is extremely disruptive to the soil, can promote establishment of secondary weeds, and results in a large amount of biomass that must be subsequently mulched or burned. Mulching of that biomass could range from $400 to $800 per acre, while burning could range from $50 to $150 (Tamarisk Coalition 2008). Plowing and raking methods also destroy native vegetation, although extraction that plucks individual trees from the ground does not. As such, post-treatment revegetation is nearly always necessary to re-stabilize the soil, replace removed native vegetation, and suppress secondary weeds. Extraction can be used to remove saltcedar trees on steep slopes, as the equipment can reach over such slopes to "pluck" out individual trees, or where ground disturbance may be necessary anyhow to facilitate revegetation. Theoretically, root crown removal should eliminate the need for herbicide, since the entire tree and roots are removed, but herbicides treatments are still necessary because any remaining root pieces and buried stems can easily resprout and re-infest cleared areas (Nissen *et al.* 2009).

Cut stump (*i.e.*, above-ground removal) methods involve cutting and/or mulching the above-ground portions of the shrubs/trees and then immediately applying an herbicide to the cut stumps. These methods are typically 85% effective on its own (Tamarisk Coalition 2008), but should include follow-up foliar applications of herbicide to saltcedar resprouts for at least three years. Like the extraction methods discussed previously, cutting methods using chainsaws, loppers, and hand saws (where access is limited or where native vegetation needs to be avoided) result in a large amount of biomass. Large trunks and branches that are manually removed should be relocated outside of the ordinary high water mark of the river, to further reduce flood risk, and reduced by means of mulching or prescribed burning. Mulching of that biomass could range from $400 to $800 per acre, while burning could range from $50 to $150 (Tamarisk Coalition 2008). Prescribed burning of debris piles must be overseen by professional crews when air, moisture, and wind conditions are appropriate. Local fire departments may perform these burns as training exercises. All local and/or state air quality permits must be obtained prior to any debris pile burning. Alternatively, an excavator equipped with a mulching head attachment (*e.g.*, Torrent EX30 Brush Cutter) can be used to directly mulch standing saltcedar. Mulched saltcedar material (*i.e.*, wood chips) should be left on-site as it offers multiple benefits, such as reducing wind- and water-induced erosion of surficial soils, conserving soil moisture loss to aid reseeding efforts, and retarding the growth of secondary weeds (Tamarisk Coalition 2008, Dreesen and Fenchel 2009). Although saltcedar removal can reduce fire risk, leaving mulch on-site may merely redistribute the fuel for fires and not remove it (Bateman *et al.* 2012) and, if exceedingly deep, mulch has been observed to suppress vegetation cover and, to a lesser extent, plant species richness (Finch *et al.* 2004).

Cut saltcedar stumps should be immediately treated with herbicide, and saltcedar resprouts should be treated with foliar and/or cut-stump herbicide applications as needed. Herbicides should include triclopyr (trade names include Garlon and Element), imazapyr (trade names include Arsenal, Habitat, Stalker, Chopper, and Polaris), and perhaps glyphosate (trade names include Roundup, Rodeo, and Aquamaster), which have all been reported to be effective on saltcedar (USFS 2014). Solutions of these herbicides, at the concentrations and rates suggested for saltcedar (*e.g.*, Tamarisk Coalition 2008, Nissen *et al.* 2009, Johnson *et al.* 2010, Ferrell *et al.* 2012, DiTomaso *et al.* 2013), should be applied to cut saltcedar stumps, or basal bark by hand "painting", or to resprouting stems by backpack sprayer. Herbicide solutions should be mixed with a color dye to determine which trees have been treated and reduce potential for overspray. Generally, herbicide should be applied until the cut saltcedar surface is thoroughly wet but not to the point of runoff to reduce damaging or killing non-target species. Ferrell *et al.* (2012) and Tamarisk Coalition (2008), among others, provide detailed discussions of appropriate herbicide types, concentrations, and application timing. Application of herbicide should be closely supervised and comply with the conditions of a Pesticide General Permit from the Arizona Department of Environmental Quality (ADEQ).

3.9 Native Plant Collection, Propagation, and Planting

Depending on individual site characteristics, the abundance of native species may be sufficient to provide natural recruitment of native plants after saltcedar is removed (see Section 3.3). This premise is the basis of many of the Saltcedar Treatment Only units (see Section 2.2.2). However, with the exception of a few areas, most units in the planning area are not anticipated to support natural recruitment sufficient to adequately revegetate saltcedar treatments sites and, as such, that habitat enhancement will be necessary. Planting after saltcedar removal will be necessary in many areas to: (1) stabilize banks and control erosion; (2) replace and enhance wildlife and pollinator

habitat; (3) provide shade for recreation and wildlife; (4) provide forage for wildlife; (5) improve aesthetics; and (6) reduce re-establishment of saltcedar and other weeds (Taylor and McDaniel 2004 as cited in Parker *et al.* 2005, Sher *et al.* 2010). In addition, native plant communities also provide ecosystem services to people, communities, and the economy, and planting native species will improve ecosystem diversity, maintain genetic diversity of native seed banks, and support wildlife and pollinator habitat.

The plant species likely to be appropriate for various vegetation management units are listed in Chapter 2 (see Tables 3–6). These species have been selected because they are native to the region, will be able to persist in the physical conditions that do and are anticipated to occur at the unit locations, and will create the desired habitat conditions. For example, dense plantings of the riparian herb, grass, shrub, and tree species in Table 3 can create suitable habitat for southwestern willow flycatcher when close enough to a water source. The species listed in Chapter 2 also include those that will provide habitat and food sources for pollinators.

It may be necessary to alter or revise the suite of plant species used for habitat enhancement based on the results of site-specific assessment (see Section 3.3). For example, plants with higher tolerance for saline soils should be used if a site is ultimately found to have relatively saline soils (examples of such species are noted in the Chapter 2 tables [Tables 3–6]). It is also possible that site assessment could determine that a site is not likely to successfully support any kind of habitat enhancement and should only be considered for saltcedar removal.

When planting is necessary, seed and planting stock should, ideally, be locally collected. This will be challenging or impossible for some species, however, given the lack of native plant diversity in the planning area. When it is necessary to collect seeds and planting stock from other areas in the region, the genotype of the source plants should be considered so that material is collected from plants that have the greatest chance to successfully persist in the relatively hot and dry conditions in the planning area (Whitham *et al.* 2006, Lojewski *et al.* 2009, Grady *et al.* 2011). Habitat enhancement areas could incorporate experimental plantings of cottonwood and willow from hotter or drier areas, which may show a difference in health, vigor, and establishment success, to promote riparian habitat resiliency to climate and water availability changes in the future (Whitham *et al.* 2006, Lojewski *et al.* 2009, Grady *et al.* 2011).

The District maintains a native plant nursery that can be used to collect local seed and cuttings, and propagate and grow many of the plants that will be needed for habitat enhancement. The nursery should establish cottonwood and willow coppicing sources (ideally from seed so that genetic diversity is maximized) so that pole cuttings can be collected from the nursery rather than from vegetation in the field. If demand exceeds the District's supply and capacity, seed and plants can be procured from other regionally-appropriate native plant nurseries.

Specific revegetation techniques play a role in where particular plant species can be successfully established. Table 12, which is modified from Parker *et al.* (2005), provides a comparison of various revegetation methods and plant-stock options for riparian restoration projects. The advantages versus costs of these methods will need to be assessed given individual site conditions and project objectives, and it is likely that a combination of methods will be necessary. When determining revegetation methods and plant stock type, the equipment necessary for planting should be considered, as this varies by stock type. For example, long augers or rotary hammer drills may be needed for pole plantings; waterjets or similar hydraulic methods for nursery stock planting may require site-specific water rights; and access for large drilling or hydroseeding

equipment may be limited by ditches, arroyos, levees, soft sand, or steep slopes. In addition, the presence of cut or burned saltcedar stumps can flatten equipment tires if the tires are not foam-filled (Dreesen and Fenchel 2009).

Table 12. Comparison of revegetation methods for riparian restoration projects (adapted from Parker *et al.* [2005][A]).

Method	Timing	Effectiveness	Comments
Controlled flooding: flood areas when seeds from desirable species are present	When native or desirable seeds are available on site (generally late spring/early summer)	20–47% survival after 2 years; could be used to cost-effectively revegetate large portions of the planning area	• May not be possible in the planning area, due to upstream flow storage, or only occasionally available if flow releases can be negotiated for above-average water year types. • Will also facilitate recruitment of saltcedar and necessitate monitoring and saltcedar treatment.
Pole plantings: cutting stems of willows and cottonwoods from established trees and planting into water table or capillary fringe	During plant dormancy (generally December–January)	90% survival, with supplemental water as-needed	• Native source material may be limited in the planning area and coppicing trees may need to be established specifically for pole cuttings. • Cuttings should ideally be 0.5–3 inches in diameter for *S. exigua*, and 2–8 inches in diameter for *S. gooddingii* and *P. fremontii* to survive harsh conditions and sufficiently long to be planted into capillary fringe. Long cuttings planted deeply are also better able to withstand flood flows (Dreesen and Fenchel 2009). • Planting density will depend on presence of native vegetation and objectives of enhancement, but for wildlife benefit, density should be at least 100 trees and shrubs per acre.
Nursery stock: planting container stock into dug/augured holes	Ideally during late fall/early winter, at beginning of rainy season, to reduce need for supplemental water	90% survival if water table is less than 5 feet from the soil surface, and with supplemental water as-needed	• Native plant nurseries must be given adequate notice to propagate species and quantity needed for individual projects. • Projects need to consider the costs vs. benefits of different stock sizes, and the cost of labor and equipment that may necessary for planting different stock sizes (Dreesen and Fenchel 2009). • Screwbean mesquite is best propagated by long-stem deep plantings (up to 5 feet deep from 0.3×2.5 foot tall pots) that require minimal to no irrigation (Dreeson and Fenchel 2008).

Method	Timing	Effectiveness	Comments
Seeding: hand, broadcast, or hydroseeding of native plant seeds	In anticipation of winter and/or monsoon rains (Dreesen and Fenchel 2009)	Depends on species and conditions; can take 3 or more years to determine if seeded plants successfully establish (Sher *et al.* 2010)	• Limited to species that readily germinate from seed and for which an adequate supply of seed can be obtained. • Can be most cost-effective option for large areas. • Can be combined with pole and nursery stock plantings to promote understory development and increase species diversity. • If dense enough and timed correctly, seeding can be sufficient to suppress saltcedar resprouting.
Rainfall harvest: excavate long, shallow V-shaped water catchment and line sides with plastic; plant seedlings at the bottom of the catchment	Construction: before rains Planting: during monsoon season	Results are comparable to previous methods	• Effective in areas with a deep water table or where moderate salinity levels are present in the soil. • An alternative to grading or excavating to improve water supply

Table footnotes:
[A] Table adapted from Parker *et al.* (2005), which was specific to riparian revegetation. As such, methods, timing, and effectiveness may be different for desert shrub, mesquite bosque, and marsh enhancement projects.

Most plantings in the planning reach are likely to benefit from soil amendment techniques to condition the soil. The need for such amendments should be evaluated during the site assessment (see Section 3.3). Such amendments could include: soil ripping by heavy equipment or by hand to improve compacted soils; use of amended topsoil or fertilizers during plantings; and/or beneficial mycorrhiza by inoculating planting areas with soil from areas where the desired species are already established.

3.10 Best Management Practices and Conservation Measures

The following measures are likely to be necessary before, during, and/or after saltcedar removal and habitat enhancement to adequately avoid and minimize impacts to environmental resources and comply with general permit terms and conditions. Additional measures are likely to be required as a result of project-specific permit terms and conditions.

1. A nesting survey for southwestern willow flycatcher, western yellow-billed cuckoo, and/or Yuma clapper rail by a surveyor with a scientific permit may be necessary prior to saltcedar removal in suitable nesting habitat for one or all of those species (USFS 2014).
2. Similarly, surveys for historical and/or cultural resources by a cultural resource specialist may be necessary prior to saltcedar removal in areas with potential for such resources to be present. Based on the results of such surveys, additional protection and/or mitigation measures may be necessary.

