FEASIBILITY STUDY FOR THE PAJARO RIVER RIPARIAN HABITAT RESTORATION PROJECT

PREPARED FOR:

Santa Clara Valley Habitat Agency
535 Alkire Avenue
Morgan Hill, CA 95037
Contact: Will Spangler
669.258.4246

PREPARED BY:

ICF
980 9th Street, Suite 1200
Sacramento, CA 95814
Contact: Kristin Lantz
916.231.9610

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Contents

Tables

Photographs

Figures

Acronyms and Abbreviations

1D	one-dimensional
2D	two-dimensional
AF	acre-feet
CN	curve number
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	geographic information system
GLO	General Land Office
GPS	global positioning system
HEC-RAS	Hydraulic Engineering Center – River Analysis System
HSG	hydrologic soil group
LiDAR	Light Detection and Ranging
NCIC	North Central Information Center
NWI	National Wetlands Inventory
OHWM	ordinary highwater mark
OSA	Open Space Authority
Preserve or PRAP	Pajaro Ranch Agricultural Preserve
RI	recurrence interval
RCP	Representative Concentration Pathway
SCS	Soil Conservation Service
SCVHA	Santa Clara Valley Habitat Agency
SPFHA	special flood hazard area
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHP	Santa Clara Valley Habitat Plan

Chapter 1
Introduction

1.1 Project Overview

The Santa Clara Valley Habitat Agency (SCVHA), in coordination with the Santa Clara Valley Open Space Authority (OSA) and Point Blue Conservation Science (Point Blue), proposes to implement the Pajaro River Riparian Restoration Project (project) on the South Pajaro River Agricultural Preserve (Preserve or PRAP) in Santa Clara County, California (Figure 1-1). The Preserve is owned in fee by OSA and the project's riparian and wetland habitat improvements would be implemented by SCVHA as part of the reserve program under the Santa Clara Valley Habitat Plan (VHP). The project team is working collaboratively on the project. OSA is the landowner. SCVHA is managing project design and permitting and providing technical support. Point Blue is providing community based restoration implementation.

Habitat improvements being considered include the following actions.

- **Habitat Improvement 1:** Planting riparian vegetation along open (unvegetated) channel sections to establish a contiguous riparian corridor and planting riparian vegetation adjacent to existing riparian habitat to widen the riparian corridor. Additionally, a portion of the plantings would include specific host plant species that would attract native pollinators.
- **Habitat Improvement 2:** Grading and lowering channel banks in areas without mature riparian vegetation to widen the channel cross-section and create low-flow benches and additional riparian habitat.
- **Habitat Improvement 3:** Constructing off-channel seasonal wetland on the adjacent floodplain, which would remain connected through improvements to the existing toe drain or new channel connections.
- **Habitat Improvement 4:** Constructing a setback levee with associated in-channel wetland habitat and additional riparian habitat.

The habitat improvements being considered would be implemented in a phased approach. Phase 1 would be a planting only phase. Habitat Improvements 1 and 2 would begin being implemented in Phase 1 and would continue to be implemented in all future phases. Habitat Improvement 3, would be implemented in Phase 2. Phase 3 would consist of either Habitat Improvement 4 or 5. Additional studies and consultation with stakeholders would be needed before determining the best option for Phase 3.

The purpose of this document is to present the results of a feasibility study that assessed the intended habitat improvements for the project. This document provides an overview of the project objectives; identifies existing resources; identifies design opportunities and constraints; and presents biological, hydrologic, and geomorphic design considerations that provide the basic framework for habitat improvements.

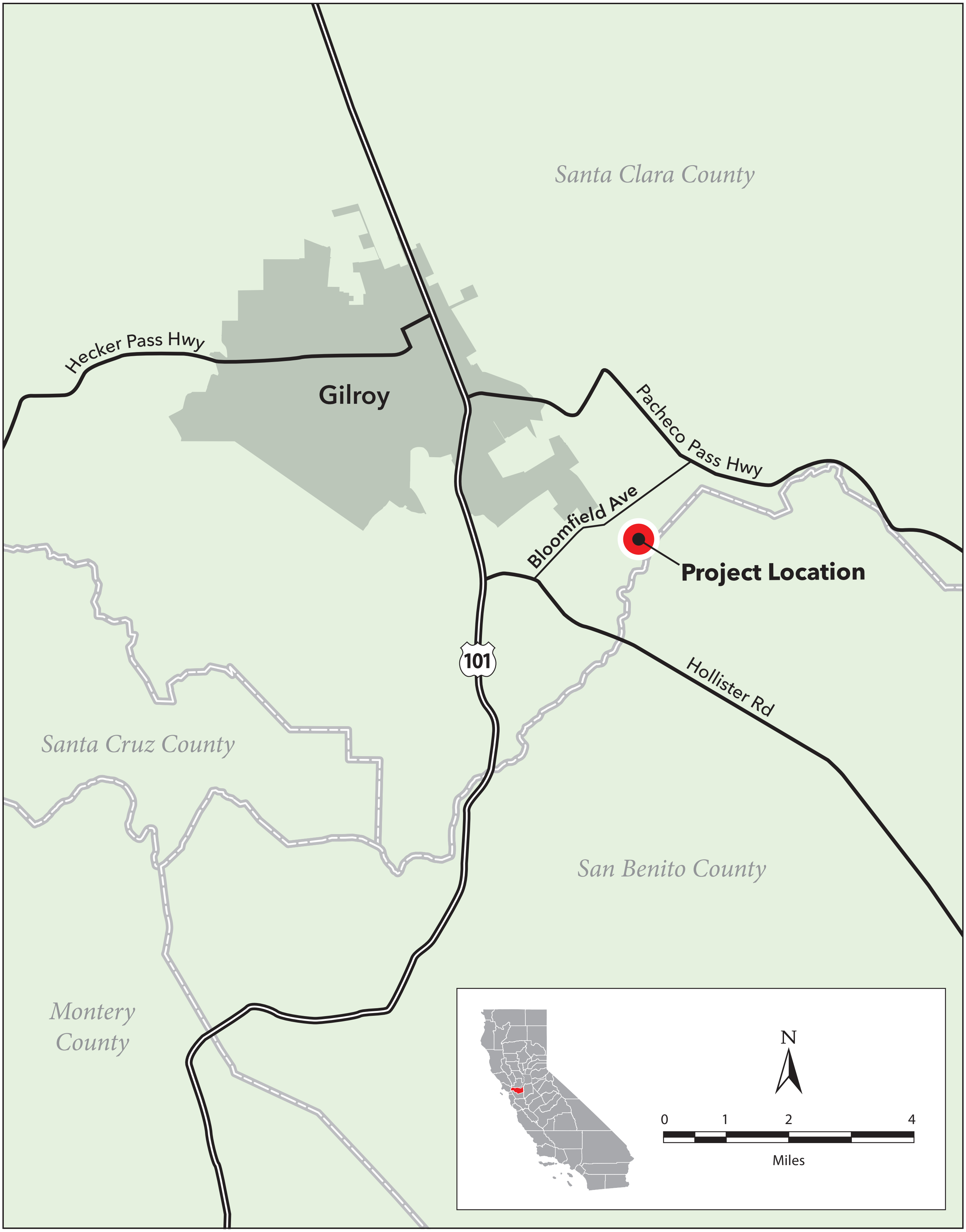

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Figure 1-1
Project Location

1.2 Project Site

The 185-acre Preserve is located in southern Santa Clara County, California (Figure 1-1). The Preserve is bounded on the north by Bloomfield Avenue, on the east by Frazier Lake Road, on the south by the Pajaro River, and on the west by Llagas Creek. The Pajaro River at this location also represents the approximate Santa Clara–San Benito County line. The Preserve is predominantly agricultural fields that are being used for row crops. Riparian, emergent wetland and ruderal habitat associated with the Pajaro River occur on the Preserve's southern boundary.

Up to 40 acres of the PRAP can be converted from agriculture to other uses, such as native habitat restoration and enhancement. Habitat restoration would be prioritized within the converted acres; however, the exact footprint would be determined once OSA determines the acreage needed for other uses such as recreation or future restoration elsewhere on the property.

The proposed project site occurs on an approximate 0.75-mile segment of the Pajaro River upstream of its confluence with Llagas Creek. The project site is relatively narrow and linear over much of its length (i.e., approximately 80 feet), widening to approximately 500 feet on the south end of the project site (Figure 1-2). The southern and southeastern boundary of the project site is the centerline of the Pajaro River. The western boundary is the centerline of Llagas Creek and the northern boundary is within an existing agricultural field.

PRAP is directly surrounded by agricultural fields that are predominately row crops. Llagas Creek that bounds the western edge flows from the north and becomes part of the Pajaro River once it merges at the confluence. The Pajaro River has limited hydrology upstream of the project site.

On a regional scale, PRAP is situated in rural South Santa Clara Valley approximately centered between the Diablo Range 2.75 miles to the east and the Santa Cruz Mountains 2.75 miles to the west. PRAP is located at the upper limits of the Pajaro River. The Pajaro River flows southwest from the project site, merges with the San Benito River prior to flowing around the southern tip of the Santa Cruz Mountains and empties into the Pacific Ocean near Watsonville.

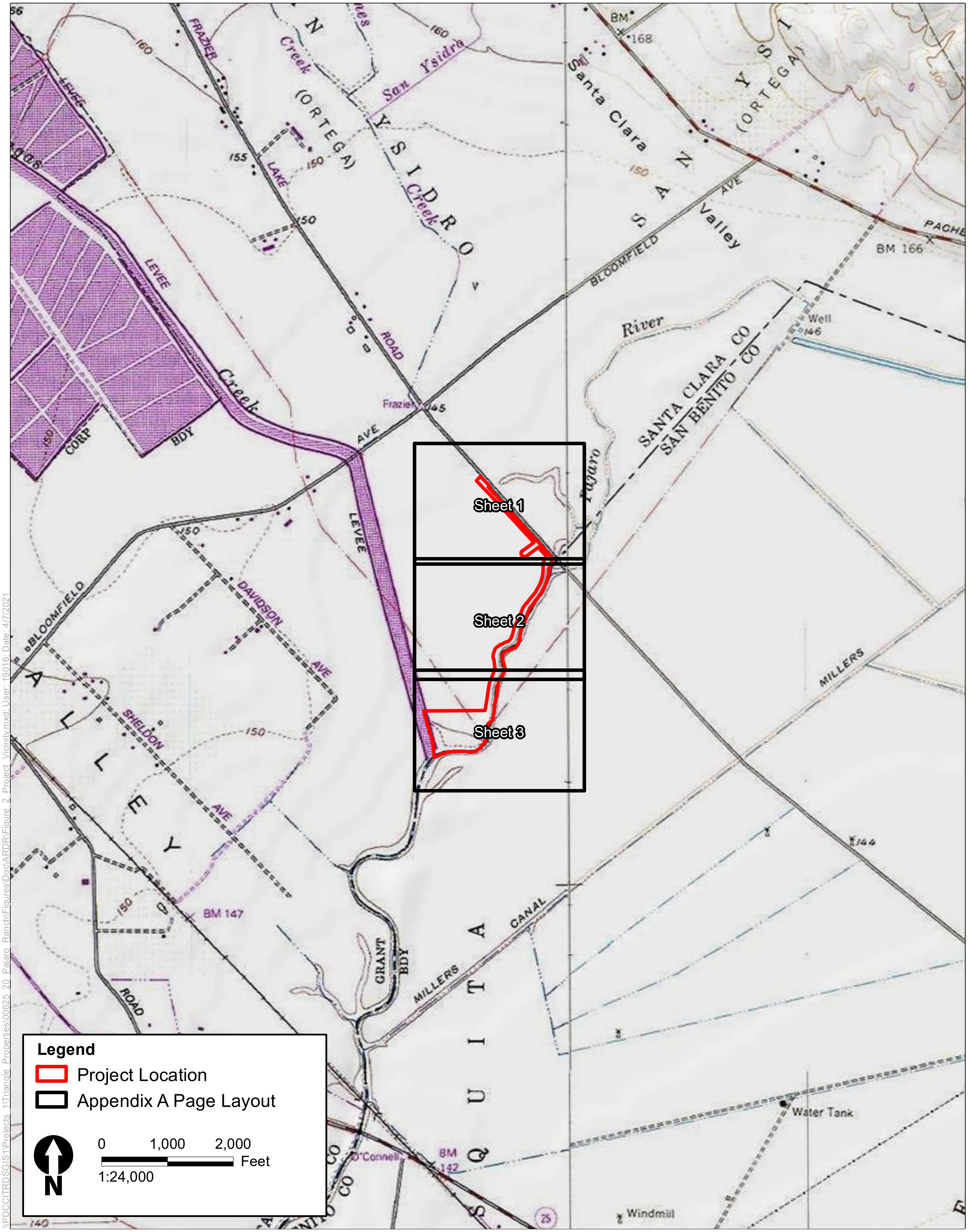


Figure 2
Project Vicinity

Chapter 2
Project Goals and Objectives

2.1 Project Need

SCVHA seeks to enhance the habitat value of approximately 4,000 linear feet of stream, currently serving primarily as an agriculture tail water channel. The site in which the stream restoration would occur is located on property that was acquired in fee by OSA with financial assistance from the Pajaro River Flood Prevention Authority. Sustaining farming operations on the majority of the property, while increasing habitat, water, and floodplain benefits on up to approximately 30 acres was identified as a goal when OSA purchased the property.

The section of stream being restored is located between a previously restored section of Pajaro River upstream of Frazier Lake Road and the confluence Llagas Creek. The project would provide habitat connectivity and greater biodiversity in a landscape that primarily consists of annual row crops and discontinuous riparian corridor. Specifically, the project would improve landscape linkages between the Santa Cruz Mountains and the Diablo Range along the Pajaro River, along primary terrestrial and aquatic/riparian linkage #18 identified in the VHP and within Conservation Analysis Zone 4 (ICF International 2012; The Nature Conservancy 2006). This linkage is identified as a Bay Area Critical Linkage and Key Riparian Corridor and buffer zone (The Conservation Lands Network 2019).

The channel within the PRAP channelized (characterized by anthropogenic manipulation). Channelization has reduced the wetted area and channel complexity relative to flow. The higher bank heights are potentially unstable in certain locations (as described in Chapter 6, *Geomorphic Assessment)*, and the extent, connectivity, and functionality of the riparian area, floodplain, and any adjacent wetlands is generally reduced.

The underlying need for the project is substantiated by the VHP (ICF International 2012), which provides the following goals for increasing native habitat acreage and biodiversity within the VHP boundaries.

- Maintain or improve opportunities for movement and genetic exchange of native organisms within and between natural communities inside and connecting to areas outside of the study area (VHP, Goal 2).
- Enhance or restore representative natural and semi-natural landscapes to maintain or increase native biological diversity (VHP, Goal 3).
- Improve the quality of the streams and hydrologic and geomorphic processes that support them to maintain a functional aquatic and riparian community to benefit covered species and promote native biodiversity (VHP, Goal 8).
- Maintain a functional riparian forest and scrub community at a variety of successional states and improve these communities to benefit covered species and promote native biodiversity (VHP, Goal 9).

The VHP is both a habitat conservation plan intended to fulfill the requirements of the Federal Endangered Species Act (FESA) and a natural community conservation plan (NCCP) to fulfill the requirements of the California Natural Community Conservation Planning Act. As an NCCP, the habitat plan not only addresses impact mitigation, but also would contribute to the recovery and delisting of listed species and help preclude the need to list additional species in the future. The VHP requires preservation and restoration or creation as mitigation for impacts on wildlife, habitat values, associated open space, and aquatic resources including riparian wetlands, non-wetland riparian, freshwater emergent marsh, seasonal wetland, spring/seep, streams, and ponds. These aquatic resources are also regulated by the U.S. Army Corps of Engineers (USACE), the California Regional Water Quality Control Board, and for streams that support listed salmonids, the National Marine Fisheries Service. To coordinate implementation of the Habitat Plan with compensatory mitigation required for impacts on aquatic resources regulated by these other agencies, SCVHA is developing the Santa Clara Valley Habitat Plan In-Lieu Fee Program (ILF Program). Once the ILF Program is adopted, the Habitat Agency would develop mitigation projects that meet the requirements of both the VHP and the ILF Program. To that end, this feasibility study was developed with the expectation that some or all parts of the project may provide mitigation under the Habitat Plan and create mitigation credits under the ILF Program.

2.2 Project Goals and Objectives

The project goals and objectives provide the basic framework for developing detailed design criteria to guide preparation of the conceptual restoration plans and construction plans and an analysis of the future success of the project.

The overall goals of the project developed by the restoration team include the following.

- Enhance the hydrologic and ecological connectivity between the Pajaro River upstream of Frazier Lake Road and Llagas Creek to enable movement and genetic exchange of terrestrial and aquatic species.
- Restore physical features, landforms, and native plant communities to create habitat diversity and structure necessary to support native fisheries, resident and migratory wildlife.

Secondary goals include the following.

- Restore native habitat that compliments the adjacent agriculture while also creating a buffer that reduces agriculture runoff flow into the Pajaro River.
- Create habitat that compliments recreational opportunities within the project site that would not adversely affect wildlife use of the restored site.
- Create habitat that contributes to the advanced mitigation credit system of the VHP.

Specific objectives related to the project goals include the following.

- Create a wider channel with inset floodplain bench in areas that lack mature riparian habitat to allow for a greater variety of habitat types and successional stages.
- Create seasonal wetland habitat with a connection to the Pajaro river to provide agriculture runoff filtering, habitat diversity, and credits for the VHP's advanced mitigation banking component.

- Improve capacity within the channel to help alleviate downstream flooding in the Pajaro River watershed.
- Restore wetland habitat to improve hydrogeomorphic processes and improve water quality to support native fish, such as the central California coast steelhead.
- Restore riparian woodland and willow scrub habitat to benefit covered species, such as the least Bell's vireo (*Vireo bellii pusillus*) and other neotropical songbirds.
- Create upland pollinator habitat adjacent to the Pajaro River to support declining species, such as the monarch butterfly (*Danaus plexippus*) and provide native pollinators to benefit the adjacent agriculture.
- Involve local students and volunteers in community supported restoration that can serve as a model for habitat restoration in the region.

Chapter 3

Biological Site Conditions

3.1 Introduction

This chapter describes the biological site conditions at the project site and surrounding areas; assesses the site's habitat suitability for VHP-covered species, special-status plant and wildlife species, and other species; identifies vegetation and wildlife resources within the project reach that may pose regulatory constraints to construction, and analyzes potential project impacts on vegetation and wildlife.

3.2 Biological Site Conditions

This section describes the biological site conditions and land cover types in and adjacent to the project site. The descriptions provided in this section are based on site observations, the aquatic resources delineation, and aerial imagery interpretation based on May 2020 Google Earth imagery.

Land cover types on the project site are riparian woodland, emergent wetland, perennial stream, ephemeral stream, agricultural ditches, ruderal, and cropland (Figure 3-1).

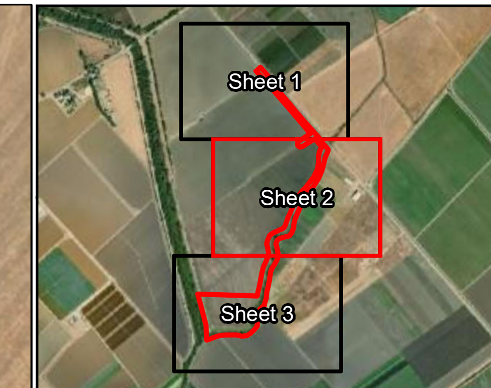
3.2.1 Riparian Woodland

Riparian woodland occurs along the Pajaro River on approximately the lower two-thirds of the project site. The riparian woodland, which is roughly equivalent to the *forested wetland* mapped in the delineation area, totals approximately 2.40 acres. The riparian woodland is dominated by red willow (*Salix laevigata*) which provides approximately 50% canopy cover along its length. A small number of arroyo willow (*Salix lasiolepis*) and one California black walnut (*Juglans hindsii*) are also present. The majority of the willows compose the woodland cover occur below the ordinary highwater mark (OHWM) of the Pajaro River; however, the canopy of some willows extends beyond the upper bank. Understory vegetation includes poison oak (*Toxicodendron diversilobum*) and California wild rose (*Rosa californica*), as well as grasses and forbs.

3.2.2 Emergent Wetland

Emergent wetland in the project site occurs below the OHWM of the Pajaro River in the perennial and ephemeral stream segments (Chapter 4, *Wetland Delineation*). The emergent wetland to the north, downstream of Frazier Lake Road, is dominated by American bulrush (*Schoenoplectus americanus*), and hardstem bulrush (*Schoenoplectus acutus*) is the dominant wetland species to the south over the remainder of the emergent wetland. Hardstem bulrush also occurs intermittently in the riparian canopy gaps, particularly at the west end of the project site in areas where willow canopy cover is less dense. Broadleaf cattail (*Typha latifolia*) is present in the emergent wetland near the confluence with Llagas Creek.

Figure 3-1
Land/Habitat Cover
Sheet 1 of 3



Legend

Land Cover
- Agriculture
- Ruderal
- Disturbed
- Agricultrual Ditch
- Agricultrual Wetland Ditch
- Coastal and Valley Freshwater Marsh
- Willow Riparain Forest
- Perennial Stream

Arborist Survey
- Arroyo Willow (lasiolepis)
- Black Walnut
- Red Willow (laevigata)
- Willow Sp.

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Figure 3-1
Land/Habitat Cover
Sheet 2 of 3

Figure 3-1
Land/Habitat Cover
Sheet 3 of 3

3.2.3 Perennial and Ephemeral Streams

Perennial and ephemeral stream segments both occur in the segment of the Pajaro River on the project site. Based on site observations in November 2020, the upstream portion of the river appears to be ephemeral. As described in Chapter 4, *Wetland Delineation*, at the time of the wetland delineation in March 2021, surface water was not always observable at the northern end of the river, but the river contained pockets of inundated water and soils were saturated throughout. Given the low rainfall preceding the delineation, it is appeared that the river is perennial in the lower portion of the reach.

3.2.4 Agricultural Ditches

Three agricultural ditches and one agricultural wetland ditch were mapped in the delineation area; two of which (AD-2 [0.036 acre] and AD-3 [0.001 acre) occur on the project site (Appendix A). These features did not have a bed and bank or other OWHM indicators. Agricultural ditch AD-1 (0.08 acre) and wetland ditch (AWD-1a [0.026 acre] and wetland ditch AWD-1b [0.026 acre]), which are outside of the project site but adjacent to the access road, lacked observable connectivity to the Pajaro River. Wetland ditches AWD-1a and AWD-1b are parallel to Frazer Lake Road and occur on the north and south sides of the culverted access road, respectively. Wetland ditches AWD-1a and AWD-2 were sparsely vegetated by perennial pepperweed (*Lepidium latifolium*). Agricultural ditches AD-1 and AD-2 (0.036 acre) documented a dominance of ruderal hydrophytes including perennial pepperweed and poison hemlock (*Conium maculatum*). Agricultural ditch AD-3 was smaller in comparison and directed flow into the Pajaro River from near the northern terminus of AD-2.

3.2.5 Ruderal and Cropland

Agricultural fields, which are used as row crops, occur on the north and west sides of the project site. A band of ruderal vegetation occurs between the top of bank for the Pajaro River and the agricultural fields to the north and west. The width of this ruderal vegetation may vary seasonally depending on agricultural operations as some of this vegetation had been mowed at the time of a November 2020 site visit but appeared to be dominated by perennial pepperweed. Ruderal vegetation at the south end of the project site occurs on a berm on the north side of the river. Species observed at this location included poison oak, perennial pepperweed, fennel and poison hemlock. A small cluster of coyote brush (*Baccharis pilularis*) and saltbush (*Atriplex* sp.) also occur at this location.

3.3 Assessment of Habitat Suitability for Habitat Conservation Plan Covered Species

An assessment of current site conditions was performed to assess baseline habitat suitability for the sixteen covered species under the VHP (Table 3-1). The assessment also considered the site's potential habitat suitability for each covered species following implementation of future restoration site actions.

Baseline habitat condition assessments were conducted in two phases.

1. Desktop assessment of site conditions relative to covered species' ranges and habitat requirements to screen out covered species that would be unlikely to occur.
2. Site field surveys to verify the desktop analysis, assess baseline habitat conditions for covered species, and identify restoration constraints and potential of the sites to benefit covered species.

The desktop assessment considered species' current and historic range and habitat requirements relative to the existing site conditions and overall constraints (the size and location of the site) to determine preliminarily the suitability for covered species. The project site was determined to potentially provide habitat, currently and/or with restoration, for 4 of the 16 species covered by the VHP: least Bell's vireo, western pond turtle (*Emys marmorata*), California red-legged frog (*Rana draytonii*), and tricolored blackbird (*Agelaius tricolor*). Table 3 summarizes the results of the desktop assessment to support habitat for covered species.

Table 3-1. Restoration Site Potential Habitat Suitability for Santa Clara Valley Habitat Conservation Plan Covered Species

Species	Habitat Description	Baseline Habitat Suitability in Project Site	Post-Restoration Habitat Suitability in Project Site
Bay checkerspot butterfly (*Euphydryas editha bayensis*)	All habitat occurs on shallow, serpentine-derived soil.	No suitable habitat in project site	No suitable habitat in project site
California tiger salamander (*Ambystoma californiense*)	Restricted to grasslands and low-foothills. Breeds in vernal pools, seasonal wetlands, or stock ponds. Upland estivation occurs in burrows formed by ground squirrels or other burrowing mammals.	No suitable habitat in project site; nearest CNNDB record approximately 1.5 miles northeast of project site	No suitable habitat in project site
California red-legged frog (*Rana draytonii*)	Permanent and semipermanent aquatic habitats, such as creeks and cold-water ponds, with emergent and submergent vegetation. Uses upland areas adjacent to aquatic habitat for foraging, cover (small mammal burrows, logs, rocks, leaf litter), and dispersal.	Suitable aquatic habitat and upland (limited) habitat in project site and Llagas Creek; nearest CNDDB record approximately 1.7 miles southwest of project site	Suitable aquatic habitat and upland habitat in project site and Llagas Creek
Yellow-legged frog (*Rana boylii*)	Breeding sites occur in aquatic habitats including streams and creeks with rocky substrate that occur in upper watersheds of woodland, forests, or chaparral.	No suitable habitat in project site	No suitable habitat in project site
Western pond turtle (*Emys marmorata*)	Perennial standing or slow-moving waters. Prefers habitats with emergent basking sites, such as logs, rocks, and shorelines; and with underwater refugia with	Suitable aquatic habitat occurs in Llagas Creek and possibly seasonally in the Pajaro River;	Similar to baseline conditions

Species	Habitat Description	Baseline Habitat Suitability in Project Site	Post-Restoration Habitat Suitability in Project Site
	adjacent upland habitats to reproduce, aestivate, and overwinter. Hatchlings require shallow aquatic habitat with dense submergent vegetation in which to feed.	suitable upland habitat in ruderal areas	
Burrowing owl (*Athene cunicularia*)	Upland habitat, open, low relief, well-drained soils. Substantial small mammal populations to provide burrows and a forage base.	No suitable habitat in project site	No suitable habitat in project site
Tricolored blackbird (*Agelaius tricolor*)	Habitat requirements for a breeding colony include open water; appropriate nesting substrate such as cattails, bulrushes, willows, and forbs; and nearby foraging habitat. Foraging areas include grasslands, open fields, and agricultural areas.	Agricultural fields and ruderal habitat provide potential foraging habitat; limited nesting habitat in emergent wetlands	Similar to baseline conditions
Least Bell's vireo (*Vireo bellii pusillus*)	Obligate riparian breeders, typically inhabiting structurally diverse woodlands along watercourses preferring early successional habitat. Early-successional dense riparian shrub and woodland. Low tolerance for brown-headed cowbird parasitism.	CNNDB record of nesting in riparian habitat on Llagas Creek; low quality nesting habitat on project site; potential foraging habitat	Increase in potential nesting and foraging habitat following restoration actions
San Joaquin kit fox (*Vulpes macrotis mutica*)	Occurs in grassland and scrubland in the San Joaquin Valley and adjacent foothills	No suitable habitat in project site	No suitable habitat in project site
Tiburon Indian paintbrush (*Castilleja affinis ssp. neglecta*)	Perennial herb; occurs in serpentine bunchgrass communities	No suitable habitat in project site	No suitable habitat in project site
Coyote ceanothus (*Ceanothus ferrisiae*)	Evergreen shrub; occurs on dry slopes in serpentine chaparral and in valley and foothill grassland communities	No suitable habitat in project site	No suitable habitat in project site
Mt. Hamilton thistle (*Cirsium fontinale var. campylon*)	Occurs in moist, serpentine soil especially near streams, seeps and springs in foothill woodland, chaparral, and valley grassland	No suitable habitat in project site	No suitable habitat in project site

Species	Habitat Description	Baseline Habitat Suitability in Project Site	Post-Restoration Habitat Suitability in Project Site
Santa Clara Valley dudleya (*Dudleya abramsii ssp. setchellii*)	Perennial herb; occurs on serpentine soils in foothill woodland and valley grassland	No suitable habitat in project site	No suitable habitat in project site
Fragrant fritillary (*Fritillaria liliacea)*	Perennial herb; occurs in Northern coastal scrub, coastal prairie, and valley grassland communities	No suitable habitat in project site	No suitable habitat in project site
Loma Prieta hoita (Hoita strobilina))	Perennial herb; occurs in chaparral and mixed evergreen woodland, often on serpentine soils; may occur in gravelly creekbeds	No suitable habitat in project site	No suitable habitat in project site
Smooth lessingia (*Lessingia micradenia var. glabrata*)	Annual herb; occurs on serpentine soil in chaparral communities	No suitable habitat in project site	No suitable habitat in project site
Metcalf Canyon jewelflower (*Streptanthus albidus ssp. albidus*)	Annual herb; occurs on serpentine soils in valley grassland communities	No suitable habitat in project site	No suitable habitat in project site
Most beautiful jewelflower (*Streptanthus albidus ssp. peramoenus*)	Annual herb; occurs on serpentine soil in foothill woodland, chaparral, and valley grassland communities	No suitable habitat in project site	No suitable habitat in project site

CNDDB = California Natural Diversity Database

Least Bell's vireo is known to occur in the project vicinity based on the California Natural Diversity Database (CNDDB) (Figure 3-2). There are two records of least Bell's vireo for Llagas Creek in close proximity f to the project site: one from 1997 and one in 2001 (CNDDB 2021). The riparian corridor along Llagas Creek provides potential breeding habitat for least Bell's vireo. The mature riparian vegetation occurring in narrow, irregular stands on the project site does not provide optimal breeding habitat for least Bell's vireo but may provide suitable foraging habitat. The species are obligate riparian breeders, typically inhabiting structurally diverse woodlands along watercourses. Two habitat features that appear to be essential include dense cover within 1 to 2 meters (3 to 6 feet) of the ground where nests are typically placed and a dense, stratified canopy for foraging (USFWS 1998). Proposed project actions to widen the riparian corridor may result in suitable breeding habitat for least Bell's vireo.

Western pond turtle is not known to occur in the project vicinity based on the CNDDB but habitat is present on and near the project site. The nearest record for western pond turtle is located 2.86 miles southwest of the project site (CNDDB 2021). Llagas Creek provides suitable aquatic habitat for western pond turtle. The segment of the Pajaro River on the project site likely provides limited aquatic habitat for this species because it is narrow and ephemeral over much of its length, and due to the presence of dense stands of vegetation including cattails and hardstem bulrush, which makes navigating the river extremely difficult for the species near the confluence with Llagas Creek. This species is associated with permanent or nearly permanent water in a wide variety of habitats, and requires basking sites, such as partially submerged logs, rocks, mats of floating vegetation, or open mud banks. Regarding the use of non-aquatic upland habitat, females pond turtles move overland for up to 100 meters (325 feet) to find suitable sites for egg-laying. Additionally, terrestrial overwintering habitat consists of burrows in leaf litter or soil. Upland habitat is limited on the project site that could be used for nesting and terrestrial overwintering and is limited to the small amount of predominately ruderal habitat on the banks of the Pajaro River banks.

California red-legged frog is known to occur in the project vicinity based on the CNDDB (Figure 3-2). There is one record of California red-legged frog within 2 miles of the project site located approximately 1.7 miles southwest of project site (CNDDB 2021). Llagas Creek and Pajaro River provides suitable aquatic habitat for breeding with upland habitat for foraging and estivation for California red-legged frog. Although the species is known to occur in habitat similar to that found on the project site, the narrow width of the Pajaro River causing high flows, the ephemeral nature of the river, the likely presence of chemical runoff from aquicultural practices in the river, and the limited upland habitat used for foraging and estivation may reduce habitat suitability.

Tricolored blackbirds are known to occur in the project vicinity based on the CNDDB (Figure 3-2) and EBird records, including one EBird record of foraging tricolored blackbirds along Frazier Lake Road near the project site. The nearest record for tricolored blackbird is located 1.84 miles northeast of the project site (CNDDB 2021). Although agricultural fields and ruderal habitat on the project site provide potential foraging habitat for tricolored blackbird, the project site likely provides limited nesting habitat for tricolored blackbird. Tricolored blackbirds have three basic requirements for selecting their breeding colony sites: open accessible water; a protected nesting substrate, including either flooded or thorny or spiny vegetation; and a suitable foraging space providing adequate insect prey within a few miles of the nesting colony (Beedy and Hamilton 1997, 1999). Although the species is known to nest in freshwater marshes including those dominated by cattails and bulrush that are found on the project site, the narrow width of the emergent wetlands, lack of open water, and the ephemeral nature of the Pajaro River may reduce nesting habitat suitability.