3. Where a nest is found, a no-treatment buffer of 0.25 mile may be necessary around the nest(s) (USFS 2014).
4. Saltcedar treatment and other potentially disturbing activities will be limited to outside of the southwestern willow flycatcher and western yellow-billed cuckoo nesting period (April through September) when within occupied or suitable habitat (USFS 2014).
5. Migratory birds other than the flycatcher may also nest in saltcedar from generally between March through August, and saltcedar treatment during this period should be avoided if possible (USFS 2014).
6. If avoidance of the migratory bird nesting period is not feasible, a qualified biologist can begin migratory bird surveys prior to the nesting season, sampling twice per week throughout the construction period. Nests that do not contain eggs or young can be removed from the planning area. Nests that do contain eggs or young can be flagged for avoidance during removal and enhancement, and removed from the planning area once birds fledge.
7. A qualified biologist may need to develop an environmental awareness training program for all on-site implementation personnel before they begin work on the project. Training should include a discussion of the avoidance and minimization measures that are being implemented to protect biological resources as well as the terms and conditions of project permits.
8. A qualified biologist and/or cultural resources specialist may be required to monitor saltcedar treatment activities during construction when working near sensitive biological and/or cultural resources to avoid risk of impacts.
9. In-water or streambank work may be curtailed during rain events, and revegetation should begin as soon as possible after saltcedar treatment to prevent erosion (Nissen *et al.* 2009).
10. Native vegetation should be avoided to the extent practical (Nissen *et al.* 2009).
11. Litter, debris, unused materials, flagging, equipment, and supplies should be removed regularly from work areas and deposited at an appropriate disposal or storage site.
12. A SWPPP should be established prior to the onset of construction activities and the BMPs in the SWPPP should be implemented as required by the conditions of a National Pollution Discharge Elimination System (NPDES) permit to prevent silt runoff from the construction site.
13. Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, should be restricted to designated staging areas that are away from waterbodies. Proper spill prevention and cleanup equipment should be maintained in all refueling areas, and any spills of hazardous materials should be cleaned up immediately and reported to the appropriate resource agencies within 24 hours.
14. Equipment should be adequately washed before moving it to other work sites to prevent the spreading of weed species.
15. Vehicles should be confined to established access routes, staging areas, and work areas, and such areas should be limited to the minimum necessary to achieve the project goals to avoid soil compaction.
16. Application of herbicide should be closely supervised and in compliance with the conditions of an ADEQ Pesticide General Permit and USFWS (2007) recommended protection measures.

3.11 Maintenance

A three to five year commitment for spot spraying of saltcedar resprouts must be part of any successful treatment project (Dreesen and Fenchel 2009, Sher *et al.* 2010). Monitoring of project sites (see Section 3.12) will reveal resprouting saltcedar and should prompt the application of herbicide before the sprouts become too large.

While the mulching practices described in Section 3.8 are intended to minimize establishment of other secondary weeds, there is potential for secondary weed problems to occur, which would trigger the need for additional herbicide treatment of established and/or spreading invasive perennial weeds. Weeds known to be problematic for vegetation management projects in the region include Canada thistle (*Cirsium arvense*), cheatgrass (*Bromus tectorum*), diffuse knapweed (*Centaurea diffusa*), hoary cress or whitetop (*Cardaria draba*), kochia (*Bassia scoparia*), leafy spurge (*Euphorbia esula*), perennial pepperweed (*Lepidium latifolium*), purple loosestrife (*Lythrum salicaria*), Russian knapweed (*Acroptilon repens*), and Russian thistle (*Salsola tragus*) (CHIP 2008). Annual weeds generally do not preclude native plant establishment but large, dense stands can limit seeding of native species and the survival and growth of small containerized stock (Tamarisk Coalition 2008, Dreesen and Fenchel 2009, Sher *et al.* 2010). If possible, annual weeds should be prevented from going to seed at the end of the first growing season after treatment to reduce weed seed in the soil seed bank before reseeding with native species. Once established, secondary weed treatment can require several years of herbicidal control (Dreesen and Fenchel 2009).

Although one of the objectives of the Plan is to produce vegetation conditions that are self-sustaining in the long-term, and some mortality of plantings is expected, there is the potential that new plantings may require supplemental irrigation and/or soil amendments to ensure survival and success, and ill-suited species may need to be replaced if plant survival or native cover objectives are not being met. Site management, such as fencing to limit livestock grazing or unauthorized access, may be required at enhancement sites, as well irrigation equipment maintenance.

Vegetation management units have been assigned and hydraulically modeled for flood risk reduction based on the expected height and density of the units at vegetation maturity. As such, maintenance, such as trimming, mowing, or clearing, is not anticipated to be needed to maintain the expected or desired level of flood risk reduction.

3.12 Monitoring and Adaptive Management

At a minimum, monitoring of saltcedar treatment and habitat enhancement sites will be needed to identify necessary maintenance activities. Monitoring will identify the location and extent of saltcedar resprouting and determine the need for saltcedar re-treatment. Resprout monitoring and treatment are generally recommended for at least three years. Monitoring at habitat enhancement sites should also document the survival of plantings and determine the need for replacement plantings, alternative species, or alternative planting locations. Survival monitoring is generally recommended for at least three years as well, which is generally the amount of time it takes to determine if plantings have become established. In light of the flood risk reduction objective of the Plan, monitoring of vegetation roughness characteristics (*e.g.*, developing vegetation height and density) and inputting that information into hydraulic models may be needed to demonstrate if vegetation management alone is sufficiently reducing flood risk.

Monitoring will also be necessary to meet the terms and conditions of project permits, which typically require at least five years of annual monitoring. In addition to identifying maintenance needs, permit compliance monitoring is likely to require evaluation of whether implementation-related impacts and loss of habitat from saltcedar removal are being adequately replaced by habitat enhancement plantings. Baseline measurements of the amount of saltcedar present pre-project and the amount of saltcedar removed are likely to be necessary for permit compliance monitoring. For example, it may be necessary to compare the amount of suitable flycatcher nesting habitat that is affected by the project, and the extent of habitat recovery that occurs over the five-year monitoring period. Permit compliance monitoring may require or recommend that surveys for southwestern willow flycatcher, western yellow-billed cuckoo, and Yuma clapper rail be conducted to help evaluate how they respond to habitat enhancement efforts.

Ultimately, post-project monitoring should be used to determine whether individual project objectives have been achieved. This may be accomplished by either maintenance or permit compliance monitoring, but additional monitoring metrics may be needed depending on the specific project objectives. For example, if the objectives are to increase water availability, enhance wildlife habitat, and reduce wildfire risk, three associated monitoring metrics would need to be established and pre- and post-treatment monitoring conducted to determine if the objectives are met. Table 13, which is modified from Parker *et al.* (2005), provides several examples of project objectives and potential associated monitoring metrics. It is important to note that most of these metrics would need to be measured before the project (*i.e.*, baseline monitoring) as well as after in order to determine if project objectives have been achieved. Monitoring plans should be developed before the project starts so that any necessary baseline or pre-project data can be gathered.

Table 13. Potential monitoring metrics to determine if project objectives have been achieved (adapted from Parker *et al.* [2005][A]).

Project Objective	Data to Collect Before and After Project
Reduce/eliminate saltcedar cover	• Measure and/or map saltcedar canopy cover; • Count/density of saltcedar resprouts (after project only); and/or • Establish and take photopoints
Reduce flood risk	• Measure and/or map woody plant cover; • Measure and/or estimate hydraulic roughness of site vegetation; and/or • Model flood hydraulics of site reflecting the changing vegetation conditions
Restore native plant community	• Measure diversity/abundance of native species; • Measure and/or map cover of native species; and/or • Establish and take photopoints
Restore wildlife habitat	• Measure key vegetation for focal wildlife species (focal species are likely to include southwestern willow flycatcher, western yellow-billed cuckoo, and/or Yuma clapper rail, but could include others, such as northern Mexican gartersnake (*Thamnophis eques megalops)* and narrow-headed gartersnake (*Thamnophis rufipunctatus*) depending on site conditions and project objectives) • Survey for focal wildlife species
Increase water supply	• Measure groundwater and surface water levels • Measure water quality

Table footnotes:
[A] Table adapted from Parker *et al.* (2005), which was specific to riparian revegetation. As such, methods, timing, and effectiveness may be different for desert shrub, mesquite bosque, and marsh enhancement projects.

Again, most of the metrics in Table 13 would need to be measured before the project as well as after. Baseline (*i.e.*, pre-project) monitoring will not only be critical in determining if project objectives have been achieved, but can also help determine which project objectives are appropriate for a site. For example, baseline monitoring of vegetation can help determine if suitable habitat for wildlife may be present (and whether BMPs or other protective measures may be necessary; see Section 3.10) and provide a point of comparison as vegetation conditions change as a result of saltcedar removal and habitat enhancement. Baseline vegetation monitoring plots that are surveyed each year can be used to determine what was there before restoration, if saltcedar is resprouting, which secondary weeds may be establishing, and how habitat enhancement plantings perform. Similarly, a pre-project inventory of wildlife (*e.g.*, endangered species, other birds, reptiles, *etc.*) can be conducted at project sites to provide a baseline of what species are there before saltcedar removal and how wildlife responds to habitat enhancement. For projects undertaken as a part of this Plan, repeat monitoring to identify how developing vegetation conditions may influence or conflict with flood risk reduction objectives will also be necessary. The kind of evidence that can be established from repeat vegetation and wildlife monitoring may be critical to long-term funding and permitting, to demonstrate how projects implemented under the Plan are performing. If projects are not performing as anticipated in project permits or funding proposals, then repeat monitoring can help identify what changes to project specifications (*e.g.*, saltcedar removal methods, habitat enhancement planting species or methods, *etc.*) can be made to ensure they perform as desired. Installation of groundwater monitoring wells will also be an important component of baseline monitoring at some project sites, to determine depths to groundwater and what plant species will be able to persist at the site.

Ideally, monitoring should also be used to understand the reasons for project success or failure, so that projects can be adaptively managed and future projects can benefit for this improved understanding (Parker *et al.* 2005, Nissen *et al.* 2009). This may require as-built monitoring (to determine if a project was implemented as designed), shallow groundwater monitoring, flood inundation measurements, *etc.* and analysis that links such monitoring to planting survival. Adaptive management monitoring can also be used to, among other things: compare the effectiveness of treatment and revegetation methods to inform future restoration efforts; evaluate patterns of saltcedar defoliation and mortality following tamarisk beetle colonization; and determine how species are responding to habitat enhancement and/or tamarisk beetle colonization.