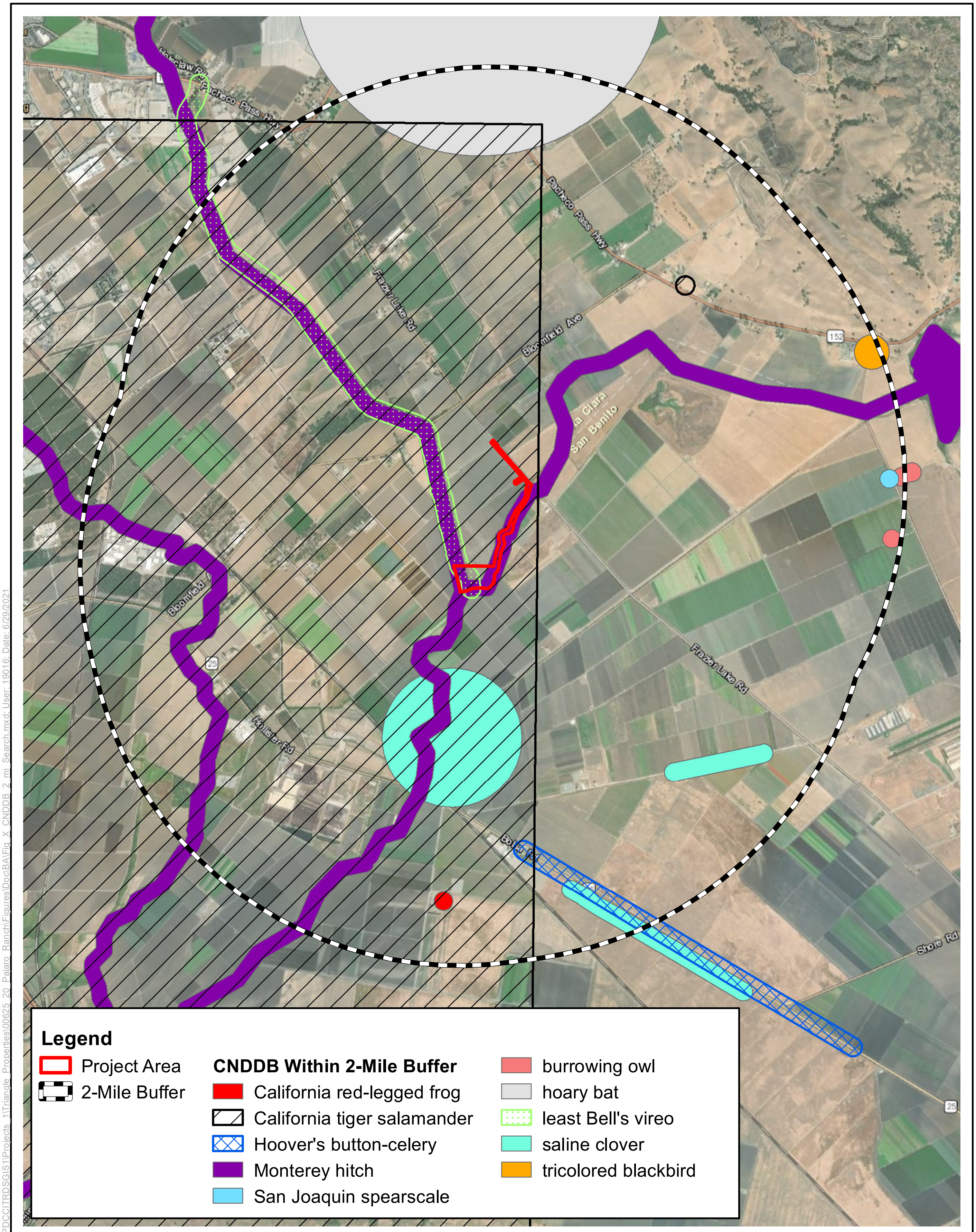

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Figure 3-2
CNDDB Records within 2-Miles of
Pajaro River Agriculture Preserve Project

3.4 Assessment of Habitat Suitability for Other Special-Status Species and Target Species

An assessment of current site conditions was performed to assess baseline habitat suitability conditions for other special-status species and other plant and wildlife species. The assessment included a review of the CNDDB, U.S. Fish and Wildlife Service (USFWS), and California Native Plant Society (CNPS) databases. Lists of special-status species generated from these databases are presented in Appendix A.

Because of the disturbed nature the agricultural land and adjacent ruderal habitat, the project site provides limited habitat value for most wildlife and plant species. Much of the project site provides limited suitable habitat for listed species. The riparian, wetland, and interspersed ruderal habitat along the Pajaro River provide potential habitat for some special-status and common species.

The spaced shrubs and low trees (including coyote brush and olive trees) in open habitat, such as the agricultural fields and ruderal habitat that is in the northern portion of the project site, provide nesting and foraging habitat for some bird species including loggerhead shrike (*Lanius ludovicianus*), which was observed during an April 2021 site visit. Riparian habitat provides potential nesting habitat, and the agricultural fields and ruderal habitat provide suitable foraging habitat for white-tailed kite (*Elanus leucurus*), Cooper's hawk (*Accipiter cooperii*), barn owl (*Tyto alba*), and other raptor species. Cooper's hawk and barn owl were both observed during a November 2020 site visit. Riparian habitats also provide potential foraging habitat and roost sites (including day, maternity, and hibernation roosts) for bats, as well as nesting and foraging habitat for resident, migratory, and wintering songbirds. The riparian and wetland habitats in the Pajaro River also provide rearing and foraging habitat for common wildlife species and as a migration corridor for other wildlife species, such as mule deer (*Odocoileus hemionus*), bobcat (*Lynx rufus*), common gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), gopher snake (*Pituophis catenifer*), northern racoon (*Procyon lotor*), pacific tree frog (*Hyla regilla*), Virginia opossum (*Didelphis virginiana*), western fence lizard (*Sceloporus occidentalis*), western gray squirrel (*Sciurus griseus*), and western toad (*Bufo boreas*), and may serve as a migration corridor for mountain lion (*Puma concolor*).

Existing ruderal vegetation, which is dominated by annual grasses and nonnative species, including perennial pepperweed and poison hemlock, provides minimal habitat value for pollinators including western bumble bee (*Bombus occidentalis*), Crotch bumble bee (*Bombus crotchii*), obscure bumble bee (*Bombus caliginosus*) and monarch butterfly. Revegetation utilizing native wildflowers and forbs would provide potential suitable habitat for these and other native pollinators.

3.5 Potential Project Effects on Vegetation

The restoration project would be designed and implemented to minimize effects on existing vegetation. No riparian trees would be removed; however, some limb removal or pruning may be required to facilitate site grading. To widen the west bank floodplain of the Pajaro River, some earthwork would be required within the OHWM that could result in temporary effects on riparian understory, emergent wetland, and ruderal habitats, as well as the root zones of some riparian trees. All disturbed habitats would be revegetated following completion of grading activities. Project implementation would result in the permanent conversion of some upland agricultural land to seasonal wetland, inset floodplain, or pollinator habitat.

3.6 Fish

The Pajaro River, which drains to Monterey Bay, is within the Monterey Bay Subprovince, one of six ichthyological provinces described by Moyle (2002:4). Historically, the streams in the Monterey Bay Subprovince supported nearly all of the freshwater fish species characteristics of the Central Valley Subprovince, due to the Pajaro River's historical connections with Coyote Creek and the San Joaquin River (Moyle 2002:13). Presently, dominant native fish species occurring in the Pajaro River include Pacific lamprey (*Entosphenus tridentata*), Monterey roach (*Lavinia symmetricus subditus*), Sacramento hitch (*Lavinia exilicauda*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), threespine stickleback (*Gasterosteus aculeatus*), prickly sculpin (*Cottus asper*), and South-Central California Coast steelhead[1] (Moyle 2002; Smith 2013:5–7). A number of nonnative fishes have been introduced to the Pajaro River watershed, including the Western mosquitofish (*Gambusia affinis*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), green sunfish (*Lepomis cyanellus*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), fathead minnow (*Pimephales promelas*), bigscale logperch (*Percina macrolepida*), inland silverside (*Menidia beryllina*), golden shiner (*Notemigonus crysoleucas*), and threadfin shad (*Dorosoma petenense*). Many or all these species may also occur in the Pajaro River in the project site.

South-Central California steelhead historically used the Pajaro River channel to access spawning and rearing habitat in the upper watershed, including habitat in Pacheco Creek, Arroyo Dos Picachos, and their tributaries. The head of the Pajaro River was originally wetlands associated with San Felipe Lake, which drained into the Pajaro River. To facilitate agricultural development, Miller Canal was constructed south of the Pajaro River, connects San Felipe Lake with the Pajaro River near its confluence with Llagas Creek, and provides adult and juvenile (smolt) steelhead with passage to and from San Felipe Lake and its tributaries (Smith 2013:23). Presently, the upper Pajaro River, including the reach adjacent to the project site, is a shallow, seasonal ditch or swale (Smith 2013:5, 23). The channel is dominated by sand or silt, has little or no riparian vegetation in the upper segment of the project reach, and is mostly choked with hardstem bulrush in the lower reaches and American bulrush in the upper reach of project site. Consequently, it is unlikely that the reach of the Pajaro River adjacent to the project site supports steelhead passage and the quality of rearing habitat for juvenile steelhead is likely very low. Nevertheless, the Pajaro River channel adjacent to the project site is designated as critical habitat for South-Central California steelhead (70 FR 52573–52575, September 5, 2002).

[1] The South-Central California Coast steelhead distinct population segment (DPS) extends from the Pajaro River south to (but not including) the Santa Maria River (71 *Federal Register* [FR] 834–862).

Chapter 4
Wetland Delineation

4.1 Introduction

This chapter summarizes the methods and results of an aquatic resources delineation conducted for the project in March 2021. The delineation results would be represented in the preliminary delineation of aquatic resources report (ICF in press).

4.2 Methods

Fieldwork was conducted on March 11 and 12, 2021, by an ICF wetland ecologist. The field study investigated for areas that could be subject to jurisdiction by USACE under Section 404 of the Clean Water Act. The wetland delineation followed assessment methods described in *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987), *Regional Supplement to the Corps of Engineers Wetland Delineation Manual for the Arid West Region* (U.S. Army Corps of Engineers 2008), and *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (Lichvar and McColley 2008).

This report's methods and standards are intended to conform to the USACE San Francisco District's Information Requested for Verification of Corps Jurisdiction (U.S. Army Corps of Engineers, San Francisco District 2016) and Revised Map and Drawing Standards for the Pacific Division Regulatory Program Delineations (U.S. Army Corps of Engineers, South Pacific Division 2016).

The delineation was prepared in support of a preliminary jurisdictional determination, which means that applicants waive or set aside questions regarding the jurisdictional status of wetlands and other waters on a particular site, as described in the USACE's *Regulatory Guidance Letter No. 16-01* (U.S. Army Corps of Engineers 2016).

4.2.1 Precipitation and Growing Season

Climate data were estimated from the nearby Gilroy and Gilroy 3.8 NNE National Weather Service cooperate weather stations, which are approximately 4.2 miles and 6.8 miles northeast of the delineation area, respectively. While the Gilroy station has collected precipitation data for over 30 years to provide a sufficient annual average, it was missing data for 2020 (Western Regional Climate Center 2021). As a result, precipitation from the Gilroy 3.8 NNE weather station was sourced to assess the amount of rain that fell during the rainy season preceding the delineation field survey (October 2020–March 2021).

The climate in the delineation area is characterized by hot dry summers and cool wet winters. The mean maximum annual air temperature is 75.0 degrees Fahrenheit (°F) and mean minimum annual temperature is 47.6°F. The mean annual precipitation in the vicinity of the delineation area is approximately 19.33 inches, which primarily falls between October and May. The length of the growing season (based on 32°air temperature thresholds and 70% probability) is 311 days.

The rainy season preceding the delineation field survey (October 2020–February 2021) accumulated 7.75 inches, which is approximately 52% of the annual average for those months.

4.2.2 Vegetation

The investigation consisted of walking the delineation area and mapping potential jurisdictional aquatic resources using a submeter accuracy global positioning system (GPS) unit while applying the routine on-site determination methods described in Section 4.2, *Methods*. Six wetland delineation sample points were established, and ten OHWM datasheets were completed to document the OHWM of the Pajaro River (Appendix A).

In the following discussion, species scientific names are based on taxonomy described in the *Jepson Manual,* second edition (Baldwin et al. 2012) and updates published online by the *Jepson Flora Project* (Jepson Flora Project 2021). Wetland indicator statuses were obtained from *The National Wetland Plant List* (U.S. Army Corps of Engineers 2018).

The delineation area occurs near the southern border of the San Francisco Bay Area subregion and northern border of the Inner South Coast Ranges subregion (Jepson Flora Project 2021). The San Francisco Bay Area Subregion was described as having a “somewhat arbitrary” southern border that follows U.S. Highways 152 and 156 from the Central Coast east through Hollister (Jepson Flora Project 2021); the delineation area occurs south of U.S. Highway 152 and north of U.S. Highway 156. There are four vegetation types in the delineation area: American bulrush marsh, hardstem bulrush marsh, red willow riparian forest, and ruderal agriculture.

4.2.3 Hydrology

The delineation area occurs in the Pajaro River watershed (Hydrologic Unit Code 18060002) (U.S. Geological Survey 2021). San Felipe Lake, a sag pond dammed by the fault scarp of the Calaveras Fault, is the terminus of the Pajaro River (Casagrande 2011). The outlet of San Felipe Lake previously drained directly to the Pajaro River through meandering sloughs and wetlands (Grossinger et al. 2008). Presently, the lake drains through artificial canals into the Pajaro River; Miller Canal also directs flows from San Felipe Lake into the Pajaro River south of the delineation area. At the southern end of the delineation area, Llagas Creek converges with the Pajaro River. Further downstream, the San Benito River converges with the Pajaro River, which ultimately drains into the Monterey Bay.

The National Wetlands Inventory (NWI) provides maps and information on the status, extent, characteristics, and functions of wetland, riparian, deepwater, and related aquatic habitats in priority areas to promote the understanding and conservation of these resources. The mapping is provided at a scale of 1:24,000 and uses the USFWS wetland definition, which differs from the USACE definition—USFWS requires one wetland parameter instead of the three wetland parameters required by USACE. The NWI mapping shows the extent of wetlands and deepwater habitats that can be determined with the use of remotely sensed data dating from 1977 to present. The NWI mapping, therefore, cannot be used to delineate wetlands and other waters of the United States but can provide useful background information on the broad types of wetland and riparian vegetation communities in the delineation area.

The following wetlands were mapped by NWI in the vicinity of the delineation area (U.S. Fish and Wildlife Service 2021).

- An excavated intermittent stream that is seasonally flooded (R4SBCx; i.e., upper reach of Pajaro River upstream and north of delineation area).
- Intermittent stream that is seasonally flooded (R4SBC; i.e., Pajaro River in the delineation area).

- Deepwater pond that that has an unconsolidated bottom, is diked/impounded, and is permanently flooded (L1UBHh; i.e., San Felipe Lake).
- An excavated seasonally flooded wetland dominated by perennial herbaceous species (PEM1Cx; i.e., Miller Canal).
- A forested wetland that is diked/impounded and temporarily flooded (PFOAh).
- A wetland dominated by herbaceous species that is diked/impounded and temporarily flooded (PEM1Ah); others equivalent but do not have hydrologic intervention include PEM1A in the delineation area.
- A permanently flooded wetland with an unconsolidated bottom (PUBH).

4.2.4 Soils

Table 4-1 lists soil map units occurring in the delineation area, which consist of Willows clay, 0% slopes; Water; Clear Lake clay, saline, drained, 0 to 1% slopes; and Riverwash (Natural Resources Conservation Service 2021).

Table 4-1. Soil Map Units in the Delineation Area

Soil Map Unit	Map Symbol	Drainage Class	Landform	Hydric Component (C) or Minor Component (M)	Hydric Criteria[a]
San Benito County					
Willows clay, 0% slopes, MRLA 14	Wc	Poorly drained	Basin floors	Sorento (M) Cropley (M) Pacheco (M) Clear lake (C) Unnamed (C)	2
Water	W	-	-	-	2
Santa Clara County					
Clear Lake clay, saline, drained, 0 to 1% slopes, MRLA 14	Ck	Poorly drained	Basin floors	Unnamed, clay loam (M) Pacheco (M) Unnamed (C)	2
Riverwash	Rg	Runoff class: Very High	Drainage ways	–	2
Willows clay, 0% slopes MRLA 14	Wa	Poorly drained	Basin floors	Sorento (M) Cropley (M) Pacheco (M) Clear lake (C) Unnamed (C)	2

[a] Hydric Criteria:

2. Map unit components in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, or Andic, Cumulic, Pachic, or Vitrandic subgroups that:

a. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or

b. Show evidence that the soil meets the definition of a hydric soil.

Source: Natural Resources Conservation Service 2021.

4.3 Results

A total of 6.54 acres of aquatic resources were delineated in the delineation area (Table 4-2). Aquatic resources in the delineation area comprise the Pajaro River, agricultural ditches, an agricultural wetland ditch, and emergent and forested wetlands below the OHWM of the Pajaro River.

Table 4-2. Aquatic Resources Identified in the Delineation Area

Feature Number[a]	Feature Type	Acres
AWD-1	Agricultural wetland ditch	0.052
EM-1	Emergent wetland	0.780
FO-1	Forested wetland	2.403
PS-1	Perennial stream	3.183
AD-1	Agricultural ditch	0.080
AD-2	Agricultural ditch	0.036
AD-3	Agricultural ditch	0.001
Total		**6.535**

[a] As shown in Figures ####.

4.3.1 Wetlands

Wetlands documented in the delineation area consist of agricultural wetland ditch (0.052 acre), emergent wetland (0.780 acre) and forested wetland (2.403 acres)(Appendix A).

4.3.1.1 Agricultural Wetland Ditch

A single 0.052-acre agricultural wetland ditch was mapped at the northern end of the delineation area (Appendix A). The ditch enters the delineation area via a crossing from Frazer Lake Road. The access road crosses over a culverted agricultural ditch. At the time of the delineation, most of the culvert was plugged with sediment; however, the ditch was nevertheless inundated with a couple inches of water. The wetland sample point was established approximately 20 feet southeast of the culvert in an area without surface water. Wetland sample point 1W (SP-1W) documented 5% cover of perennial pepperweed, and many of prior year's cocklebur (*Xanthium strumarium*) seeds were observed on the soil's surface. Redoximorphic features were not observed in the soil's dark matrix of 10YR 2/1. (The sample point occurs in the soil map unit Clear Lake clay, saline, drained, 0 to 1% slopes near the border of Willows clay, 0% slopes (Natural Resources Conservation Service 2021.) Both of these soil map units are poorly drained soils containing dark grey components and are known to contain relatively high organic matter.

The water table was observed at a depth of 4 inches, and the soils were saturated at a depth of 1 inch. In comparison, upland sample point 2U (SP-2U) was dominated by perennial pepperweed and salt grass (*Distichlis spicata*), had the same dark matrix lacking redoximorphic features, and did not contain wetland hydrology (Photograph 18, Appendix D). Given sample point SP-1W had wetland hydrology and a dominance of hydrophytes, it is assumed the soils are problematic, in that the dark color and high organic matter obscured detection of redoximorphic features. While sample point SP-2U had the same dark matrix, the sample point is regarded as an upland point because wetland hydrology was not observed.

4.3.1.1 Emergent Wetland

The emergent wetland mapped in the delineation area totaled 0.780 acre and occurred below the OHWM of the Pajaro River. The emergent wetland was dominated by American bulrush to the north and hardstem bulrush to the south. Some broadleaf cattail is also present to the south near the confluence with Llagas Creek. Wetland sample point SP-5W documented 95% coverage of American bulrush with 8 inches of surface water; soils were assumed hydric in the inundated feature. Similar to upland sample point SP-2U, SP-6U had a dark matrix (10YR 2/1), a dominance of hydrophytes, and lacked wetland hydrology; SP-6U occurs on the bank of the Pajaro River above the OHWM (Appendix A).

4.3.1.2 Forested Wetland

The forested wetland mapped in the delineation area totaled 2.403 acres and occurred below the OHWM of the Pajaro River. The forested wetland was dominated by red willow with approximately 50% canopy cover. Hardstem bulrush occurred intermittently in the canopy gaps. Wetland hydrology was inferred by the river's flowing water and the soils were assumed hydric.

4.3.2 Non-Wetland Waters

Non-wetland waters documented in the delineation area consist of the Pajaro River (3.183 acres) and three agricultural ditches, which total 0.117 acre (Appendix A).

4.3.2.1 Pajaro River

The Pajaro River is channelized and deeply incised. The OHWM was mapped using OHWM indicators: break in slope, change in vegetation, and wrack lines. Surface water was not always observable at the northern end of the delineation area, but the river contained pockets of inundated water and soils were saturated throughout. Given the low rainfall preceding the delineation, it appeared that the river is perennial in the lower portion of the reach. Two corrugated metal pipe culverts were observed that would direct flows into the river; however, both culverts were dry and one was sealed.

4.3.2.2 Agricultural Ditches

Three agricultural ditches were mapped in the delineation area. These features did not have a bed and bank or other OWHM indicators (Appendix A). Only agricultural ditch AD-1 lacked observable connectivity to the Pajaro River, but there may be a culvert that outfalls to the river that could be buried under sediment. Upland sample points SP-3U and SP-4U were established in agricultural ditches AD-1 and AD-2, which documented a dominance of ruderal hydrophytes, a dark soil matrix, and no wetland hydrology. Agricultural ditch AD-3 was smaller in comparison and directed flow into the Pajaro River.

Chapter 5
Hydrologic Assessment

5.1 Introduction

This chapter describes the existing watershed hydrology conditions at the project site and the site's upstream watershed, including historical anthropogenic manipulations to the local watershed. It also describes the various flows of interest (i.e., baseflow, 2-year recurrence interval [RI] discharge, 5-year RI discharge, 10-year RI discharge, and 100-year RI discharge), and the one-dimensional (1D) modeling effort used to establish a better understanding of hydraulic variables. The 1D model would also be used to assess existing conditions and to inform the future restoration design.[2] Opportunities and constraints associated with hydrology are presented in Chapter 11, *Restoration Opportunities and Constraints*.

5.2 Watershed Hydrology

5.2.1 Historic Conditions

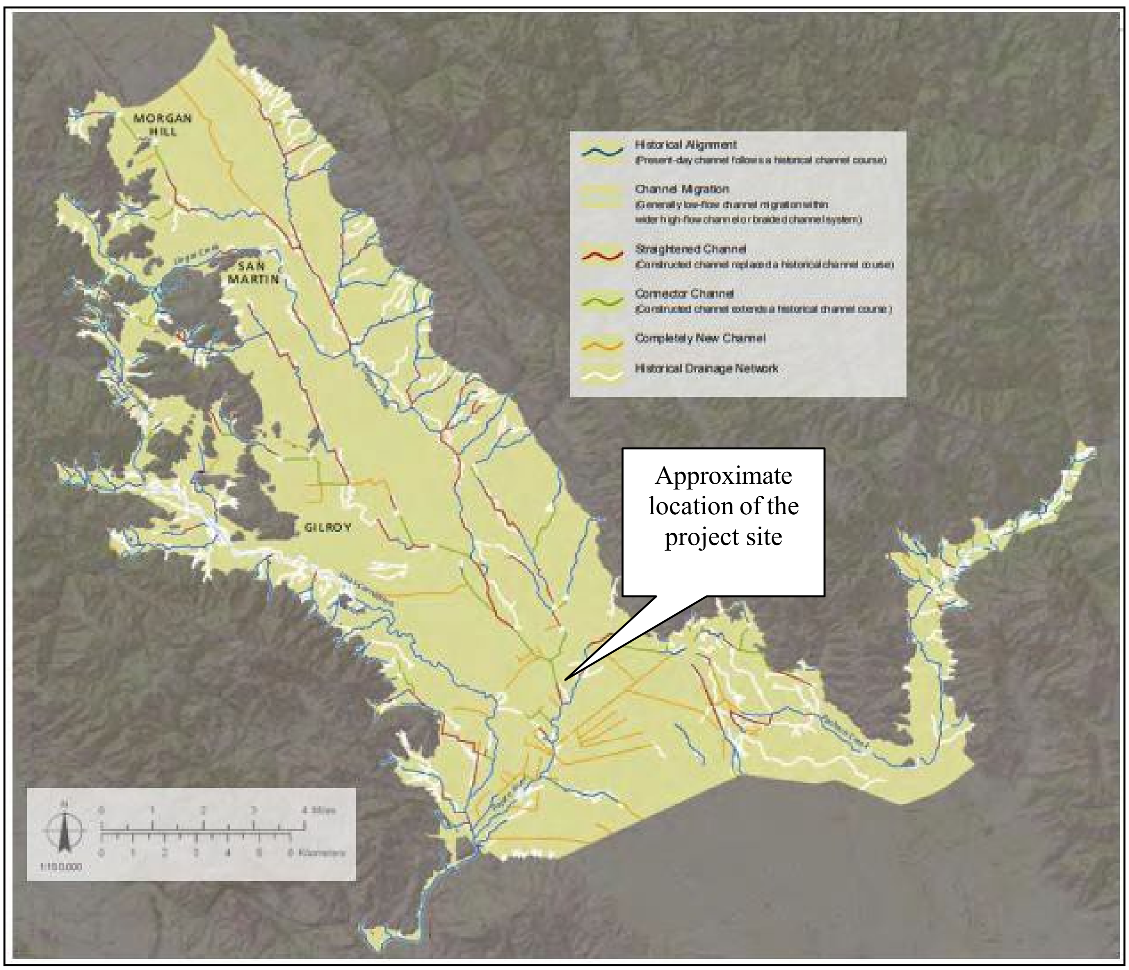
The southern Santa Clara Valley drainage network has been significantly modified with respect to its size and channel alignments. Before modifications in the 19th and 20th centuries, the drainage network was more dispersed and discontinuous. Wetlands with poorly defined and or multiple channels were common. Alluvial fans that developed from smaller creeks in the hills dispersed into distributary channels, where sediment dropped out of the channels and flow went subsurface. Many areas of the valley did not have defined alluvial channels that naturally drained the area. This inefficient water conveyance system attenuated flood peaks with large, shallow storage areas and increased retention of water for groundwater recharge (Grossinger et al. 2008: 42–49.)

In the surrounding floodplain, sloughs made up the scattered, shallow drainage system. These channels were characterized as small, slow-moving streams with high width-to-depth ratios (wide active and bankfull channels). Common in the low-gradient area between San Felipe Lake and the Pajaro River, the sloughs and wetlands were seasonally evaporative and historically referred to as salty or alkaline. Downstream, streams were relatively wide, active channels supporting a broad but open riparian corridor. With the exception of the Pajaro River, other streams in the valley were historically characterized as intermittent. With surface flow restricted to the drier months, scattered pools were connected by a strong subsurface flow. This flow was observed as sufficiently persistent and reliable enough to serve as summer refuges for native fish with strong interaction in the hyporheic zone. (Grossinger et al. 2008:49–52, 67–74)

The descriptions above predate dams, diversions, and groundwater depletion. The transformation of land use is discussed in more detail in Chapter 10, *Land Use*, but hydrologically significant alterations are noted below.

[2] It is likely that future restoration phases for the project would include two-dimensional modeling to better examine hydraulic dynamics (such as velocity vectors and scour potential).

Indigenous management of the watershed pre-dates Spanish contact in 1769, noted for controlled burning to manipulate vegetation patterns. The Mission era extended from 1769 to 1834, with orchards and cattle raising on natural wet meadows. The Ranchero era (1834 to 1864) fragmented the land into grazing with grain or fruit cultivation. The early American era from 1864 to 1874 was underway with significant drought and the development of watershed-scale infrastructure. Dairy and wheat production focused on the rich valley soil, with beef cattle relegated to the upland areas. Agricultural intensification lasted from 1874 to 1930, with the rapid drilling of artesian wells, ditching for irrigation and draining, and expansion of orchard cultivation on newly drained soils. Finally, flood control and urban expansion starting in the 1930s has developed the existing landscape seen today. Pacheco Reservoir, Hernandez Reservoir, Chesbro Reservoir, and Uvas Reservoir were all built during this era to counteract the decreased groundwater levels. Levee construction and channel excavation added to flood protection and transformed the once intermittent, poorly defined streams into hydraulically efficient conveyance systems with little connection to their floodplains (Grossinger et al. 2008: 15–37). Figure 5-1 illustrates changes to the historical drainage network, showing contemporary drainage network with channels coded with regard to their origin. The historical drainage network is shown in white.



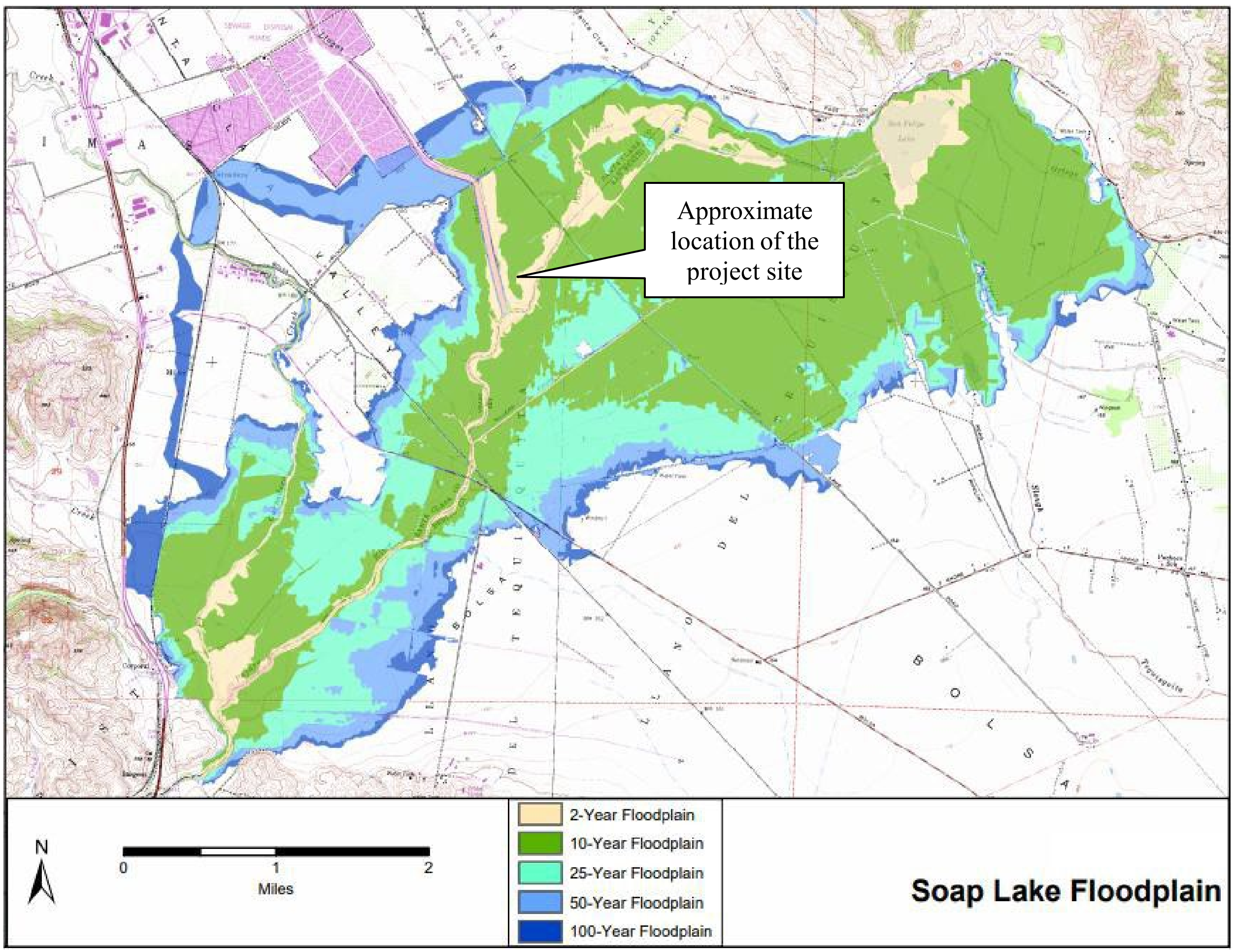
Source: Grossinger et al. 2008: 44.