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Appendix A

Vegetation Management Units Maps

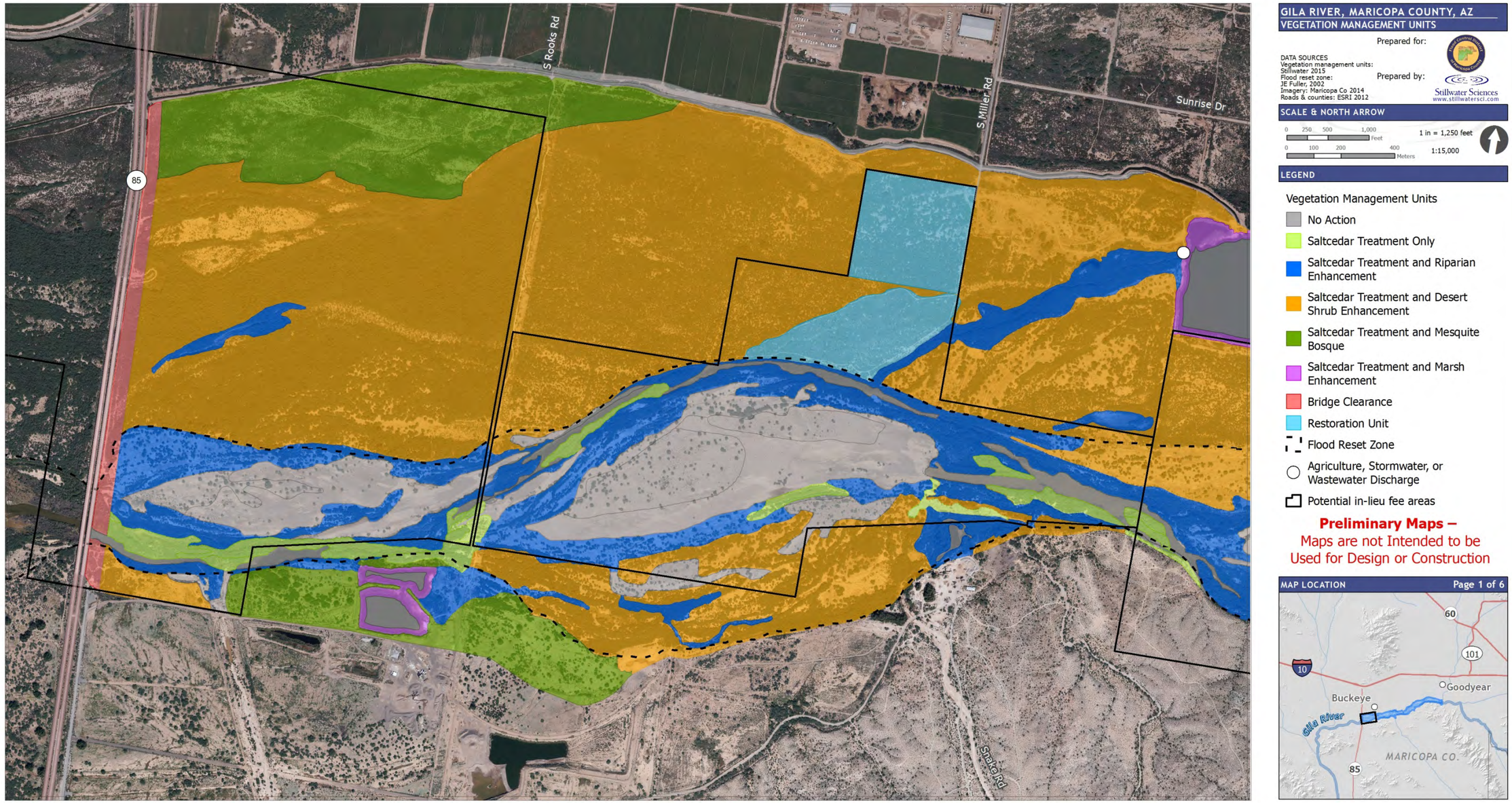


Figure A-1. Vegetation management units map (tile 1 of 6) of the planning area.

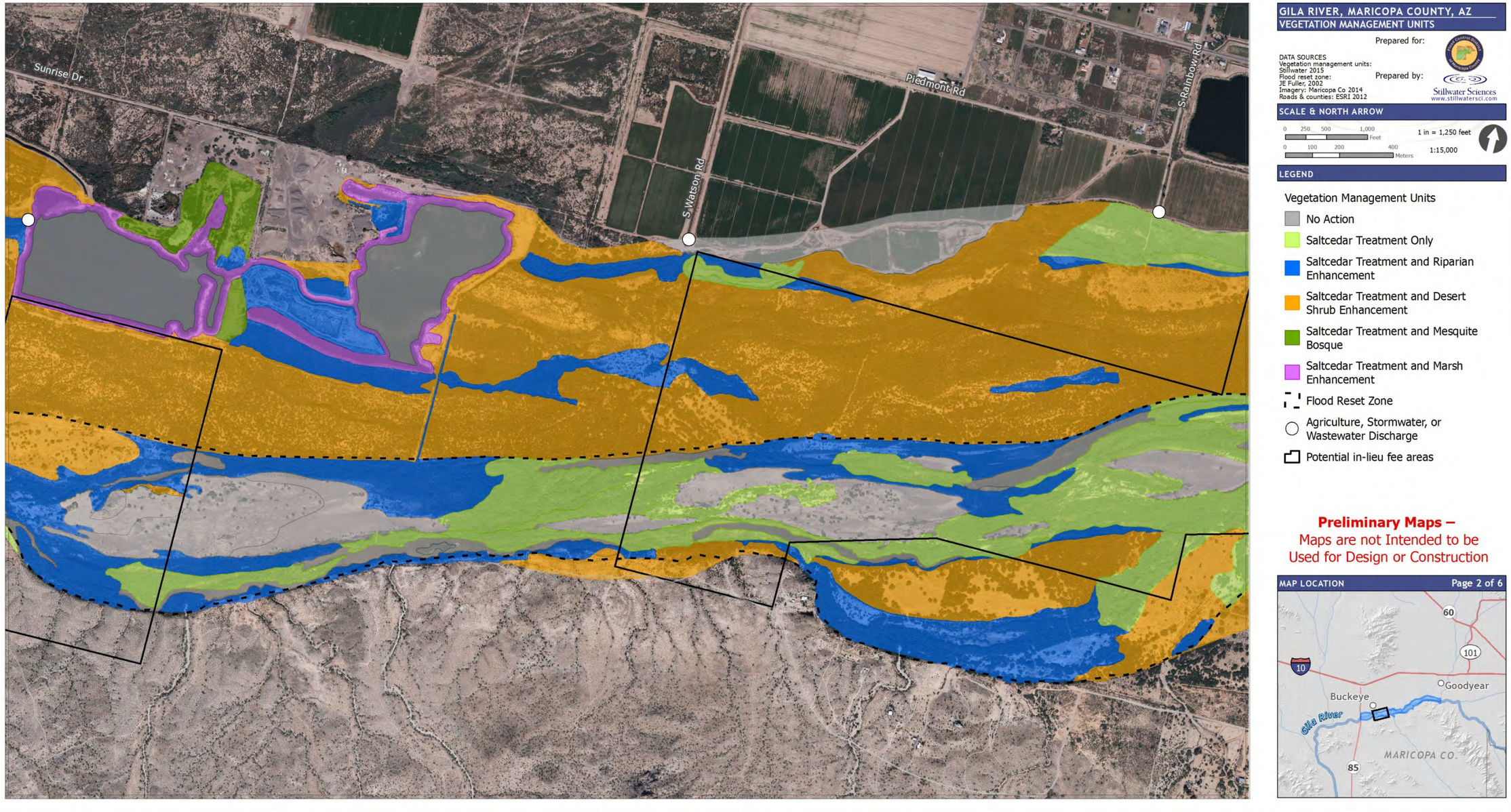


Figure A-2. Vegetation management units map (tile 2 of 6) of the planning area.

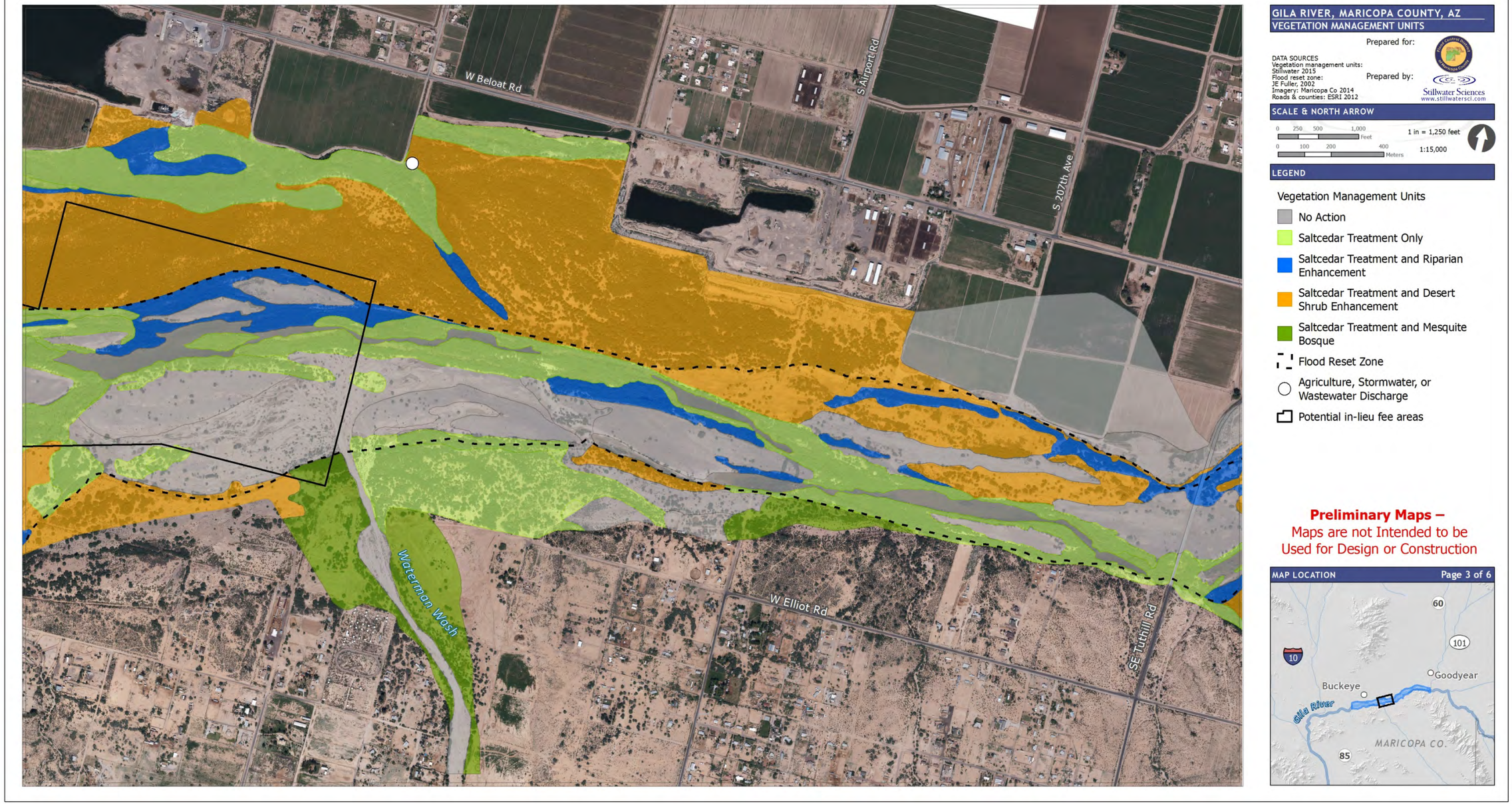


Figure A-3. Vegetation management units map (tile 3 of 6) of the planning area.

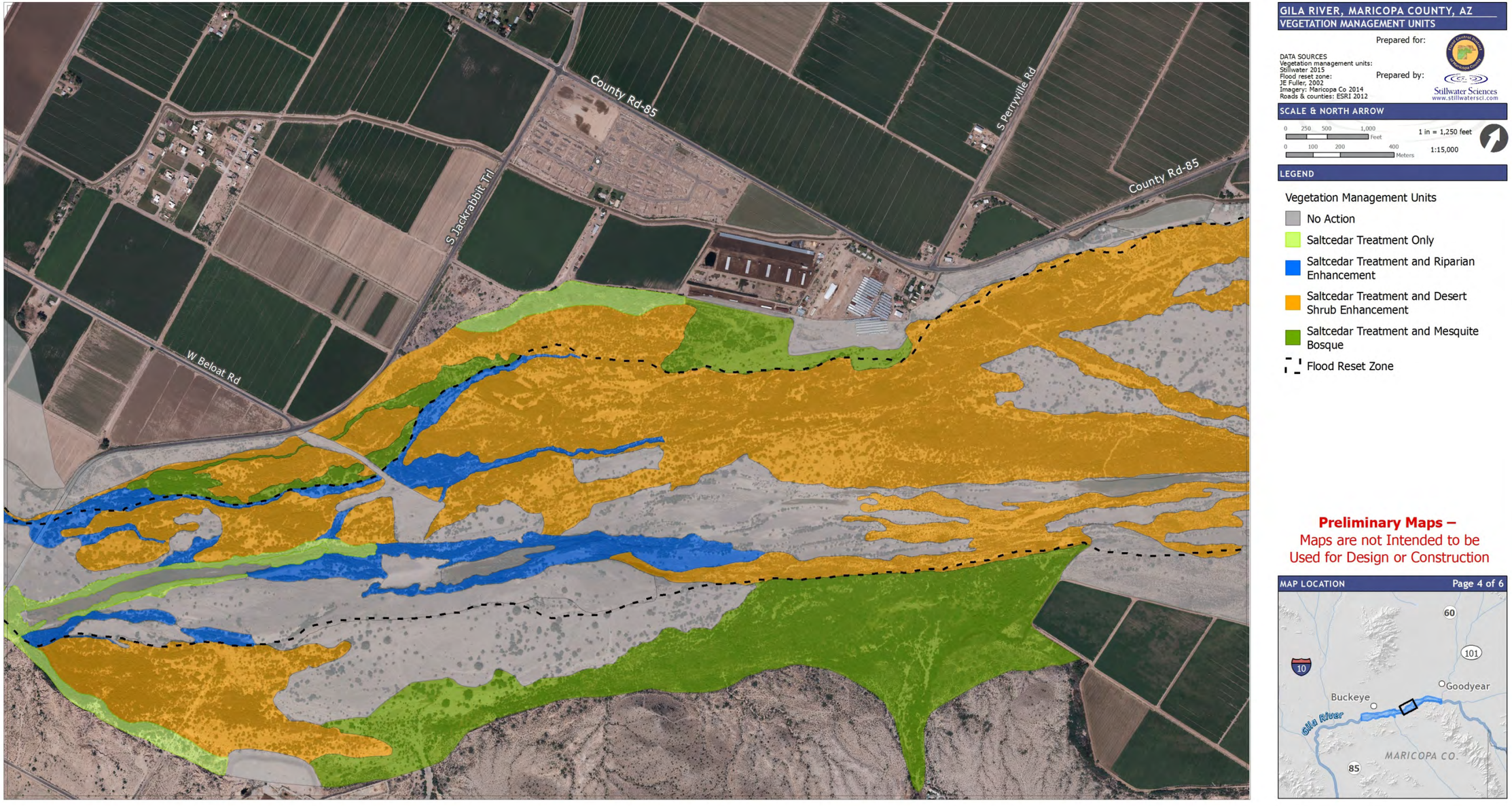


Figure A-4. Vegetation management units map (tile 4 of 6) of the planning area.