Figure 5-1. Contemporary Drainage Network with Channels Coded According to Origin

5.2.2 Present-Day Conditions

The watershed area draining to Pajaro River for the following locations are 282 square miles (outlet of San Felipe Lake), 406 square miles (confluence of Llagas Creek and Millers Canal), and 505 square miles (confluence with Uvas-Carnadero Creek). The project site experiences Mediterranean climate with a mean annual rainfall that ranges from 24 inches in Pacheco Creek to 14 inches near Gilroy. The area is typically under summer drought conditions with a mean annual temperature of 60°F. Across the watershed, topography is extremely level with a high of 159 feet near Tequisquita Slough and Shore Road and low of 135 feet in San Felipe Lake. (Phillip Williams & Associates 2008: 12)

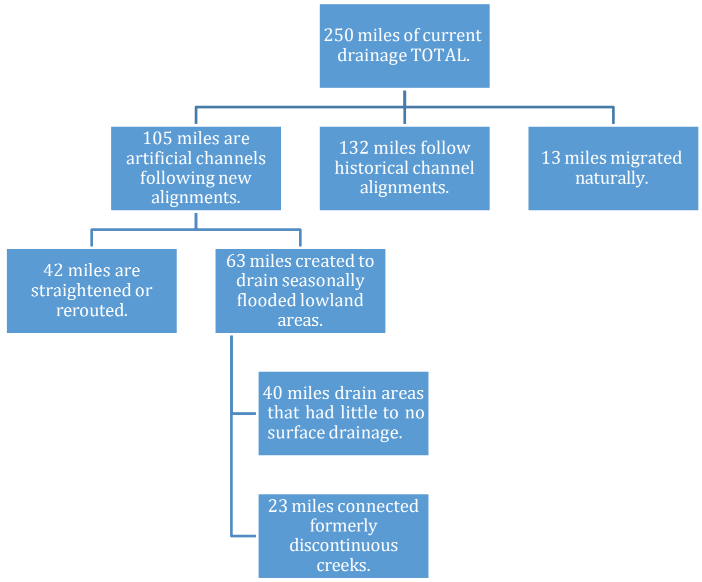
PRAP is subject to varying levels of inundation under several flood recurrence intervals (RMC 2005: 2-5) (Figure 5-2). The 2-year floodplain extends just beyond top of bank for Llagas Creek and the Pajaro River, with ponding occurring at the southern end of the site. The 10-year event shows inundation of the entire project site and much of the historical Soap Lake area.



Source: RMC Water and Environment 2005: 2–5.

Figure 5-2. Soap Lake Floodplain Inundation Extents

The estimated 250 miles of channels currently draining the valley can be categorized according to the chart illustrated in Figure 5-3.



Source: Grossinger et al. 2008: 42-43.

Figure 5-3. Channels of the Contemporary South Santa Clara Valley Drainage Network

Channel narrowing across the watershed has reduced lateral activity and extent of vegetation. After extensive flood protection projects in the 1970s, the number of streams with widths less than 200 feet has increased more than twofold.

The Pacheco Reservoir also has the potential to influence streamflow dynamics at the PRAP, which is a reservoir and dam that impounds water from the north fork of Pacheco Creek. The reservoir is located in the upper reaches of Pacheco Creek, approximately 7.5 miles west of San Luis Reservoir and 13 miles northeast of the PRAP. The Pacheco Reservoir Expansion Project, currently in in its planning and permitting stages, would boost Pacheco Reservoir's operational capacity from 5,500 acre-feet (AF) to up to 140,000 AF, which is enough to supply up to 1.4 million residents with water for 1 year during an emergency. The project would also reduce the frequency and severity of water shortages during droughts, protect local drinking water supply and infrastructure, and improve fish habitat. Pacheco Creek ultimately flows into San Felipe Lake, which is discussed further in Section 5.3, *Local Hydrologic Conditions*.

5.3 Local Hydrologic Conditions

5.3.1 Historic Conditions

The historical trajectory of the Pajaro River flowed across Soap Lake, a 9,000-acre floodplain on the border of Santa Clara and San Benito Counties. This area was mainly alkaline due to high summer evaporation and shallow groundwater levels. Originating from San Felipe Lake, the Pajaro watercourse was wide, shallow, and poorly defined. Perennial and seasonal wetlands mingled with grassy, alkaline meadows. The confluence with Llagas Creek was historically considered the true head of the river as it transformed into a well-defined, meandering channel (Phillip Williams & Associates 2008: 1; Grossinger et al. 2008: 196)

Prior to Euro-American settlement in the late 18th century, the land around San Felipe Lake was populated by Ohlone Indians. Before channelization, the three major tributaries to the Pajaro River were branching distributary channels that spread flow into the wetland complexes. The lower portion of Llagas Creek, in particular, was spread over hundreds of acres in a low, flat marsh. This area regularly overflowed during flooding events. (Phillip Williams & Associates 2004: 2; Grossinger et al. 2008: 45, 186).

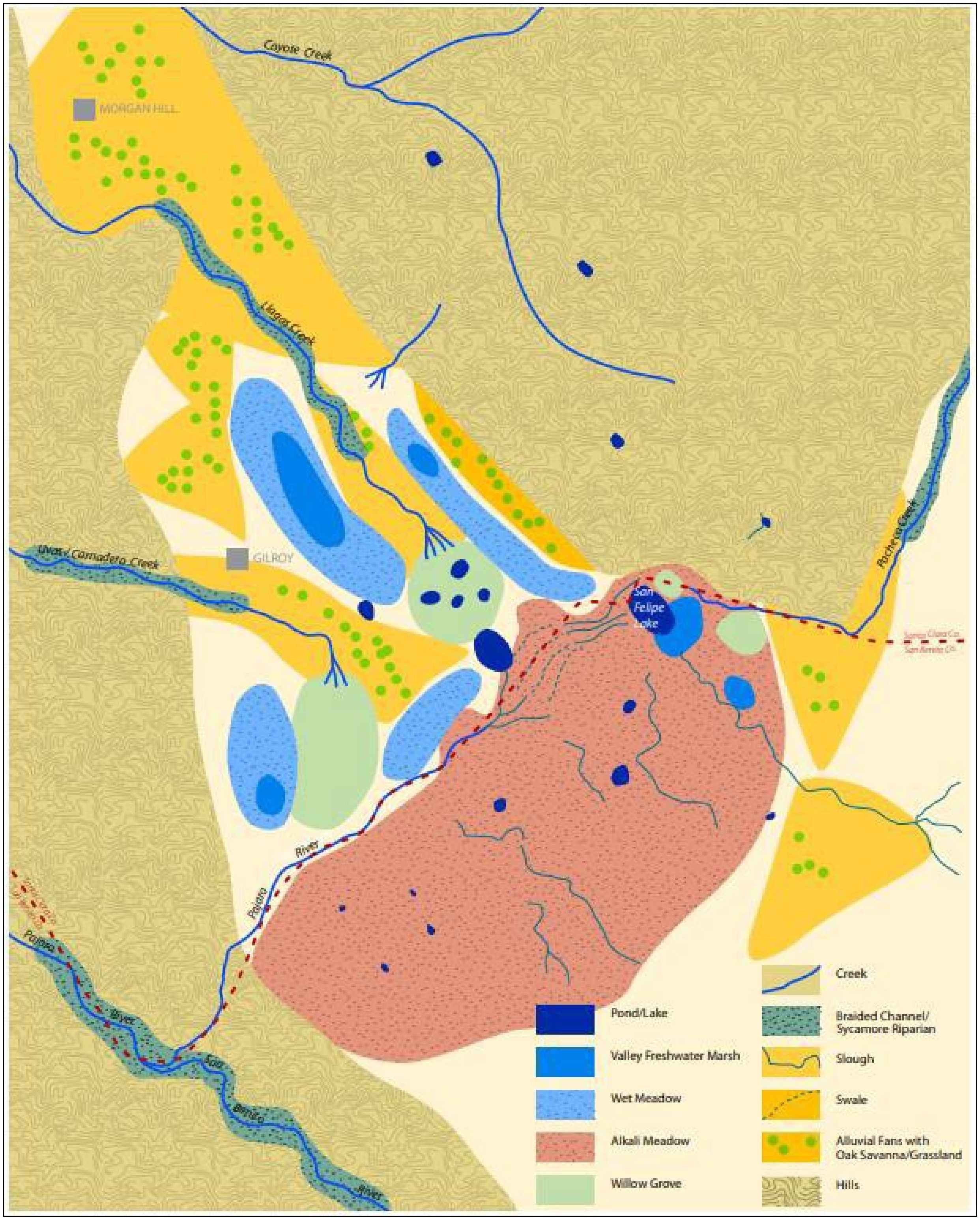
The project site contained lagoons and willow swamps before being developed into the Montes property in 1808. In 1874, the 3-mile-long Millers Canal was built to efficiently convey water from San Felipe Lake. In addition, a levee was built at the former outlet for Pajaro River, effectively cutting off surface water supply to the upper four miles of the Pajaro River. By 1917, Llagas Creek was channelized, and the property became well drained for cattle grazing. Llagas Creek was then leveed sometime before 1955, reducing the channel-floodplain connectivity, flood frequency, moisture content, and sediment deposition on the property. (Phillip Williams & Associates 2004: 2–3)

The Soap Lake area has experienced variable groundwater levels due to pumping and water imports from the Central Valley Project. In 1977, the aquifer reached historic lows due to extractions for municipal, irrigation, and industrial uses. Finally, by 1993 Llagas Creek was reconstructed and enlarged. Once a larger watercourse than Llagas Creek, the Pajaro River within the project site was now a relict channel with little flow or dynamism. The river was converted to a narrow ditch used for drainage of surrounding grazing lands (upstream of Frazier Road) and row crop agriculture lands (downstream of Frazier Lake Road). (Phillip Williams & Associates 2004: 2)

5.3.2 Present-Day Conditions

The existing Pajaro River at the project site is largely a groundwater-fed remnant channel, approximately 4 to 6 feet deep and 30 feet wide. For 1 mile upstream of Frazier Lake Road, the Pajaro River acts as a maintained agricultural ditch until transitioning to an unmaintained swale heading east for 1.3 miles that terminates at an unnamed road and levee. Dry legacy sloughs are scattered across the remaining 0.4 mile to San Felipe Lake. The morphological legacy channel at the project site is a wide, shallow swale and adjacent low-flow channel, which runs in winter due to high groundwater levels. Millers Canal currently captures the surface water blocked by the levee at the former Pajaro watercourse. Since 1987, groundwater has been imported into San Felipe Lake by the Central Valley Project to recover or exceed historic levels.

The downstream confluence of the Pajaro River and Llagas Creek provides a source of ponding in the southern section of the property during flood events in Llagas Creek. Larger winter flood events (> 7-year events) generate overflow from San Felipe Lake that spills from Miller Canal into the upper Pajaro River (Phillip Williams & Associates 2008: 4). These surface flows tend to be extremely brief. Willow patches are present along the project portion of the Pajaro River, before transitioning to alkaline meadow upstream of the project site. Several other small drainages join the mainstem downstream of the Llagas Creek confluence, developing the river into a perennial system in contrast to the seasonal nature of the upper portion. Figure 5-4 illustrates the conceptual model of landscape-level habitat patterns in south Santa Clara and north San Benito Counties prior to significant Euro-American modification.



Source: Grossinger et al. 2008: 178

Figure 5-4. Conceptual Model of Landscape-Level Habitat Patterns in South Santa Clara and North San Benito Counties

5.3.3 Storm Recurrence Intervals

No stream gage exists on the Pajaro River upstream of Llagas Creek, thus requiring hydrologic investigation to determine streamflow for relevant storm recurrence intervals (FlowWest 2016: 1). StreamStats is a web-based tool that provides streamflow statistics for both U.S. Geological Survey (USGS) stream gaging stations and user-selected ungaged sites on streams (U.S. Geological Survey 2016). This tool was used to delineate the watershed at the project site, so that the watershed area could be used in rainfall-runoff calculations. The historic drainage area to the site has been heavily altered by roadways, irrigation ditching, and the installation of Millers Canal. Therefore, the drainage delineated by StreamStats at the project site had to be manually edited using geographic information system (GIS) technology to remove drainage that is primarily captured by Bloomfield Avenue, Route 152, and Millers Canal. The estimated drainage area is 2.17 square miles (1,392 acres). The Graphic Peak Discharge was then used to compute peak volumetric flow at the project site. The peak discharge equation is as follows:

$$q_p = q_u A_m Q F_p$$

Equation 5-1

Where q_p is peak discharge (cfs), q_u is unit peak discharge (csm/in), A_m is drainage area (mi^2), Q is runoff depth (in), and F_p is the pond and swamp adjustment factor. There are no ponds in the watershed, so F_p is 1.00. The Soil Conservation Service (SCS) runoff curve number method was used to calculate runoff depth because the watershed area is larger than 1 square mile, making the Rational Method unusable (Natural Resources Conservation Service 1986). The SCS runoff equation is as follows:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

Equation 5-2

Where Q is runoff (in), P is rainfall (in), and S is potential maximum runoff retention after runoff begins (in). S is related to the soil and cover conditions of the watershed through the curve number (CN). S is related to CN by:

$$S = \frac{1000}{CN} - 10$$

Equation 5-3

The hydrologic soil group (HSG), land cover, and impervious area each determine the CN. Table 2-2a of TR-55 was used to estimate the curve number based on the project site's characteristics. ArcGIS Online provides spatial coverage of these three characteristics as basemap layers that can be intersected with the watershed area (Natural Resources Conservation Service 2019a; Multi-Resolution Land Characteristics 2020; NOAA GeoPlatform 2020). This tool was used to determine the HSG, land cover, and impervious area that make up the contributing watershed at the project site. Clay, clay loam, and loam are the primary surface layer soil textures in the watershed and the soils are generally in HSGs C and D. The watershed land cover is primarily open space and low intensity development, grassland, and cultivated crops. The maximum percent impervious is 65% with a minimum of 0% and median of 9%. The overall curve number for the watershed was weighted by area for these three components.

The precipitation depths of each storm reccurrence interval had to be determined using NOAA Atlas 14, which provides precipitation frequency estimates for various areas of the United States (Perica et al. 2014); 24-hours was selected as the storm duration for each event as directed in TR-55. The site falls under rainfall distribution type I.

With the SCS runoff equation we are able to calculate runoff depth, but further investigation is required to determine runoff discharge with the Graphical Peak Discharge equation. Time of concentration is estimated as water moves through the watershed as sheet flow, shallow concentrated flow, and open channel flow. Sheet flow is first calculated for the first 300 feet in the headwater of the watershed:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$

Equation 5-4

Where T_t is travel time (hr), n is Manning's roughness coefficient (dimensionless), L is flow length (ft), P_2 is the 2-year, 24-hour rainfall (in), and s is the slope of hydraulic grade line (land slope, ft/ft). Cultivated soils with residue cover more than 20% was used to describe the land cover in this section from Table 3-1 in TR-55. Shallow concentrated flow is then calculated with the following equation:

$$T_t = \frac{L}{3600V}$$

Equation 5-5

Where V is average velocity (ft/s). Figure 3-1 from TR-55 was used to estimate the average velocity based on the watercourse slope and unpaved conditions in this segment. Open channel flow makes up the last segment in this watershed as runoff enters the Pajaro River. Manning's equation is used to estimate flow velocity as follows:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

Equation 5-6

Where r is hydraulic radius (area/wetted perimeter, ft). Manning's n for this segment was assumed to be very weedy reaches with heavy stand of underbrush (Chow 1959). Time of concentration is calculated as the sum of T_t values for the three segments. Exhibit 4-1 of TR-55 is then used to estimate unit peak discharge with the time of concentration and the ratio of initial abstraction (I_a = 0.2S) and precipitation. With this information the peak discharge for each storm recurrence interval was calculated (Table 5-1, column 2).

Despite capturing a majority of the Pajaro's historic flows, Millers Canal also contributes flow to the current day Pajaro by way of overflow. Phillip Williams and Associates (2008) determined that water in Millers Canal overflows around the 7-year event and estimated flows into the Pajaro at the project site for each recurrence interval (Table 5-1, column 3). The total peak discharge for this section of the Pajaro River is sum of watershed runoff and Millers Canal overflow (Table 5-1, column 4).

Table 5-1. Selected Peak Discharge Recurrence Intervals and Corresponding Discharges

Storm Recurrence Interval (years)	Watershed Runoff (cfs)	Overflow from Millers Canal (cfs)	Total Peak Discharge (cfs)
1	52	0	52
2	94	0	94
5	153	0	153
10	205	51	256
25	282	4,191	4,473
50	344	6,790	7,134
100	409	8,453	8,862
500	563	8,454	9,017

cfs = cubic feet per second

5.4 HEC-RAS Model Development

5.4.1 Introduction

This section presents the procedures and results of a hydraulic analysis performed by ICF to analyze water surface elevations. This study used a numerical hydraulic model, Hydraulic Engineering Center – River Analysis System (HEC-RAS) v5.0.7, a 1D model gradually varied flow model developed and maintained by the US Army Corps of Engineers. HEC-RAS is the most common modeling platform for floodplain studies and was the platform used by Valley Water to analyze Llagas Creek.

5.4.2 Model Background

In the scope of work proposed by ICF and project partner (Triangle), the feasibility study requires a 1D model to be developed and calibrated using data collected in the field during flow events. This model would be used to assess existing conditions and to inform the restoration design (35% plans).