Figure A-5. Vegetation management units map (tile 5 of 6) of the planning area.

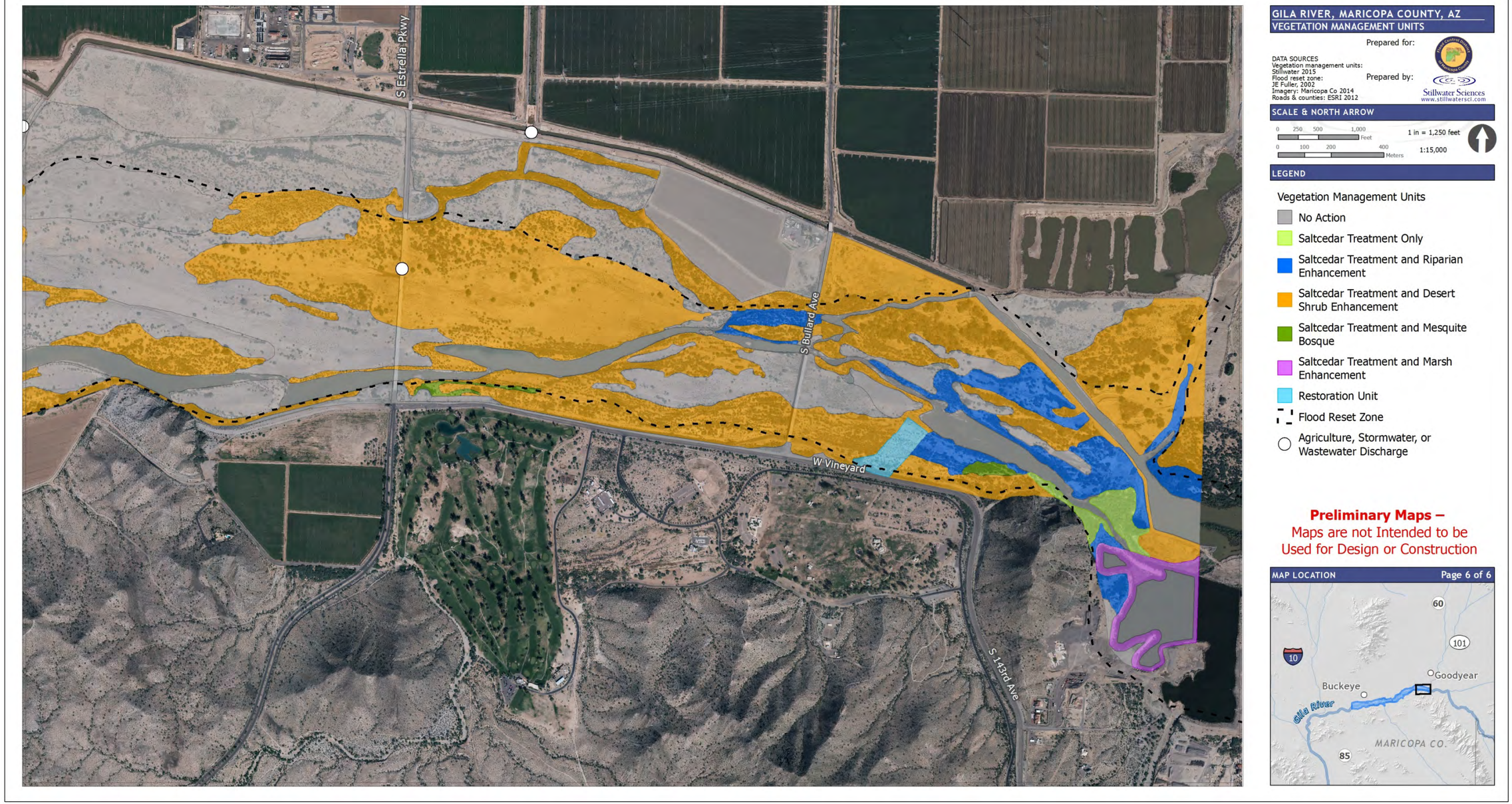


Figure A-6. Vegetation management units map (tile 6 of 6) of the planning area.

Appendix B

Vegetation Management Units under Altered Land Use Conditions Maps

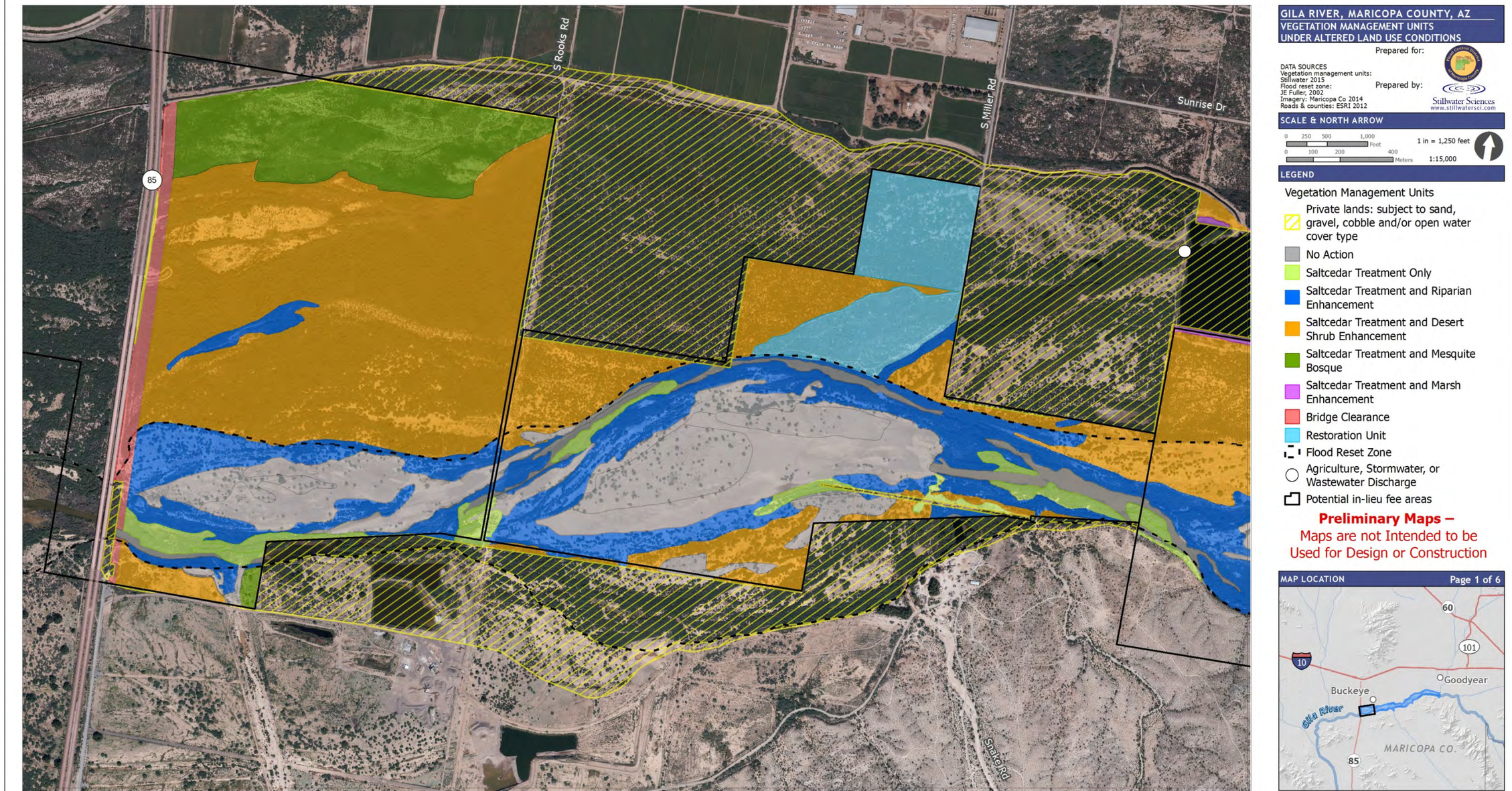


Figure B-1. Vegetation management units under altered land use conditions map (tile 1 of 6) of the planning area.

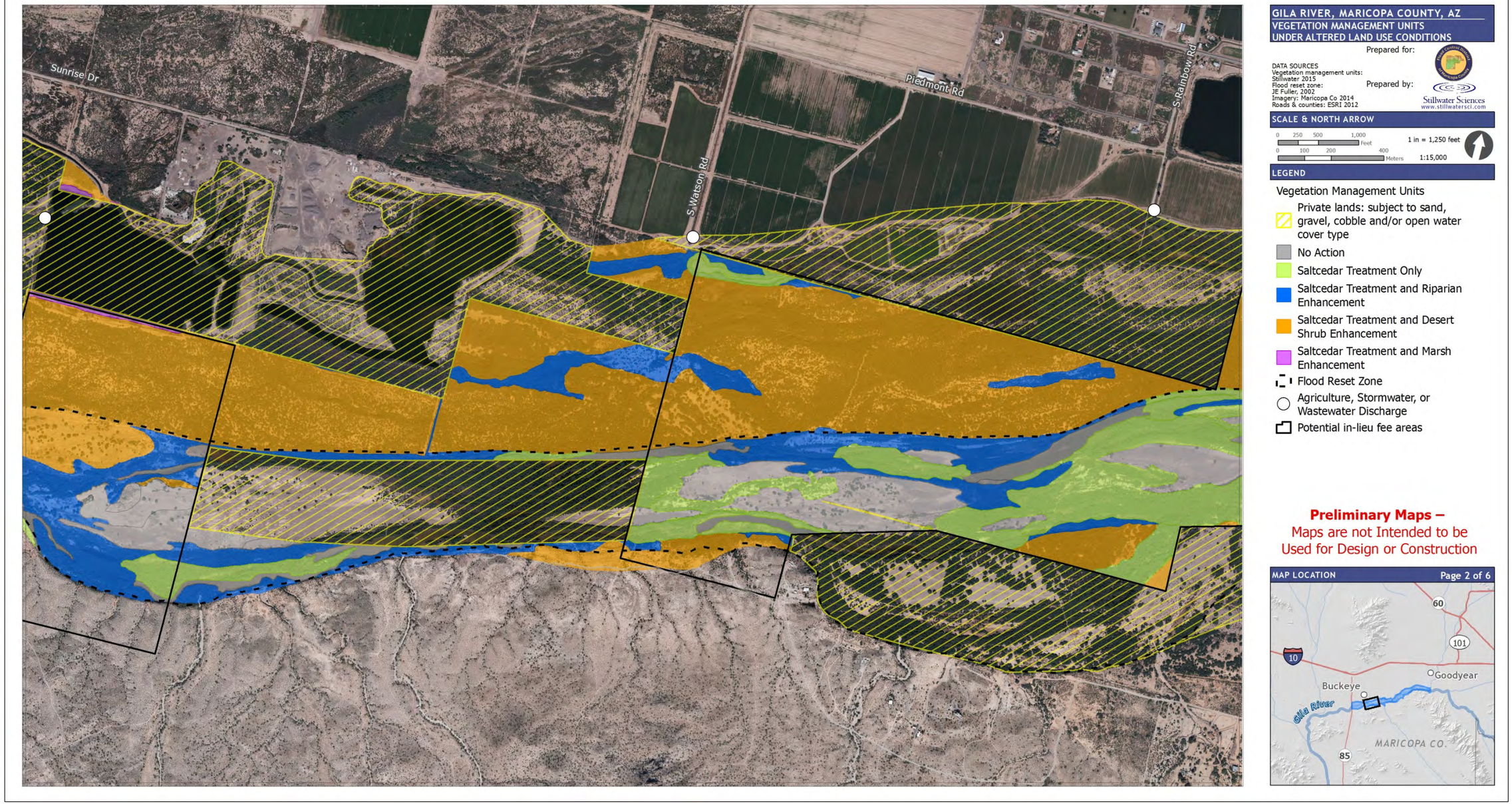


Figure B-2. Vegetation management units under altered land use conditions map (tile 2 of 6) of the planning area.

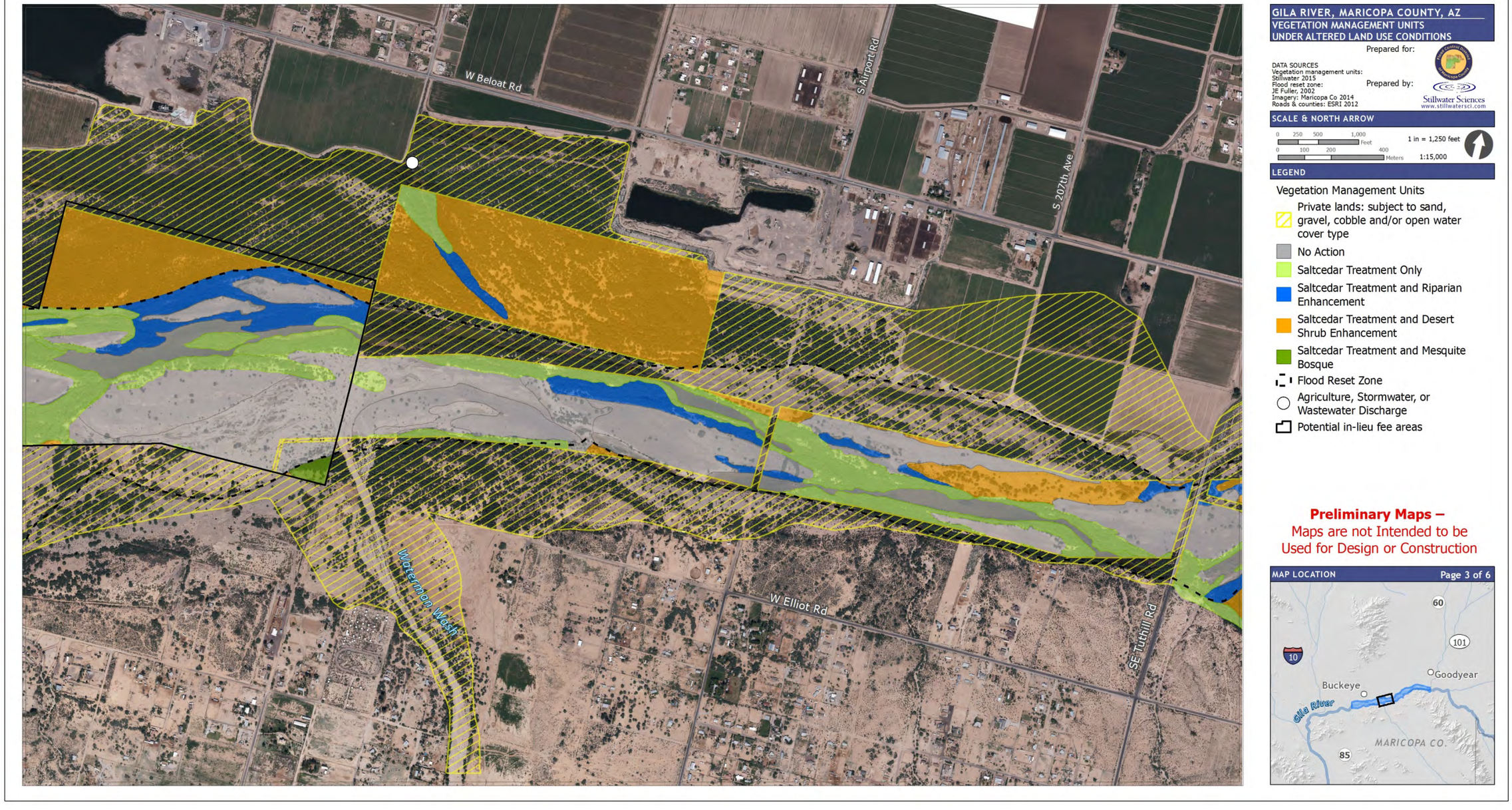


Figure B-3. Vegetation management units under altered land use conditions map (tile 3 of 6) of the planning area.

Figure B-4. Vegetation management units under altered land use conditions map (tile 4 of 6) of the planning area.

Figure B-5. Vegetation management units under altered land use conditions map (tile 5 of 6) of the planning area.

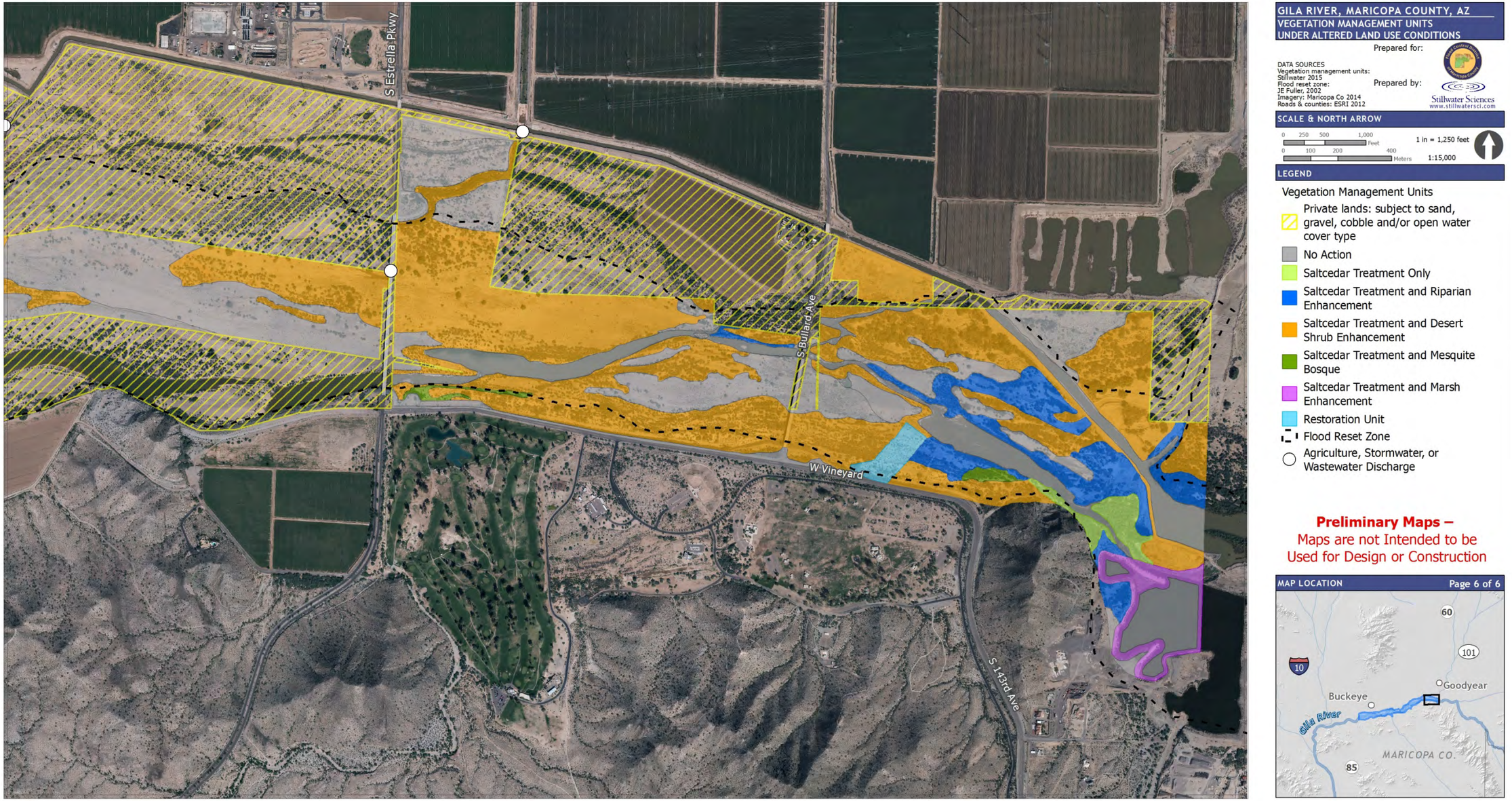


Figure B-6. Vegetation management units under altered land use conditions map (tile 6 of 6) of the planning area.

Appendix C

Permitting Requirements

1 INTRODUCTION

This appendix provides additional information about the potential permitting requirements of actions undertaken as a part of Plan implementation that are summarized in Section 3.6. As introduced in Section 3.6, the approach taken to comply with Section 404 of the Clean Water Act (CWA) will influence many aspects of the permitting process, including timing and level-of-effort. As such, options for Section 404 compliance are presented first.

It is important to note that informal and formal communications with the permitting and resource agencies—U.S. Army Corps of Engineers (USACE), U. S. Fish and Wildlife Service (USFWS), Arizona State Historic Preservation Office (SHPO), and Arizona Department of Environmental Quality (ADEQ)—and affected landowners will be critical to completing the permitting process in a timely manner. A pre-application meeting, in particular, held at either a potential project site or the lead agency's office, is an efficient way of making the agencies aware of the project, describing it to them, and soliciting and receiving agency input on the project before the project description is finalized and permit applications have been submitted. This is also the time when the permitting agencies specify the information that will be required and offer suggestions for measures that can be taken by the project proponent to avoid or minimize impacts and streamline the permitting process. The discussion points and outcomes of any such communications and meetings should be recorded and included as part of the permitting and project administrative record.

2 CLEAN WATER ACT SECTION 404

The objective of the CWA is to restore and maintain the integrity of the nation's waters, including wetlands. Section 404 of the CWA requires that project proponents receive a permit from the USACE to discharge dredged or fill materials into jurisdictional waters of the U.S., including wetlands. Permits can also be required for the operation of heavy machinery in jurisdictional waters and wetlands.

The lower Gila River is a jurisdictional water of the U.S., and removal of saltcedar using heavy machinery and any grading are activities subject to USACE jurisdiction. Based on the scope and objectives of the Plan, there are three primary options for Section 404 permitting. One option is that USACE establishes a Regional General Permit (RGP) that would cover removal of saltcedar and other nonnative, invasive plants across a geographic range that includes the planning area, such as Maricopa County, so long as permit terms and conditions are complied with. An RGP for saltcedar removal in the planning area does not currently exist, so it is not currently a viable permitting option, but the District is working to have one established. Current viable options for Section 404 permitting are that project proponents apply for an Individual or General Permit or apply for coverage under a Nationwide Permit (NWP; the most applicable is NWP #27, for habitat restoration).

Given the benefits and disadvantages of Section 404 permitting options (which are discussed below), it is likely that a combination of these options will be needed: (1) the RGP process can be initiated as soon as possible to streamline permitting of Plan activities in the future, but (2) Individual Permits or NWP coverage can be used to permit projects that are ready for implementation prior to RGP authorization. If a project undertaken as a part of Plan implementation is ultimately determined to be outside of USACE's jurisdiction (e.g., all actions

would occur outside of waters of the U.S., including wetlands) then a Section 404 permit would not be required.