The model encompasses approximately 4,000 feet of the Pajaro River downstream of Frazier Lake Drive to its confluence with Llagas Creek (Figure 5-5). This reach is in a Federal Emergency Management Agency (FEMA) special flood hazard area (SPFHA), commonly referred to as the 100-year floodplain (Zone A). The left bank is covered by Flood Insurance Rate Map (FIRM) Panel 06069C0050D and the right bank is covered by FIRM Panels 06085C0757H and 06085C0760H. This area contains both freshwater marsh and riparian woodland vegetation, buffered by seasonal farmlands. Llagas Creek is a heavily regulated floodway with levees on its right and left banks and terminates at its confluence with the Pajaro River.

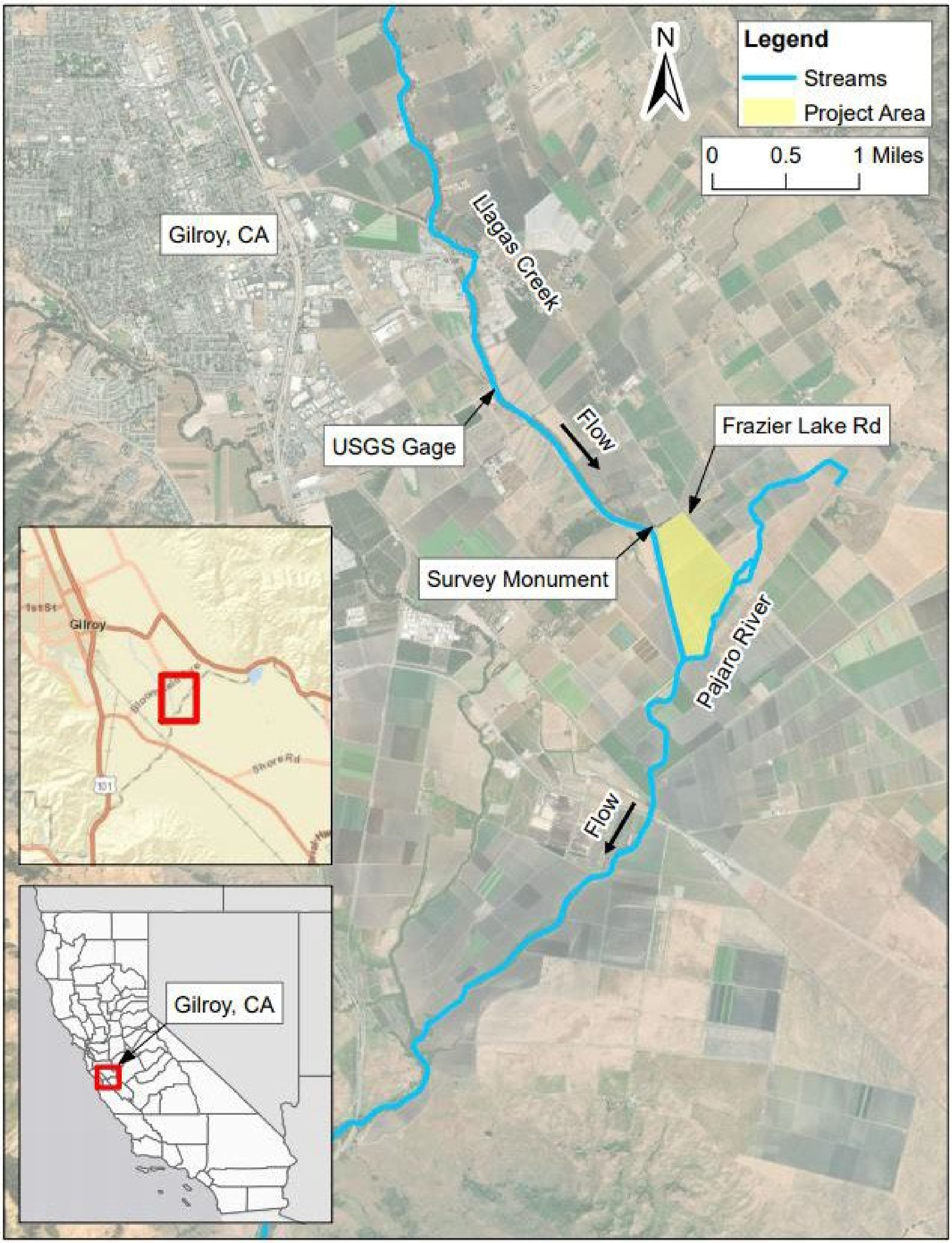


Figure 5-5. Pajaro Ranch River Agricultural Preserve Vicinity Map

The reach of the Pajaro River at the project site (project reach) currently does not have an existing FEMA model. Therefore, a topographic and bathymetric survey was completed on November 18 and 19, 2020. A brass disk on top of the concrete bridge deck of Bloomfield Road as it crosses Llagas Creek was used as a known elevation monument (158.01 US feet, NAVD88). The model centerline representing the project site of Pajaro River was traced from satellite imagery and cross referenced with the National Hydrography Dataset for California. The first cross section was located 118 feet downstream of the Frazier Lake Road bridge and the last cross section was located 3830 feet downstream of the bridge. Another 709 feet of river downstream of the surveyed cross sections were added to the model such that the confluence with Llagas Creek and its influence on upstream cross sections could be modeled. In HEC-RAS, one cross section was created in the upstream reach and two cross sections were created in the downstream reach of Pajaro River, the reach below the confluence with Llagas Creek. They were created using Light Detection and Ranging (LiDAR) imagery provided by Technology Services and Solutions GIS Department on March 8, 2021. The presence of abundant riparian and in-stream vegetation in the LiDAR surface required interpolation of the channel bottom for these three cross sections.

The District provided a copy of its existing conditions model for Llagas Creek, which was imported into the ICF-created Pajaro River model (Figure 5-6). The original model included an upper reach and tributary that combine to form the main channel with levees, where the cross sections are evenly spaced 100 feet apart. For the purposes of the Project, the Llagas Creek model was shortened to start at river station 10900 where a USGS gage is located (discussed below). This model was joined to the upstream and downstream reaches of Pajaro River with a junction labeled “Confluence.” With all three reaches connected, the river stations were recalculated in RASMapper to reflect new distances to the downstream-most cross section.

Manning’s roughness coefficient was previously defined for the Llagas Creek cross sections in three areas: 0.09 to 0.1 for the channel, 0.045 to 0.05 for the levee, and 0.038 for the overbank.

Accordingly, the Manning’s roughness coefficient was estimated for the Pajaro River reaches: 0.11 to 0.12 for the channel and 0.038 for the overbank locations. The channel roughness corresponds to the normal value for very weedy reaches with deep pools or floodways with heavy stand timber and underbrush (Chow 1959). The overbank roughness corresponds to floodplains located in pastures with no brush and low grass (Chow 1959).

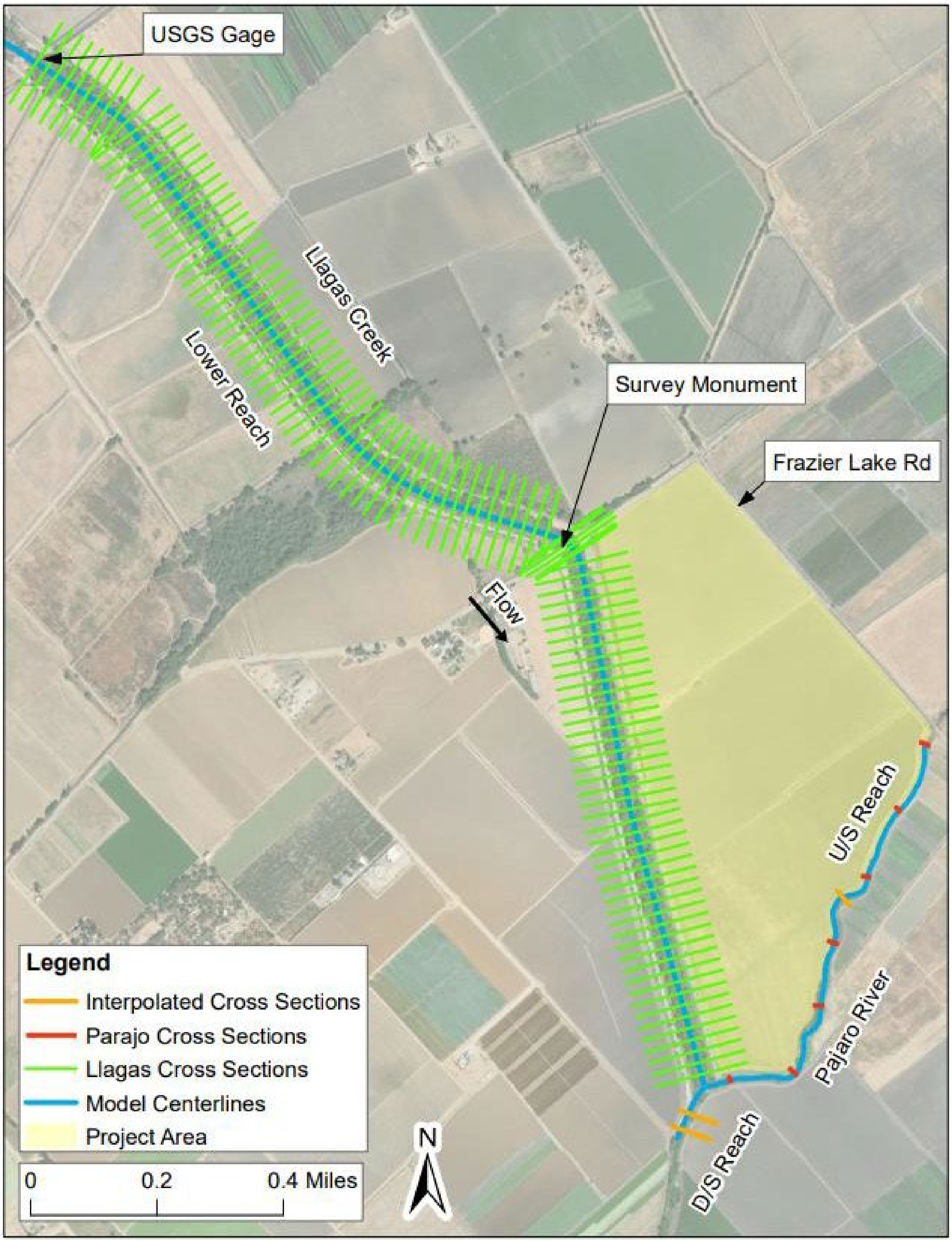


Figure 5-6. Pajaro Ranch River Agricultural Preserve Existing Conditions Map

The existing conditions model is based on a flood event that occurred January 30, 2021 (Table 5-2). The flow entering the project reach was measured as 3.2 cfs at the intersection of Pajaro River and Frazier Lake Drive. Water surface elevations were also recorded at each cross section on the upstream reach of Pajaro River during the event for calibration purposes. The flow for Llagas Creek was downloaded from USGS gage number 11153650, using the daily flow value from January 30. This gage is located at 36°59’15”, 121°31’34” NAD27, approximately 2 miles upstream of Llagas Creek’s confluence with Pajaro River. To define the inflow for the downstream reach of the Pajaro River, the discharges from Llagas Creek and upstream Pajaro River were simply added together. Boundary conditions were dependent on the junction (Confluence) between reaches and the normal depth based on the downstream longitudinal slope (Table 5-3). Since the downstream most cross section was drawn from LiDAR, the water surface elevation was not recorded in the field and thus could not be used to set the downstream boundary condition.

Table 5-2. Steady Flow Data in the Existing Conditions Model

River	Reach	River Station	Flow (cfs)
Llagas Creek	Lower	10,912	17.1
Pajaro River	Upstream	4,421	3.2
Pajaro River	Downstream	231	20.3

cfs = cubic feet per second

Table 5-3. Boundary Conditions in the Existing Conditions Model

River	Reach	Upstream	Downstream
Llagas Creek	Lower	N/A	Junction = Confluence
Pajaro River	Upstream	N/A	Junction = Confluence
Pajaro River	Downstream	Junction = Confluence	Normal Depth S = 0.008

N/A = not applicable

5.4.3 Model Results and Discussion

A steady flow simulation of the January 30 flood flow was run using subcritical conditions to determine the pending effective water surface elevation (Table 5-4).

Table 5-4. January 30 Flood Water Surface Elevations for Existing Conditions

River	Reach	River Station (feet)	Modeled WSE (feet)
Pajaro River	Upstream	4,421	140.3
Pajaro River	Upstream	3,799	139.4
Pajaro River	Upstream	3,177	138.5
Pajaro River	Upstream	2,882	137.8
Pajaro River	Upstream	2,457	137.8
Pajaro River	Upstream	1,913	137.7
Pajaro River	Upstream	1,275	137.7
Pajaro River	Upstream	709	137.7
Pajaro River	Downstream	231	137.6

River	Reach	River Station (feet)	Modeled WSE (feet)
Pajaro River	Downstream	83	137.1
Llagas Creek	Lower	10,912	147.0
Llagas Creek	Lower	10,812	147.0
Llagas Creek	Lower	10,712	146.7
Llagas Creek	Lower	10,612	146.3
Llagas Creek	Lower	10,512	146.1
Llagas Creek	Lower	10,412	146.1
Llagas Creek	Lower	10,312	145.9
Llagas Creek	Lower	10,212	145.8
Llagas Creek	Lower	10,112	145.8
Llagas Creek	Lower	10,012	145.7
Llagas Creek	Lower	9,912	145.6
Llagas Creek	Lower	9,812	145.5
Llagas Creek	Lower	9,712	145.3
Llagas Creek	Lower	9,612	145.0
Llagas Creek	Lower	9,512	144.9
Llagas Creek	Lower	9,412	144.7
Llagas Creek	Lower	9,312	144.4
Llagas Creek	Lower	9,212	144.2
Llagas Creek	Lower	9,112	144.0
Llagas Creek	Lower	9,012	143.8
Llagas Creek	Lower	8,912	143.4
Llagas Creek	Lower	8,812	143.1
Llagas Creek	Lower	8,712	143.0
Llagas Creek	Lower	8,612	142.8
Llagas Creek	Lower	8,512	142.5
Llagas Creek	Lower	8,412	142.3
Llagas Creek	Lower	8,312	142.2
Llagas Creek	Lower	8,212	142.1
Llagas Creek	Lower	8,112	142.0
Llagas Creek	Lower	8,012	141.9
Llagas Creek	Lower	7,912	141.9
Llagas Creek	Lower	7,812	141.8
Llagas Creek	Lower	7,712	141.8
Llagas Creek	Lower	7,612	141.8
Llagas Creek	Lower	7,512	141.7
Llagas Creek	Lower	7,412	141.7
Llagas Creek	Lower	7,312	141.7
Llagas Creek	Lower	7,212	141.7
Llagas Creek	Lower	7,112	141.6

River	Reach	River Station (feet)	Modeled WSE (feet)
Llagas Creek	Lower	7,012	141.6
Llagas Creek	Lower	6,912	141.6
Llagas Creek	Lower	6,812	141.6
Llagas Creek	Lower	6,712	141.5
Llagas Creek	Lower	6,612	141.5
Llagas Creek	Lower	6,512	141.5
Llagas Creek	Lower	6,412	141.4
Llagas Creek	Lower	6,312	141.4
Llagas Creek	Lower	6,212	141.4
Llagas Creek	Lower	6,112	141.4
Llagas Creek	Lower	6,012	141.3
Llagas Creek	Lower	5,912	141.2
Llagas Creek	Lower	5,812	141.1
Llagas Creek	Lower	5,712	140.8
Llagas Creek	Lower	5,612	140.5
Llagas Creek	Lower	5,512	140.2
Llagas Creek	Lower	5,412	139.8
Llagas Creek	Lower	5,312	139.7
Llagas Creek	Lower	5,212	139.5
Llagas Creek	Lower	5,112	139.4
Llagas Creek	Lower	5,012	139.4
Llagas Creek	Lower	4,912	139.3
Llagas Creek	Lower	4,796	139.2
Llagas Creek	Lower	4,773	139.2
Llagas Creek	Lower	4,716	139.2
Llagas Creek	Lower	4,694.5	Bridge
Llagas Creek	Lower	4,673	139.2
Llagas Creek	Lower	4,623	139.1
Llagas Creek	Lower	4,603	139.1
Llagas Creek	Lower	4,512	138.9
Llagas Creek	Lower	4,412	138.8
Llagas Creek	Lower	4,312	138.7
Llagas Creek	Lower	4,212	138.7
Llagas Creek	Lower	4,112	138.6
Llagas Creek	Lower	4,012	138.5
Llagas Creek	Lower	3,912	138.5
Llagas Creek	Lower	3,812	138.4
Llagas Creek	Lower	3,712	138.4
Llagas Creek	Lower	3,612	138.4
Llagas Creek	Lower	3,512	138.3

River	Reach	River Station (feet)	Modeled WSE (feet)
Llagas Creek	Lower	3,412	138.3
Llagas Creek	Lower	3,312	138.3
Llagas Creek	Lower	3,212	138.2
Llagas Creek	Lower	3,112	138.2
Llagas Creek	Lower	3,012	138.2
Llagas Creek	Lower	2,912	138.2
Llagas Creek	Lower	2,812	138.1
Llagas Creek	Lower	2,712	138.1
Llagas Creek	Lower	2,612	138.1
Llagas Creek	Lower	2,512	138.1
Llagas Creek	Lower	2,412	138.0
Llagas Creek	Lower	2,312	138.0
Llagas Creek	Lower	2,212	138.0
Llagas Creek	Lower	2,112	138.0
Llagas Creek	Lower	2,012	137.9
Llagas Creek	Lower	1,912	137.9
Llagas Creek	Lower	1,812	137.9
Llagas Creek	Lower	1,712	137.8
Llagas Creek	Lower	1,612	137.8
Llagas Creek	Lower	1,512	137.8
Llagas Creek	Lower	1,412	137.8
Llagas Creek	Lower	1,312	137.8
Llagas Creek	Lower	1,212	137.8
Llagas Creek	Lower	1,112	137.8
Llagas Creek	Lower	1,012	137.7
Llagas Creek	Lower	912	137.7
Llagas Creek	Lower	812	137.7
Llagas Creek	Lower	712	137.7
Llagas Creek	Lower	612	137.7
Llagas Creek	Lower	512	137.7
Llagas Creek	Lower	412	137.7
Llagas Creek	Lower	312	137.7
Llagas Creek	Lower	212	137.6
Llagas Creek	Lower	112	137.6

WSE = water surface elevation

The water surface elevations modeled in HEC-RAS were compared to field surveyed values such that the model could be calibrated using Manning's roughness coefficient (Table 5-5).