2.1 Individual Permit

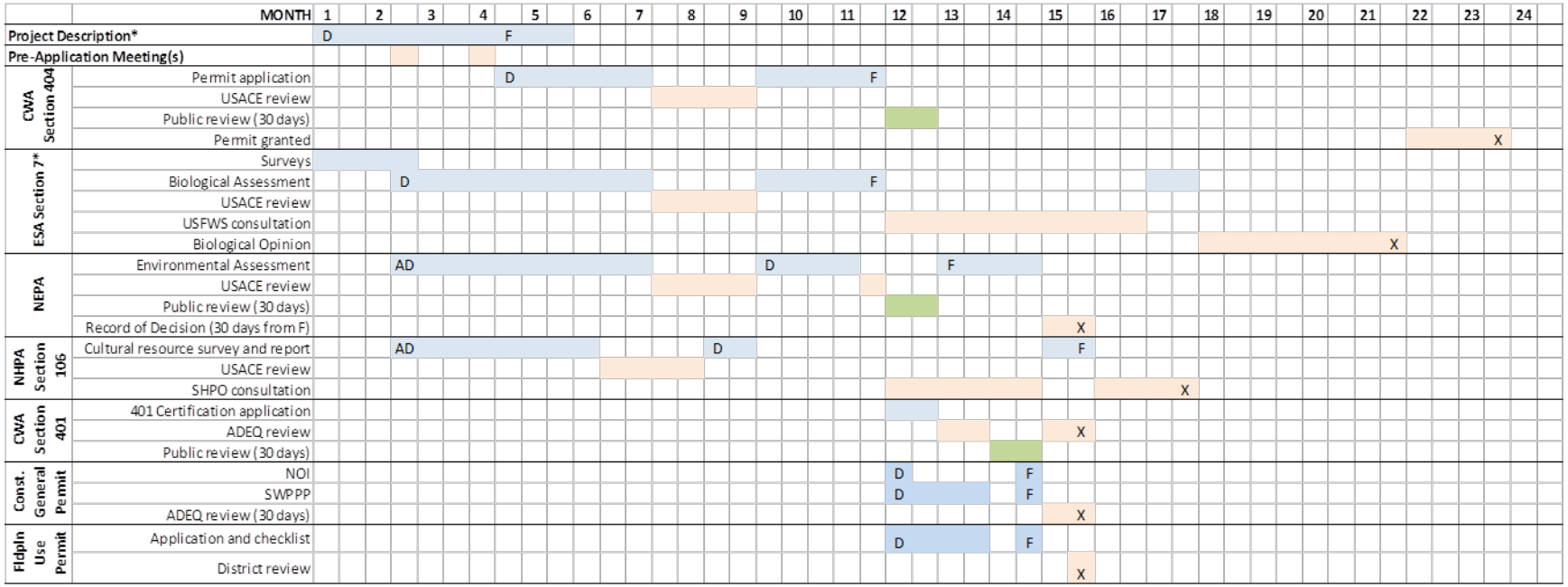
Individual Permits generally require the following steps and processes:

- An individual project proponent submits an application for a USACE permit (USACE ENG Form 4345), detailed project description (see Section 2.4 below for more detail), delineation of USACE jurisdiction (see Section 2.5), a project-specific Biological Assessment for USFWS consultation (see Section 3), and a project-specific cultural resources report for SHPO consultation (see Section 5).
- Any comments received on the application materials are addressed by the project proponent.
- Once the application materials are considered complete, USACE issues a 15-day public notice and, optionally, holds a public hearing. Comments received during this period are addressed by the project proponent.
- USACE consults with USFWS and SHPO, and Section 401 water quality certification is obtained from ADEQ. (These regulations and requirements are discussed in greater detail in the sections below.)
- A National Environmental Policy Action (NEPA) compliance document (see Section 4) and a more detailed analysis of alternatives referred to as 404(b)(1) guidelines are prepared (to facilitate timely processing of the permit application, project proponents often prepare these materials on behalf of USACE). A mitigation and monitoring plan may also be required if there may be permanent impacts to waters and wetlands. The NEPA document and consequent findings also require public review periods.

The primary drawback of using Individual Permits for Plan activities is the amount of time necessary to prepare all the required materials and conduct public reviews. The primary benefit is that Individual Permits can cover longer time periods than other Section 404 permitting options. Figure B-1 provides an estimated schedule for acquiring an Individual Permit, although this could be much shorter if there are no listed species or cultural resources issues.

Costs to prepare Individual Permit applications (there is no permit fee) can range widely, depending on the size and potential impacts of a project. For projects implemented under the Plan, the cost to prepare and process an Individual Permit application (not including other required permitting) is roughly estimated to range from $5,000–$20,000.

Figure B-1. Potential timeline for preparing and acquiring an Individual Permit



Legend:

*	Critical path item	AD	Administrative draft document preparation
	Project proponent activity	D	Draft document preparation
	Permitting agency activity	F	Final document preparation and submittal
	Public review period	X	Agency decision/permit granted

2.2 Regional General Permit

RGPs are issued on a regional basis and can cover a suite of activities or project types under a relatively large geographic area. For example, USACE has an RGP for nonnative invasive vegetation removal in their southern California region. RGPs may only be issued following the publishing of a public notice, and preparation of a decision document to ensure that the activities authorized under the RGP cause only minimal individual and cumulative environmental impacts. RGPs typically contain conditions to further ensure that environmental impacts are minimal during the implementation of activities that are covered by the RGP, including conditions for the submittal of a permit application prior to activities occurring within waters of the U.S.

Permitting under an RGP would require that the USACE Los Angeles District, Phoenix office first authorize an RGP that covers Plan activities and the planning area (at a minimum). This process would likely include the following steps and processes:

- Developing a detailed description of the activities and geographic area to be covered under the RGP.
- Consultations with USFWS, SHPO, and ADEQ under the Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), National Historic Preservation Act (NHPA), and Section 401 of the CWA to determine appropriate terms and conditions for the RGP to ensure that projects implemented under the RGP will be in compliance with these laws.
- A public interest review that includes preparation of an appropriate NEPA document and circulation of the document for public review (see Section 4 below).
- Once the final NEPA document is adopted and a Record of Decision issued, USACE would authorize the RGP.

All told, it may take two years for an RGP to be authorized. Like all other Section 404 permits, RGPs are typically valid for five years, so USACE would need to reauthorize the RGP every five years. Reauthorization of RGPs is typically much more streamlined than the initial application process.

Once the RGP is in place, the District or another project proponent (e.g., the City of Buckeye) planning to implement a project under the Plan and that is covered by the RGP, would submit a concise letter to USACE describing the basic elements of the project and ways in which the project is authorized by and complies with the terms and conditions of the RGP, as well as a delineation of USACE jurisdiction (see Section 2.5 below), a project-specific Biological Assessment for USFWS consultation (see Section 3 below), a project-specific cultural resources report for SHPO consultation (see Section 5 below), and Section 401 certification from ADEQ (see Section 6 below). The District is currently working to produce planning-area wide resources to assist individual project proponents with these aspects of permitting, including suitable habitat modeling for endangered species to determine where surveys may or may not be necessary.

The primary drawback of an RGP is the initial time—upwards of two years (not unlike the schedule for an Individual Permit in Figure B-1)—that is necessary for it to be authorized. The primary benefit, however, is that the initial effort should greatly streamline permitting of

individual actions/projects that are covered by the RGP, no matter who the project proponent is. The timeline for permitting a project under the RGP is likely to be similar to that under a NWP (see Section 2.3 below). The cost to permit an individual project under an RGP (not including other required permitting) is roughly estimated to range from $3,000–$8,000.

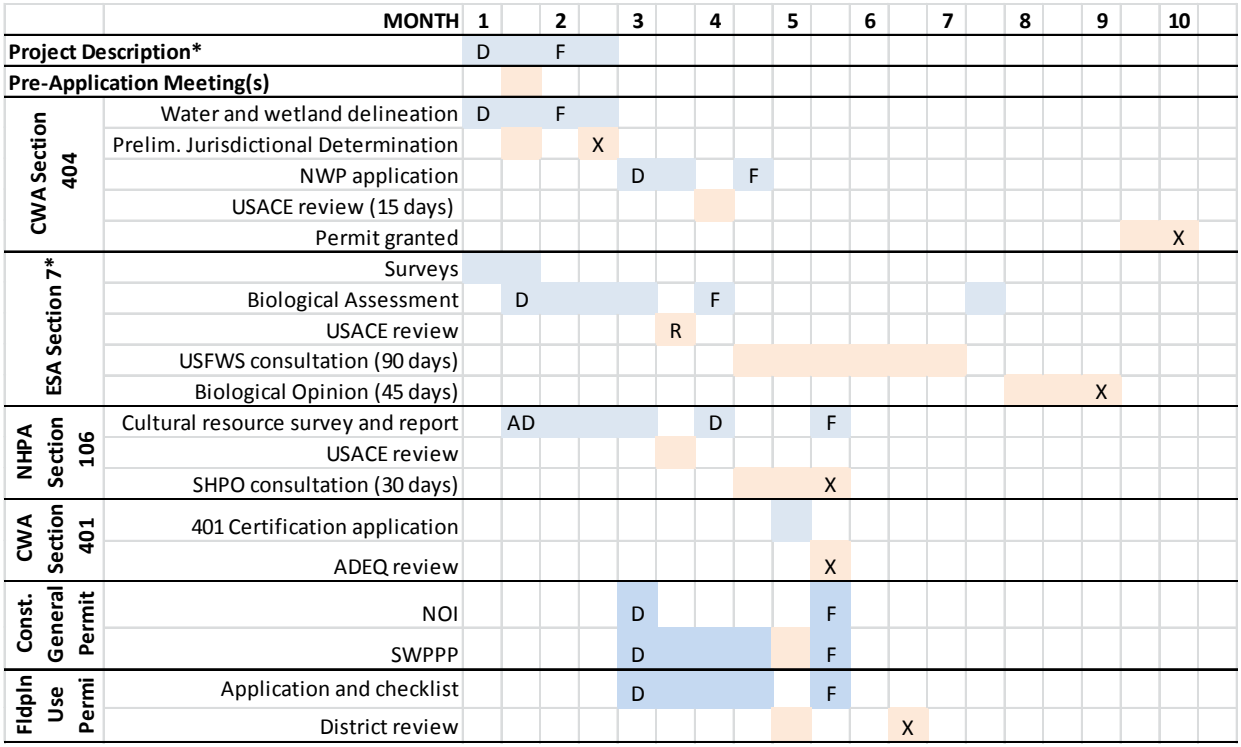
2.3 Nationwide Permit

NWPs are a more streamlined option for Section 404 compliance, without the need for a NEPA compliance document, 404(b)(1) analysis, or a public review period. Activities under the Plan that include habitat enhancement are likely to qualify for a NWP #27 for Aquatic Habitat Enhancement. Permitting of individual projects under the Plan and under a NWP would include the following steps and processes:

- An individual project proponent would submit a Pre-Construction Notification (PCN) application (USACE ENG Form 4345), detailed project description (see Section 2.4 below for more detail), delineation of USACE jurisdiction (see Section 2.5 below), a project-specific Biological Assessment for USFWS consultation (see Section 3 below), a project-specific cultural resources report for SHPO consultation (see Section 5 below), and Section 401 certification from ADEQ (see Section 6 below).
- Any comments received on the application materials would need to be addressed by the project proponent.
- USACE would consult with USFWS and SHPO, and Section 401 water quality certification would be required from ADEQ. (These regulations and requirements are discussed in greater detail in the sections below.)
- Once confirmation of compliance with all other relevant laws is received by USACE, they would verify coverage under the NWP and on-the-ground work could begin, subject to the permit terms and conditions. NWPs can be authorized for up to five years. If the project is not completed before the NWP expires, then reauthorization under the NWP would be necessary.

The primary drawback of using NWPs for Plan activities is that only particular project types are covered. While projects that include habitat enhancement as a goal can be covered under NWP #27, there are not currently NWPs available that would cover activities without a habitat enhancement component, such as removal of saltcedar without subsequent revegetation. The primary benefit, however, is that authorization under NWPs typically requires less than one year (see Figure B-2), and may only take a few months if there are no listed species or cultural resources issues. During implementation, individual projects would need to comply with the terms and conditions of the NWP and any other project permits. The cost to permit an individual project under an NWP (not including other required permitting) is roughly estimated to range from $3,000–$8,000.