Table 5-5. Comparison of Surveyed and Modeled Water Surface Elevations (feet)

River Station	Surveyed WSE	Modeled WSE	Difference between modeled and surveyed WSE[a]
4421	140.6	140.3	-0.3
3799	139.7	139.4	-0.3
3177	138.7	138.5	-0.2
2882	N/A	137.8	N/A
2457	138.5	137.8	-0.7
1913	138.4	137.7	-0.7
1275	138.3	137.7	-0.6
709	138.0	137.7	-0.3

[a] Negative values mean a decrease in water surface elevation between modeled and surveyed WSEs.
WSE = water surface elevation; N/A = not applicable

The difference between modeled to surveyed WSE ranges from -0.2 to -0.7 feet. The discrepancy between these results may arise for several reasons. The discharge used for Llagas Creek is the daily mean from the same day where flow was recorded for the Pajaro River upstream reach, rather than the exact discharge measured at the same time. The interpolated cross sections were drawn from LiDAR that was heavily influenced by in-stream vegetation, requiring estimation of the channel bottom in contrast to the surveyed cross sections.

Although the 1D hydraulic model provides insight on the Pajaro River's conveyance capacity, more advanced two-dimensional (2D) modeling would be required to investigate channel-floodplain interactions. The hydrologic assessment determined that flood events in this section of the Pajaro River range from 50 to 9,000 cfs, significantly higher than the flow of 3 cfs recorded in the field.

Chapter 6
Geomorphic Assessment

6.1 Introduction

A geomorphic assessment was conducted to better understand the fluvial geomorphic dynamics within the project site. The surveyed area examined included a distance of approximately 4,000 feet, and included the entirety of the project site (i.e., the area between and the Pajaro River's confluence with Llagas Creek; however, the channel network upstream of the project site was also examined at other accessible locations to provide a greater understanding of the local watershed geomorphic characteristics. Data collected during the field assessment included a host of geomorphic attributes, or indicators, described below. Topographic data (longitudinal profile and cross sections) needed for the HEC-RAS model as described in Chapter 5, *Hydrologic Assessment*, was also collected during the field assessment. Relevant literature findings are also included where appropriate and needed. Opportunities and constraints associated with geomorphology are presented in Chapter 11, *Restoration Opportunities and Constraints*.

6.2 Methods

The focus of the geomorphic assessment was to determine the dominant geomorphic processes, document the landforms, and determine how the observed morphology of the project site is influenced by the surrounding land uses and the hydrologic regime. Likewise, collection of geomorphic information aided in the determination of overall project site stability (and how proposed restoration activities would influence the present level of stability).

The geomorphic assessment was conducted in late fall 2020 to evaluate the channel bed and banks with the lowest amount of water possible. The geomorphic assessment was conducted by a geomorphologist with expertise in channel and floodplain restoration, channel stability analyses, and topographic surveying techniques. The geomorphologist was assisted by both a fish biologist with extensive topographic surveying experience and a conservation biologist with abundant familiarity of the project site.

The geomorphic assessment included evaluation of the following indicators.

- Channel Classification
- Local Watershed Inputs
- Hydrologic and Flow Patterns
- Riparian Vegetation Condition
- Bankfull Width and Depth and Wetted Width
- Bank Instability and Bank Characteristics
- Channel Bed Substrate Composition and Embeddedness
- Channel Complexity

- Degree of Channel Incision
- Stage of Channel Evolution
- Cross Section and Longitudinal Profile Surveys

These variables were assessed for each reach in the project site (Figure 6-1). In addition, permanent cross sections were established within each reach for collection of additional qualitative and quantitative information. Methods for collection of these indicators are described below.

6.2.1 Channel Classification

River segments can be classified into three generalized classifications based on their position in the watershed and the relative balance of transport capacity to sediment supply (Montgomery and Buffington 1998). Headwater source areas are typically transport-limited (often due to limited channel runoff) but do offer sediment storage that is intermittently initiated under large flow events, debris flows, or other gravitational events. Transport segments are composed of morphologically resilient, supply-limited reaches (e.g., bedrock, cascade, and step-pool) that rapidly convey increased sediment inputs. Response segments consist of lower-gradient, more transport-limited depositional reaches (e.g., plane-bed, pool-riffle) where channel adjustments occur in response to changes in sediment supply delivered from upstream.

The Pajaro River in the vicinity of the project site was classified accordingly based on the types of segments as described above.

6.2.2 Local Watershed Inputs

A reconnaissance of the watershed immediately upstream of the project site was conducted to identify any major inputs of sediment and runoff into the Pajaro River. The objective was to identify any land use changes that could alter the balance of sediment supply and runoff that could lead to future instability (e.g., channel aggradation or degradation) in the project site. Any other anthropogenic features (such as, pipe outfalls, rock slope protection, grade control structures, etc.) were also noted within each reach at the project site.

6.2.3 Hydrologic and Flow Patterns

The hydrologic pattern of the Pajaro River was determined throughout the length of the project site and included identifying whether streamflow is perennial, intermittent, or ephemeral. Perennial streams are those that flow year-round; intermittent streams are those that flow during certain times of the year and they receive water from both surface water and groundwater; and ephemeral streams are those that have their channels above the water table year-round and only receive water from surface runoff.

Flow pattern information was synthesized from previous studies, primarily FlowWest's 2016 technical memorandum (FlowWest 2016).

Figure 6-1
Pajaro River Reaches and Cross Section Locations

6.2.6 Riparian Vegetation Condition

Riparian condition refers to a description of the general health of the riparian area, focusing on the amount and type of vegetative cover. Riparian condition was described as low (0–25 % vegetative cover), moderate (25–50 % vegetative cover), high (50–75 % vegetative cover), or very high (75–100% vegetative cover). The size and approximate age of any riparian vegetation growing in the active channel margin was documented since this is evidence of channel adjustment and possible restabilization from a prior disturbance.

6.2.7 Bankfull Width and Depth and Wetted Width

Bankfull width and depth measurements were recorded to assess the hydraulic capacity of the channel. Specifically, a geomorphic or effective bankfull surface was identified in the field. The geomorphic bankfull or effective surface is the surface that gets inundated by the discharge that performs the most geomorphic work on a system, typically a flow that occurs every 1.5 to 2 years (Knighton 1999). This discharge, known as the geomorphic bankfull discharge, is defined as that water discharged when stream water just begins to overflow into the active floodplain. The geomorphic bankfull or effective surface was identified based on the methodology of Harrelson et al. (1994) and Hauer and Lamberti (1996). Once this surface was recognized, width and depth measurements were recorded.

Similar to bankfull width and depth measurements, wetted width and depth measurements were recorded. Specifically, the wetted surface was identified in the field, and once determined, width and depth measurements were recorded.

In addition, the “active channel” width was identified, which represents a typical low to moderate flow regime within the Site and, in the case of the Pajaro River, is bounded by the width of the in-channel vegetation.

6.2.8 Bank Instability and Bank Characteristics

The term *bank instability* refers to streambanks that are either actively retreating or have the potential to retreat in the near future. In brief, weakening processes are any bank or near-bank processes that act to erode or prepare streambanks for further erosion (Lawler 1992). The purpose of assessing this indicator was to identify fluvial erosion (erosion associated with flowing water) and bank failure (erosion associated with gravitational forces and weakening processes). Fluvial erosion is closely related to boundary shear stress, which can be loosely approximated by unit stream power variations, and bank failure is collapse of all or part of the streambank in situ (Lawler 1995).

Bank stability is defined as the natural streambank that has stable groundcover. Stable ground cover includes rooted trees, shrubs, herbaceous plants, and naturally occurring rocky substrates. The terms defined in Table 6-1 were used to describe observed bank stability conditions, and banks were either described as stable, potentially unstable, or unstable.

Table 6-1. Terms Used to Describe Bank Stability Conditions[a]

Category	Term	Definition
Streambanks	Stable streambank	Has 75% or more cover of live plants and/or other stability elements that are not easily eroded and has no instability elements
	Potentially unstable streambank	Has 75% or more cover but has one or more instability element(s)b
	Unstable streambank	Has less than 75% cover of live plants and/or other stability elements and/or one or more instability element(s) (unstable streambanks are often bare or nearly bare streambanks composed of non-cohesive soil that is susceptible to fluvial erosion; particle size may vary depending on streambank material)
Stability elements	Live plants	Perennial herbaceous species, such as grasses, sedges, rushes; woody shrubs, such as willows; broadleaf trees, such as cottonwood and alder; conifer trees; and plant roots that are on or near the surface of the streambank and provide substantial binding strength to the streambank material
	Rock	Boulders, bedrock, and cobble/boulder aggregates that are combined to form a stable mass
	Downed wood	Logs firmly embedded in streambanks
	Erosion-resistant soil	Hardened conglomerate or cohesive clay/silt streambanks
Instability elements	Bank height	Moderately high to high bank height relative to surrounding streambanks
	Fracturing, blocking, or slumping	Cracks near the top of the streambank, slumping streambanks, and blocks of soil/plant material that have fallen off or slid down the streambank
	Mass movement	Bank failure from landslides and gravity erosion of over-steepened streambank slopes
	Undercutting	Frequent or continuous scour; significant to severe undercutting

[a] Based on definitions of streambank conditions in the U.S. Forest Service Region 5 Stream Condition Inventory Guidebook.

[b] Exception: Streambank would be classified as stable if bank height is the only instability element present.

6.2.9 Channel Bed Substrate Composition and Embeddedness

Substrate composition and embeddedness refer to the size of the substrate materials on the channel bed, and the degree to which these materials are embedded. These conditions indicate how frequently the channel substrate is mobilized. Substrate composition and embeddedness typically are measured using the methods described by Bunte and Abt (2001). However, formal pebble counts were not necessary because of obvious fine-dominated nature of the channel bed. Accordingly, substrate composition and embeddedness were visually described (not directly measured).

6.2.10 Channel Complexity

The presence or absence of gravel bar development and evidence of scour and/or deposition was determined throughout the length of the project site. Pool and riffle habitats containing in-channel structures (e.g., instream woody material) that create complexity and habitat niches for aquatic organisms were also documented. Basic channel or habitat units (e.g., pool, riffle, and run) were delineated according to standard habitat mapping descriptions at each cross section.

Channel or habitat units were defined as follows.

- **Pool:** Slow water, length and width at least one-half the bankfull channel width, and a 10-inch minimum residual pool depth. Subcategories define the general type of pool and include scour (lateral, channel, channel confluence, plunge), dam, and backwater, as defined by Overton et al. (1997).
- **Riffle:** Swiftly flowing, turbulent water, some partially exposed substrate, substrate cobble, and/or boulder dominated (McCain et al. 1990).
- **Flatwater:** Wide, uniform channel bottom, low to moderate water velocity, and little surface agitation. Encompasses any areas that do not qualify as pool or riffle (McCain et al. 1990).

No formal stream habitat inventory was conducted for the entire project site, such as the habitat inventory based on the methods described in the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 2010).

6.2.11 Degree of Channel Incision

The degree to which the channel is incised was recorded. The degree of incision was qualitatively analyzed using the following criteria.

- **Identification of any Quaternary landforms on the floodplain (e.g., terraces, low floodplain, fan, etc.).** Terraces typically have steep streambanks and the channel may not necessarily be incised. Steep, unstable streambanks adjacent to a low floodplain surfaces, however, typically indicate incision.
- **Identification of bedforms downstream of the site where and if the channel is less incised.** Bed and streambank material from incised channels would typically be deposited downstream in somewhat uncharacteristically large deposits on the channel bed (downstream aggradation).
- **Recognition of base level changes downstream.** Dams and other barriers can create upstream changes in channel bed elevation (i.e., headward migration of incision).
- **Visual survey of channel bed at the project site.** Channel or habitat sequences, such as pool-riffle sequences, are rare in incised channels, and those that do exist do so for only limited time intervals. Additionally, the increased depth of flow associated with incision, coupled with an increased flashy regime, results in bed armoring and a decreased frequency of bed mobilization.
- **Determination of the health of the riparian and floodplain plant species.** Plants that are found in similar, un-incised reaches are usually not present in incised reaches. No vegetation at all is an indicator of no hydrologic interaction between the floodplain and the channel and therefore incision.

- **Identification of recent evidence of overbank deposition of fine sediment, plant debris, or other organic matter.** A channel that floods its streambanks frequently would typically have splay (i.e., sand) deposits and vegetation with a smoothed, flooded appearance in the downstream direction. Natural levee development is also an indication of frequent flooding.

The degree of incision was recorded as negligible, low, moderate, high, or very high.

6.2.12 Stage of Channel Evolution

A stream evolution model (Cluer and Thorne 2013) was applied to the Ephemeral Drainage to provide a template for understanding geomorphic responses and processes within the immediate watershed. The stream evolution model of Cluer and Thorne (2013) revisits and updates two well-established channel evolution models (Schumm et al. 1984; Simon and Hupp 1987) in light of recent research and the authors' practical experiences.

6.2.13 Cross Section and Longitudinal Profile Surveys

Permanent[3] cross sections were established throughout the project site perpendicular to the primary channel following the methodology of Harrelson et al. (1994). In the field, a topographic cross section was collected at seven permanent locations throughout the project site, occurring approximately every 500 to 600 feet (Figure 6-1). Each transect was surveyed using ground-based surveying equipment to capture and track channel morphology; elevations along the cross section were collected at intervals close enough to capture slope breaks and distinct morphological features within the floodplain, and along the channel sides and bottom.

In addition to the seven permanent cross sections that were established in the field, an eighth cross section was interpolated (cross section XS-4) using LiDAR. This cross section is at the upstream end of Reach 2a (Figure 6-1), downstream of where anticipated grading activities would occur in Reaches 1a and 1b.[4]

The location of each cross section was permanently marked in the field using 4-foot-tall metal t-posts or wooden lathes (to easily find the general transect location) and with rebar driven vertically into the ground surface, capped with an appropriate cover (to establish known permanent elevations [permanent monuments or benchmarks] on each side of the transect). The permanent benchmarks for each transect was placed in a stable location above the active channel on the left (south) and right (north) banks (or terraces) of the channel. Transect endpoints (i.e., the permanent monuments) were documented using a GPS unit. Numerous representative photographs were taken at each cross section.

In addition to the cross sections, a longitudinal profile was surveyed throughout the length of the channel within project site. The longitudinal profile encompassed the entire length of the project site (approximately 4,000 feet). The spacing between channel bed data points varied depending on the complexity of the channel bed characteristics, averaging roughly every 40 feet (spacing was significantly smaller in the upstream portion of the project site [Reaches 1a and 1b] where a

[3] The morphology of these cross sections may change at certain locations, depending on the chosen restoration activities, but they could continue to be surveyed on a periodic basis post-construction to document changes to the channel morphology, as well as the adjacent floodplain.
[4] The presence of this cross section with the HEC-RAS model will aid in the determination of hydraulic effects in this transition zone, once proposed conditions are modeled.

majority of the restoration activities for the second phase of the project would occur). Digital photographs were taken in the upstream and downstream directions at various locations throughout the longitudinal profile. The location of each cross section was surveyed on the longitudinal profile for graphical plotting purposes.