Figure B-2. Potential timeline for preparing and acquiring a NWP or coverage under an RGP



2.4 Project description

A written description of the project to be implemented, accompanied by maps and drawings, is required for Section 404 permitting and key to nearly every other regulatory process. The project description must be well-articulated in sufficient detail before an assessment of potential project-related effects and completion of permit applications can be produced. The schedules in Figures B-1 and B-2 assume that 10–30%-level engineering designs, or equivalent project details if engineering designs are not needed, are available at Month 0. These would be translated to a draft project description with associated graphics in Months 1 and 2. Site-specific assessments and consequent project designs will be needed to develop the necessary level of detail for the project description. The project description would then be revised or refined in response to input from the permitting agencies. The schedules in Figures B-1 and B-2 assume that the project description would not change materially during the course of the permitting phase or after permits have been acquired. Such changes generally result in significant schedule delays if they require re-analysis of potential impacts and re-submittal of materials to the permitting agencies, or re-starting permit review phases.

The following information must be provided in the project description that accompanies a 404 permit application. As a general rule, project descriptions submitted to various permitting agencies should be consistent with one another, if not exactly the same.

- Complete written description of activity
- Location
- Scheduling of the activity
- Type and quantity of structural materials used or removed
- Purpose of proposed activity
- Need for the proposed activity
- Maps and drawings (there are USACE standards for those that accompany the 404 permit and ADEQ standards for those that accompany the 401 Certification application)
- Photographs of the project site (aerials if available)
- Type of material to be dredged or used as fill
- Composition of material to be dredged or used as fill
- Quantity of material to be dredged or used as fill in cubic yards
- Method of dredging, if applicable
- Plans and location for disposal of the dredged material
- Dimensions of the fill area in square yards
- Location of the discharge site
- Source of the fill material
- Method of discharging material
- Method of transportation of dredged material
- Dimensions of the adjacent structures
- Proposed use of fill area, including specific structures to be erected on fill area or platform

The cost to develop a sufficiently detailed project description is roughly estimated to range from $2,000–$8,000.

2.5 Water and wetland delineation

A water and wetland delineation must be prepared to determine the extent of USACE jurisdiction in a project area, potential impacts to jurisdictional waters and wetlands, and any necessary mitigation. Under any Section 404 permitting option, it is assumed that water and wetland delineations submitted to USACE would be project-site-specific. In other words, the delineation would only cover the property or portion of a property where project access, staging, saltcedar removal, and habitat enhancement would occur. Alternatively, a delineation of the entire planning area could be submitted as a part of an RGP, which could further streamline individual project authorization since project-specific delineations would not theoretically be required. This approach, however, has the potential to conflict with project-specific delineations that may be submitted for other projects in the planning area, such as for gravel mining operations.

The following information must be provided to receive a preliminary jurisdictional determination (PJD) from USACE, complete 404 permitting, and accompany the 401 certification application:

- Delineation of waters of the U.S., including wetlands, in accordance with USACE protocols, guidance, and minimum standards. The delineation should include the full extent of any project activities, including temporary access routes and staging areas, plus a reasonable buffer around those activities (e.g., 100 feet); together these are referred to as the "review area." Delineation of the ordinary high water mark (OHWM) of the Gila River, as well as wetland boundaries, would need to be included.
- Delineation and description of any special aquatic sites within the review area. Special aquatic sites relevant to the El Rio planning area include refuges, wetlands, and stream riffle and pool complexes.
- Functional/condition assessment of wetlands within the review area. Such an assessment is not always required, but it is likely to be if wetlands would be impacted, since the assessment informs the kind of mitigation and mitigation ratios that would be required.

The cost to delineate waters of the U.S. at the site scale and acquire a PJD from USACE is roughly estimated to range from $3,000–$8,000.

3 ENDANGERED SPECIES ACT

The objective of the ESA is to protect critically imperiled species from extinction. If a project, regardless of who is undertaking it, has the potential to directly or indirectly affect a species listed under the ESA or its designated critical habitat, then the project must comply with the ESA. Required compliance activities are dependent on many factors and may range from avoiding habitat for an ESA-listed species, working outside of certain time periods, consulting informally with USFWS, to acquiring an incidental take permit. The involvement, or not, of a federal agency in a project triggers different sections of the ESA, which have very different ESA compliance requirements. If a federal agency is funding or authorizing a project, by allowing a project to occur on federal property or issuing a federal permit for a project, compliance with the ESA occurs via Section 7. Section 7 of the ESA requires federal agencies to consult with USFWS if any project that they are authorizing, funding, or carrying out occurs in the habitat of a species listed under the ESA, and provides a relatively streamlined process for ESA compliance. It is anticipated that nearly every project implemented under the Plan would have some sort of federal nexus, either as a result of receiving federal funds, requiring a federal permit, or occurring on federal property. As a result, the discussion below focuses on Section 7 requirements and processes.

If individual projects under the Plan do not have a federal nexus and could affect listed species or their habitat, compliance with the ESA would need to occur via Section 10. Section 10 requires the preparation and implementation of a Habitat Conservation Plan that describes how the project will be implemented to limit and/or mitigate impacts to species listed under the ESA, and can take far longer and much more effort, depending on the size and complexity of the project, than the Section 7 process. Vegetation management in areas that would require ESA compliance via Section 10 should not be undertaken, in order to protect the ESA-listed species that could be affected and avoid the lengthy and complex Section 10 process.

Independent of both Section 7 and Section 10, project proponents and federal lead agencies can consult informally with USFWS to discuss the project, develop protection measures that will

avoid impacts to listed species and their habitat, and/or determine whether ESA compliance activities are necessary and, if so, the most efficient process for completing them.

3.1 Biological Assessment

Due to the documented occurrences of federally listed species in and around the planning area, consultation with USFWS may be necessary for projects implemented under the Plan, and a Biological Assessment (BA) would be prepared to inform the USACE's (who would be issuing a Section 404 permit) Section 7 consultation process.

The following information is typically required in a BA:

- Summary of species and critical habitat that have potential to occur in the project area and be affected by project activities
- Description of any consultation with USFWS to-date
- Description of the project, including location, timing, construction activities, and conservation measures (see Section 2.4 above)
- Description of the status of the listed species and/or critical habitat in the project area, including the results of any focused surveys for the species
- Description of baseline conditions in the project area
- Analysis of the potential effects of the project on listed species and/or critical habitat, including potential cumulative effects of the project, given the overarching Plan

Under the Section 404 permitting options, the BA would be prepared for the project area by the project proponent, submitted to the USACE for review with the other permit application materials, and then USACE would distribute the BA to USFWS to initiate formal Section 7 consultation for the project. If the BA determines and USFWS concurs that "take" of listed species or their habitat may result from the project, then USFWS would issue a Biological Opinion (BO) that authorizes some level of incidental take of listed species or their critical habitat (incidental to an otherwise lawful activity). The definition of "take" can vary somewhat, but typically refers to the pursuit, injury, killing, or harassment of a wild animal, and can include modification and destruction of the species' habitat. BOs for individual projects will likely include numerous conditions to limit the take of listed species, such as pre-construction surveys, construction monitoring, and mitigation for permanent impacts to listed species habitat, if necessary. These can increase implementation costs significantly. Generally USFWS has 90 days to perform their consultation and 45 days to prepare the BO, but this timeframe would be much longer for a BO that covers the entire Plan, since review and analysis would be more complex. If the BA determines and USFWS concurs that take will not occur, then a BO authorizing take is not necessary and the USFWS will generally provide a letter of concurrence instead.

The cost to prepare a BA and acquire a BO from USFWS for an individual project is roughly estimated to range from $15,000–$30,000.

4 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA establishes policy and goals for the protection, maintenance, and enhancement of the environment. Under NEPA, federal agencies, such as USACE and USFWS, are required to analyze the potential effects of their actions, including permitting and funding, on the environment. This analysis is done via an Environmental Assessment (EA), if significant effects are not anticipated, or an Environmental Impact Statement (EIS). It is anticipated than an EA would be the appropriate document for NEPA compliance for most projects implemented under the Plan. If an EIS was determined to be appropriate, then most aspects of NEPA compliance would be more complex and take more time than the EA process described below. The terms and conditions of RGPs and NWPs are such that no significant impacts on the environment should occur. As a result, NEPA compliance is typically embedded in a RGP or NWP and no NEPA document needs to be prepared.

4.1 Environmental Assessment

The EA would likely be prepared by the project proponent on behalf of the federal lead agency for NEPA, which for projects under the Plan would likely be USACE (since they would be issuing a Section 404 permit)[1]. The following information is typically required to prepare and process an EA for which USACE is the lead agency (33 CFR 325, 40 CFR 1502):

- Prepare the Draft EA, to include:
    - Purpose and need of the project
    - Alternatives analysis that is thorough enough to be used for both the USACE public interest review and 404(b)(1) guidelines
    - Affected environment: a succinct description of the environment of the area(s) to be affected or created by the alternatives under consideration
    - Environmental consequences: an analysis of potential environmental impacts of the alternatives, including the proposed action, any adverse environmental effects which cannot be avoided, the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources
- Publish Notice of Intent to adopt the EA
- Circulate (generally for 15 to 30 days) and receive comments on the Draft EA
- File Draft EA with the U.S. Environmental Protection Agency
- Prepare, circulate, and file Final EA
- Adopt Final EA and prepare Record of Decision

The Migratory Bird Treaty Act (MBTA) makes it unlawful to take or kill individuals of over 1,000 species of migratory bird found in the United States (50 CFR 10.13). The MBTA sets

[1] Other potential lead agencies could be U.S. Bureau of Land Management or USFWS, if Plan activities are being conducted on their lands or with their funding.

seasons and bag limits for hunted species and protects migratory birds, their occupied nests, and their eggs (16 USC 703, 50 CFR 21, 50 CFR 10). In accordance with the MBTA, potential impacts of projects to migratory birds should be assessed as part of a project EA. If no EA is required, then potential impacts under the MBTA can be assessed as part of a project BA. In Arizona, most bird species are protected under the MBTA.

Although bald eagles were removed from the federal list of threatened and endangered species on August 9, 2007, and are no longer protected under the ESA, they remain protected under the Bald and Golden Eagle Protection Act (16 USC 668) enacted in 1940. The Bald and Golden Eagle Protection Act prohibits anyone without a permit issued by the Secretary of the Interior from taking, possessing, or transporting eagles, including their parts, nests, or eggs. An assessment to determine whether a project has the potential to non-purposefully take eagles is generally conducted as part of a project EA, but can be included in a project BA if no EA is required. Based on the assessment, the need for a take permit for eagles is evaluated.

The cost to prepare and process an EA for an individual project is roughly estimated to range from $30,000–$50,000.

5 NATIONAL HISTORIC PRESERVATION ACT

Similar to Section 7 of the ESA, Section 106 of the NHPA requires federal agencies to consult with SHPO if any project that they are authorizing, funding, or carrying out may affect historic, cultural, and/or archaeological resources. Consultation with SHPO, which is initiated by USACE as a part of the Section 404 permitting process, typically requires:

- A search of the Arizona State Museum online database (AZSITE) for previously recorded archaeological sites with the project review area
- A cultural resource survey of the project review area to identify any historic, cultural, and archaeological sites that may be present and evaluate the potential for adverse effects of the project on any previously recorded or surveyed sites.
- Submittal of the resulting cultural resources report, meeting SHPO (2012) standards, to SHPO for a 30-day review period.

As with ESA consultation, SHPO consultation can result in numerous conditions to limit risks to cultural resources. Due to the density of saltcedar in much of the planning area, pedestrian surveys of many project areas may not be possible and, as a result, an on-site cultural monitor may be required during ground disturbing activities. This can increase implementation costs significantly. The cost to conduct the cultural resource surveys and prepare a report for an individual project is roughly estimated to range from $5,000–$8,000.

6 CLEAN WATER ACT SECTION 401

When a Section 404 permit is required and there is potential for Plan activities, such as removal of saltcedar using heavy equipment, to affect surface water quality, 401 Certification for CWA Section 401 compliance would be necessary. Section 401 of the CWA requires project proponents

to "certify" that any discharge subject to Section 404 will comply with Arizona water quality standards. Certifications can also require mitigation and sediment testing and/or monitoring during and after construction. The following information is required for the 401 certification application:

- Application form
- Project description
- A topographic or contour map of the project area
- Plans or drawings to illustrate the project
- A map delineating the OHWM of jurisdictional waters to be affected by the project (see Section 2.4)
- A copy of the 404 Permit application
- Description of the measures that will be taken to demonstrate compliance with state surface water quality standards

These materials are typically prepared and submitted to ADEQ during the 404 permit public review period and, as a part of their 401 certification review, ADEQ may issue a public notice that provides the public with the opportunity to comment on the ADEQ certification. ADEQ certification can come with conditions that specify limitations and/or best management practices that must be undertaken by the project to ensure state water quality standards are not violated.

The cost to prepare a 401 certification application (assuming the necessary supporting materials, such as the project description and delineation of the waters of the U.S., have been completed) is roughly estimated to range from $2,000–$8,000.

7 STORMWATER CONSTRUCTION GENERAL PERMIT

Stormwater and other discharges from construction sites are overseen by ADEQ under the Arizona Pollutant Discharge Elimination System (AZPDES) permitting program. If a project will disturb greater than one acre, or is a smaller part of a larger development that will disturb at least one acre, then the project needs to obtain an AZPDES General Permit for Stormwater Discharges Associated with Construction (referred to as a Stormwater Construction General Permit). This permit is not required if a project is entirely within USACE's Section 404 jurisdiction. Project proponents submit a Notice of Intent (NOI) to the ADEQ. The NOI is a three-page document that requires:

- Construction site location
- Estimated start date and duration of construction
- Name and location of receiving water for runoff
- A confirmation that a stormwater pollution prevention plan (SWPPP) has been completed
- Payment of a fee (for projects over 50 acres the fee is $500)

Because the Gila River within the planning area is listed as an impaired Arizona Water, the SWPPP must be submitted to ADEQ with the NOI. The purpose of the SWPPP is to identify controls and procedures to minimize the negative impacts from stormwater discharges to the environment. Controls minimize runoff from the project site and procedures identify and describe the implementation of stormwater management Best Management Practices (BMPs).

The SWPPP must include:

- Project contact information
- Site and activity description, and site maps
- Identification of potential pollutant sources and description of pollutant controls
- Maintenance and inspection procedures
- Records of inspections and follow-up maintenance of BMPs
- SWPPP amendments and SWPPP certification

The fee for ADEQ to review the SWPPP is $1,000 (this is in addition to the fee associated with the NOI described previously). Following submittal of the NOI and SWPPP, the ADEQ has 30 days to notify the applicant if the SWPPP needs revisions or if permit coverage is granted or denied. Although the permitting schedules in Figures B-1 and B-2 show the Stormwater Construction General Permit being obtained far in advance of the Section 404 permit, in actuality it can be obtained just before construction starts; no other permit is dependent on it.

The cost to prepare a SWPPP for an individual project is roughly estimated to range from $5,000–$10,000.

8 FLOODPLAIN USE PERMIT

Any construction within the floodplain requires a Floodplain Use Permit from the District, or relevant local municipality, including projects undertaken by the District. The use permit ensures that the project complies with the Floodplain Regulations for Maricopa County, which regulate the construction of buildings and other improvements within designated floodplains to alleviate the upstream or downstream impacts of such improvements on flood risks.

To obtain a floodplain use permit, project proponents would need to submit an application and a checklist, which insures completeness of the application. The application needs to include:

- Project description
- Site plan, plot plan, and grading and drainage plan (these are detailed plans showing all project elements and flood elevations)

Since Plan activities are being undertaken to reduce flood risk, it is anticipated that engineering analyses and submittal of materials to Federal Emergency Management Agency would be unnecessary.

The fees associated with a Floodplain Use Permit are waived for projects undertaken by the District. Although the permitting schedules in Figures B-1 and B-2 show the Floodplain Use Permit being obtained far in advance of the Section 404 permit, in actuality it can be obtained just before construction starts; no other permit is dependent on it.

9 LONG-TERM MITIGATION-BENEFIT STRATEGY

Section 404 permitting and ESA Section 7 compliance can require mitigation to compensate for impacts to USACE-jurisdictional waters and wetlands and endangered species habitat, respectively. If compensatory mitigation is necessary to offset unavoidable impacts to water, wetland, or biological resources subject to USACE and USFWS jurisdiction, the amount of required compensatory mitigation must be sufficient to replace lost resource functions (USACE 2008). A minimum one-to-one acreage or linear foot compensation ratio (i.e., a 1:1 mitigation ratio; one acre of mitigation for every one acre of impact) may be used to determine the amount of mitigation necessary. Commonly, however, USACE requires mitigation at a ratio greater than 1:1; temporal loss, the difficulty of restoring the aquatic resource type, the distance from the impact site, and other factors affect how much compensatory mitigation may be required (USACE 2015[2]).

Implementation of the Plan, or individual projects under the Plan, may have short-term, construction related impacts to waters or wetlands that are subject to USACE jurisdiction, as a result of ground disturbance, as well as suitable habitat for species listed under the ESA, as a result of noise and habitat loss. Although the primary objective of the Plan is to reduce flood risk, implementation of the Plan should also benefit biological resources in the long-term, by replacing nonnative saltcedar with native species, particularly where native vegetation sufficiently replaces the habitat structure and cover that was provided by the removed saltcedar. Table B-1 provides a coarse estimate of the amount of habitat that is anticipated to be created or enhanced by implementation of the Plan. The benefits listed in Table B-1 should make Plan activities "self-mitigating" since they will offset, or compensate, the short-term, construction related impacts. As such, a detailed Mitigation and Monitoring Plan is not anticipated to be required for Section 404 or ESA permitting of the Plan (additional detail is provided in Section 10 below in case it is).

Mitigating for potential loss of habitat structure as a result of saltcedar removal would be most efficiently accomplished by enhancing habitat on the in-lieu fee (ILF) lands in the planning area. Under an in-lieu fee mitigation program, permittees provide funds to an in-lieu fee program sponsor for habitat creation and enhancement, instead of implementing permittee-responsible mitigation or purchasing credits from a mitigation bank. The ILF lands in the planning area are primarily federally owned, but are administered by AGFD, the ILF program sponsor. As the sponsor, AGFD will be able to receive funds (fees) from permittees to cover the costs of saltcedar removal, habitat creation and enhancement, and long-term maintenance and monitoring (which can be funded by using the fees to create an endowment). The ILF program is currently used for

[2] USACE. 2015. Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines for South Pacific Division USACE. Accessed March 30, 2016 at: http://www.spd.usace.army.mil/Portals/13/docs/regulatory/mitigation/MitMon.pdf

Section 404-related mitigation only (i.e., to replace the loss of wetland habitat), but can be used for ESA-related mitigation as well[3] (i.e., to replace the loss of specific habitat types).

Table B-1. Summary of the mechanism for and amount of habitat creation or enhancement anticipated by implementation of the Plan.

Type and Mechanism	Habitat Type	Acres
Habitat Creation: saltcedar treatment and habitat enhancement in areas currently mapped as "disturbed" or "water"	Desert scrub	180
	Marsh	50
	Mesquite bosque	30
	Riparian (cottonwood/willow)	40
	Habitat Creation Subtotal	*300*
Habitat Enhancement: saltcedar treatment and/or habitat enhancement in vegetated areas currently mapped as either saltcedar or a mixture of saltcedar and native species	Desert scrub	2,770
	Marsh	60
	Mesquite bosque	660
	Riparian (cottonwood/willow)	1,440
	Habitat Enhancement Subtotal	*4,930*
Habitat Creation and Enhancement Total		**5,230**

Any habitat creation or enhancement that is conducted on ILF lands is protected in perpetuity, thus meeting one of the more cumbersome requirements of areas that can serve as mitigation by USACE and USFWS. Under this scenario, habitat creation or enhancement funded or conducted on ILF lands could serve as mitigation for short-term construction-related impacts from Plan implementation. Additionally, lands outside of the ILF on which habitat enhancement is undertaken could be added to the ILF program. This could be accomplished by transferring ownership of the land to AGFD or placing the land under a conservation easement that is held by AGFD, and providing a maintenance and monitoring endowment for the land. Exceptions are tribal, other federal, or Arizona State Trust lands; these cannot be incorporated into the ILF program (T. Wade, pers. comm., 2015). Land transfers and conservation easements could be written to allow District to address flood risks or other safety issues that arise in the future, but would otherwise restrict activities on the covered property.

An alternative to the ILF program would be for the District to establish their own mitigation/ conservation bank. A bank is a privately or publically owned large parcel or contiguous parcels of land managed for natural resource values. A mitigation bank mitigates for losses of waters of the United States (CWA Section 404) by protecting, restoring, establishing, and enhancing wetland

[3] While the ILF program can serve as mitigation for multiple regulatory processes, acres of ILF lands used for mitigation under one regulatory process may not be counted or used under any other regulatory process. For example, if a permittee pays for 12 acres of mitigation for impacts under Section 404 of the CWA, there are 12 less acres that may be used to mitigate impacts under the ESA.

and stream habitats. A conservation bank mitigates for impacts to listed species (ESA Section 7) by protecting habitat for threatened, endangered, or special status resources. Credits may be sold by the bank sponsor to project proponents who need to satisfy legal mitigation requirement for environmental impact projects. A detailed planning document (prospectus) and a bank enabling instrument must be prepared. This process includes an agreement between a bank sponsor, bank property owner, and the signatory agencies. Additional requirements may include conservation easements, a property assessment and warranty, and development of a long-term management plan. In light of the ILF program, the effort and cost of satisfying the requirements to establish a bank is not warranted.

An additional alternative would be for the District to use implementation of Plan activities as permittee-responsible mitigation for other District activities. This approach, however, would require that any lands used as mitigation be protected and maintained in perpetuity. As such, this approach would have many of the same requirements as the ILF program, but would make the District responsible for the liability and maintenance requirements of the lands, rather than the AGFD as is provided under the ILF.

10 MITIGATION AND MONITORING PLAN

If, for some reason, the Plan or projects under the Plan are not determined to be self-mitigating, then a mitigation and monitoring plan would need to be developed to demonstrate that additional mitigation will be provided to offset impacts. This plan would then need to be funded, implemented, and monitored by the project proponent. For Section 404 permitting, this requires that a "mitigation statement" be prepared and submitted along with the 404 permit application. The mitigation statement must discuss the amount, type, and location of any proposed compensatory mitigation, including any out-of-kind compensation (e.g., compensation of impacts to emergent wetlands with riparian wetlands), or indicate an intention to use an approved wetland mitigation bank or in-lieu fee program (USACE 2015). If project proponents decide to undertake permittee-responsible compensatory mitigation, rather than invest in the ILF program[4], then the 404 permit application should include, at a minimum, a conceptual mitigation plan. Alternatively, the development of the mitigation plan can wait until USACE has determined the project's compensatory mitigation requirements, but this could result in schedule delays as a USACE-approved final mitigation plan is required prior to commencing work subject to the 404 permit. Although the information in this section stems primarily from guidance provided by USACE, USFWS is likely to have similar requirements, and mitigation related to both Section 404 and ESA Section 7 compliance can be planned, documented, and implemented together.

Based on the conditions in the lower Gila River and activities under the Plan, permittee-responsible mitigation is likely to involve the planting and maintenance of native riparian and wetland vegetation and other restoration actions in currently degraded areas in or nearby to the El Rio planning area (i.e., mitigation via re-establishment, establish, rehabilitation, and enhancement), but could also include preservation. Monitoring plan requirements for these forms of mitigation are lengthy and detailed (see Chapter 4 of USACE [2015]) and include:

[4] The documentation necessary for wetland mitigation bank and in-lieu fee credit purchase is described in the compensatory mitigation and monitoring guidelines that have been recently developed for the USACE South Pacific Division (USACE 2015).

- Objectives and methods of compensation
- Mitigation site selection criteria
- Baseline information about the impact and mitigation sites
- Work plan to implement proposed mitigation (e.g., schedule of planting, species lists)
- Site protection instrument (e.g., conservation easement)
- Maintenance plan
- Ecological performance standards
- Monitoring requirements
- Long-term management plan
- Adaptive management plan
- Final assurances

Permittee-responsible mitigation is ideally implemented prior to the impacts that are being mitigated for and typically required to be monitored for a minimum of five years, with annual monitoring reports to USACE and USFWS.