6.2.13.1 Channel Geometry Metrics

As mentioned previously, bankfull width and depth measurements were recorded to assess the hydraulic capacity of the primary channels. This was completed at the cross sections measured in the field. In addition to bankfull and active channel width and depth measurements, the bankfull and entire channel width-to-depth ratio was calculated for each cross section, and sinuosity and gradient of the longitudinal profile was determined.

6.3 Results

Results from the geomorphic assessment are described below. Refer to Table 6-2 for a synthesis of the measured indicators.

6.3.1 Channel Classification

Based on field observations and the stream classification methodology of Montgomery and Buffington (1998), the Pajaro River in the vicinity of the project site (Figure 6-1) is an unconfined alluvial valley segment (not bound by valley wall topography on each side of the channel) dominated by a plane-bed morphology (a smooth channel bed with limited complexity). It is considered transport-limited, with the ability to adjust its bed morphology based on the available water or sediment input. Therefore, the channel in the project site generally hypothetically behaves as an area of geomorphic response (when adequate water is available) and is influenced by fluvial processes from upstream (as well as a backwater effect from Llagas Creek during periods of high flow on Llagas Creek).

As further discussed below the Pajaro River at the project site is a lowland, groundwater-driven, alluvial watercourse with a homogenous channel bed with significant instream vegetation, and functions as more of wetland than a riverine environment.

6.3.2 Local Watershed Inputs

Based upon our observations, there are no significant dams, weirs, or other structures that would act to control input of streamflow and/or modify the sediment transport regime. One well (artesian) was observed on the right bank at the downstream end of Reach 1b, located approximately 200 feet from the top of bank at cross section XS-3; this well appears to have no influence on the Pajaro River's hydrologic regime. Sediment sources in the channel appear to be mostly derived from the local banks and floodplains/terraces. The bedform structure (plane-bed morphology) and low gradient of the channel in the project site equate to a depositional environment that appears to act as a sediment sink, until flushing flows transport the material to downstream reaches. Without further study it is difficult to ascertain whether the amount of sediment transported out of the project site is in balance with the amount of sediment supplied into the project site; however, based on the geomorphic assessment observations, the channel bed does not appear to be excessively aggrading.

Table 6-2. Pajaro River Site Geomorphic Characteristics

	Reach				
Indicator	**1a**	**1b**	**2a**	**2b**	**3**
Riparian Vegetation Condition	Essentially absent (each bank)	Low (each bank)	High (each bank)	Very high (each bank)	Low to moderate (each bank)
Bankfull Width (feet)	XS-1 (40.0) and XS-2 (19.0)	XS-3 (43.0)	XS-4 (32.1), XS-5 (52.0), and XS-6 (44.5)	XS-7 (38.0)	XS-8 (42.0)
Average Bankfull Depth (feet)	XS-1 (0.91) and XS-2 (1.54)	XS-3 (2.39)	XS-4 (3.13), XS-5 (2.15), and XS-6 (2.33)	XS-7 (2.18)	XS-8 (1.88)
Wetted Width (feet)	N/A	N/A	N/A	N/A	XS-8 (10.3)
Bank Stability	Left bank – potentially unstable to stable / right bank – stable	Left bank – potentially unstable to stable / right bank – stable	Left bank – stable / right bank – stable	Left bank – stable / right bank – stable	Left bank – potentially stable to stable / right bank – stable
Bank Composition	Alluvium (primarily clay)	Alluvium (primarily clay)	Alluvium (primarily clay)	Alluvium (primarily clay)	Alluvium (primarily clay)
Bank Height (feet)	XS-1 (LB: 5.3 / RB: 4.6) and XS-2 (LB: 5.3 / RB: 4.5)	XS-3 (LB: 5.6 / RB: 5.1)	XS-4 (LB: 6.2 / RB: 9.1), XS-5 (LB: 7.6 / RB: 4.5), and XS-6 (LB: 5.4 / RB: 6.7)	XS-7 (LB: 4.9 / RB: 7.2)	XS-8 (LB: 3.2 / RB: 9.6)
Substrate Types	Clay and organics	Clay and organics	Clay and organics	Clay and organics	Fine gravels, clay and organics
Channel Complexity	Minimal (flatwater-dominated)	Minimal (flatwater-dominated)	Minimal (flatwater-dominated)	Minimal (flatwater-dominated)	Minimal (flatwater-dominated)
Degree of Incision	Low-moderate	Low - moderate	Low - moderate	Low - moderate	Low - moderate
Stage of Channel Evolution	Channelized	Channelized	Channelized	Channelized	Channelized

N/A = not applicable

Although no significant dams, weirs, or other structures that would act to control input of streamflow and/or modify the sediment transport regime were noted, the project site is essentially hydrologically severed from the mainstem Pajaro River and its former upstream drainage basin. In other words, anthropogenic manipulations to the local drainage network (as described in Chapter 5, *Hydrologic Assessment*) have greatly altered the hydrology and thus the sediment transport regime of the project site.

6.3.3 Hydrologic and Flow Patterns

Based on the well-documented groundwater presence associated with the project site (Casagrande 2011: 11; Grossinger et al. 2008: 49; Northgate Environmental Management, Inc. 2014: 6; Philip Williams & Associates, The San Francisco Estuary Institute, and H.T. Harvey & Associates 2008: 50-51; Wendell 2013:1), visual observations during the driest time of the year, and its longitudinal position within the drainage network, the Pajaro River in the vicinity of the project site appears to be a perennial watercourse. It is likely; however, that upstream of Frazier Lake Road it becomes an intermittent feature.

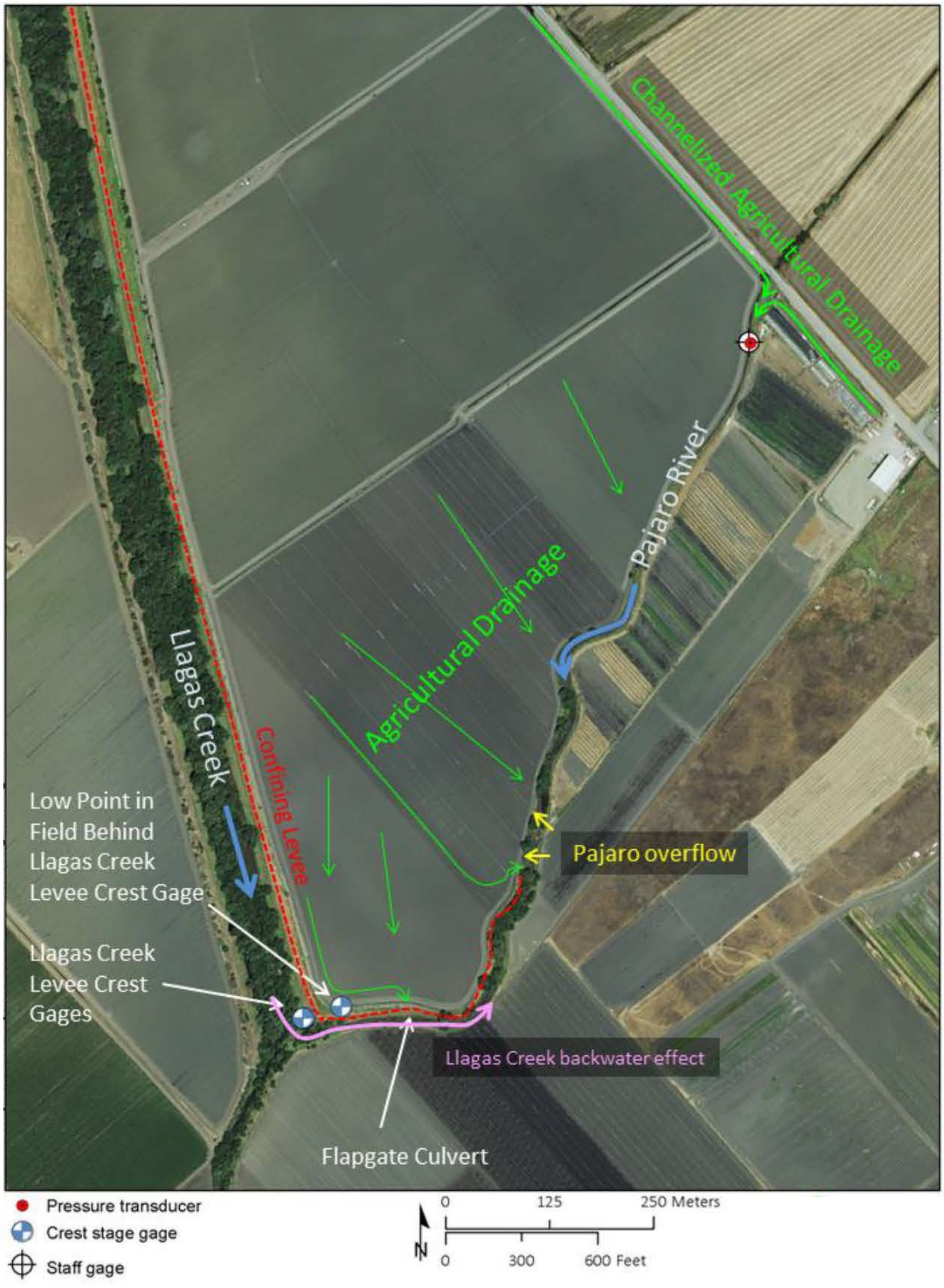
Based on available literature (FlowWest 2016: 6) and direct observations during the winter of 2020/2021, the river and local groundwater table antecedent conditions have a significant effect on how quickly river “wets” (sustains a minimal amount of water). As primarily a groundwater-fed system, the Pajaro River at the project site can only overbank a) when the system is previously partially to fully saturated; b) Llagas Creek is producing an adequate streamflow, which creates a backwater effect near its confluence with the Pajaro River (Photograph 6-1); and c) overflow channels in the vicinity of San Felipe Lake are activated and eventually direct flow into the project site.

Photograph 6-1. Slight backwatering effect on Pajaro River immediately upstream of confluence with Llagas Creek (January 30, 2021).

Findings from FlowWest (2016) relevant to this indicator are illustrated in Figure 6-2 and include the following.

- Once the Llagas Creek watershed becomes saturated enough to produce runoff, it creates the dominant water-surface-controlling conditions at its confluence with the Pajaro River, which reduces the ability of the Pajaro River upstream of the confluence to efficiently drain and typically causes a backwater effect that can lead to overtopping of the Pajaro River onto the project site (FlowWest 2016: 6).
- The northern portion of the project site drains partly to the east and west. The eastern half of the northern portion drains to a ditch running along the eastern boundary of the parcel and is conveyed to the Pajaro River at the Frazier Lake Road crossing. The western half of the northern portion drains to the northwest and into a ditch running down the western side of the project site and into Llagas Creek (FlowWest 2016: 6).
- The southern portion of the PRAP site generally drains from north to south, and readily ponds at the southern and southeastern ends during storms of about 0.75 to 1.0 inch in a 24-hour period (depending on antecedent conditions preceding a storm). Ponding on the southern portion of the project site can be exacerbated by break-out flows from the right bank of the Pajaro River (FlowWest 2016: 6).
- When Llagas Creek water surface elevations are influencing the streamflow dynamics at the project site, the Pajaro River can easily overtop its northern bank upstream of the Pajaro-portion of the confining levee (Figure 6-2 shown in red) and inundate parts of the project site (FlowWest 2016: 6).

During the geomorphic assessment, ICF observed a flapgate culvert (with a diameter of 3 feet and an approximate length of 43 feet) at the downstream end of Reach 3 which presumable serves to drain water of the inundated southern corner of the project site (Figure 6-2). The culvert's northern end starts at the left edge of the Toe Drain Channel (Figure 6-1) (a narrow, excavated channel that starts at the upstream end of Reach 2b, and runs parallel to the river on the landward side of the right bank levee terminating at the flapgate culvert) and extends in a southward direction under the right bank levee before discharging into the river.



Source: FlowWest 2016, Figure 5

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Figure 6-2
Hydrologic Character and Observed Flow Patterns

6.3.5 Riparian Vegetation Condition

Table 6-2 shows that riparian vegetation condition was described as essentially absent in Reach 1a; low in Reach 1b; high in Reach 2a; very high in Reach 2b; and low (at the upstream end) to becoming moderate in Reach 3 (toward the confluence with Llagas Creek). As described in Chapter 3, *Biological Site Conditions*, typical riparian trees on the banks include red willow and arroyo willow. Typical instream vegetation includes broadleaved cattail (*Typha latifolia*), hardstem bulrush, and American bulrush.

All riparian vegetation (in the form of trees) growing within the active channel margin appears to be mature, suggesting that there have been no major channel adjustments and restabilization following a prior disturbance (Photograph 6-2).

Photograph 6-2. Mature willow growth on active channel margins, Reach 2a (January 30, 2021).

6.3.6 Bankfull Width and Depth and Wetted Width

As shown in Table 6-2, bankfull width measurements ranged from 19.0 to 52.0 feet (average of 38.8 feet), while (average) bankfull depths ranged from 0.91 to 3.13 feet (average of 2.10 feet). Variation in bankfull width in the downstream direction is fairly minimal, equating to a relatively similar channel geometry with an average bankfull with of approximately 40 feet. Wetted width measurements were only possible in Reach 3 (at the cross section closest to the confluence with Llagas Creek, where wetted width was 10.3 feet) during the geomorphic assessment due to low flow conditions. However, wetted widths ranged from 15.5 to 50.0 feet (average of 34.7 feet) on January 30, 2021 after a large storm event (when data were collected for calibration of the HEC-RAS model).

6.3.7 Bank Instability and Bank Characteristics

Based on site observations, the left banks exhibited varying degrees of stability, although most banks fell under the stable and potentially unstable categories, while the right banks were primarily stable (Table 6-2). The potential instability of the left bank segments in Reaches 1a, 1b, and 3 stems from lack of stabilizing mature vegetation, oversteepening, and poor land use practices (improper erosion control) on the farmland property on the left bank terrace. Photographs 6-3 and 6-4 show examples of stable and potentially unstable banks as observed during the geomorphic assessment.

Photograph 6-3. Stable left bank, cross section XS-6, Reach 2a (November 17, 2020).

Photograph 6-4. Potentially unstable left bank, cross section XS-2, Reach 1a (January 30, 2021).

Bank composition is extremely uniform throughout the project site, dominated by clay (Table 6-2). Lenses of silt and fine sand were observed in various locations as well. The composition of the banks becomes dominated by coarser materials towards the confluence with Llagas Creek.

As shown in Table 6-2, bank height measurements (as measured from the toe of each bank to the top of each bank) ranged from 3.2 to 7.6 feet (average of 5.4 feet) on the left bank; and ranged from 4.5 to 9.6 feet (average of 6.4 feet) on the right bank.

6.3.8 Channel Bed Substrate Composition and Embeddedness

The channel bed substrate is dominated entirely by clay within each reach (Table 6-2). Organic material resulting from decomposition of the abundant in-channel vegetation is also present. Based on site observations, sediment sources in the channel appear to be mostly derived from the local banks and floodplains/terraces. Although the small size of the substrate lends itself to being readily entrained and transported, the excessive in-channel vegetation (and limited hydrology) renders the channel bed immobile at most times of the year.

6.3.9 Channel Complexity

No gravel bar development was observed within any reach within the project site. Additionally, no evidence of scour features and/or significant deposition areas was determined throughout the length of the project site. Pool and riffle habitats containing in-channel structures (e.g., instream woody material) that create complexity and habitat niches for aquatic organisms were absent. In brief, the dominant channel or habitat units are flatwater-dominated (primarily glide[5]) (Photograph 6-5).

Photograph 6-5. Uniform channel bed, Reach 3 (November 17, 2020).

As stated, no formal stream habitat inventory was conducted for the entire project site. As such, it is possible that there are small pools (or other channel/habitat units) that were not identified during the geomorphic assessment. However, it can be stated with certainty that no riffle habitat is present throughout the project site.

6.3.10 Degree of Channel Incision

Although there is some oversteepening of the left bank at various locations within some of the reaches, the Pajaro River in the vicinity of the project site is not significantly incised. The connection

[5] A glide is defined as flatwater channel or habitat unit with a wide, uniform channel bottom; flow with low to moderate velocities; and minimal turbulence (Flosi et al. 2010: III-33).

to the floodplain is adequate (i.e., the channel can access its floodplain on a semi-regular basis); however, as stated above, overtopping events are entirely dependent on a variety of factors throughout the local watershed.

6.3.11 Stage of Channel Evolution

Aerial photography (Google Earth imagery from 1985 to 2020) was reviewed for recent channel changes. Based on review of the available photography, the project site has remained relatively static during that time period. No marked vegetative loss or other evidence of a widening trend over the past 25 years was noticeable. However, the resolution of the imagery for certain years was of lower quality; therefore, it is difficult to determine the exact amount of recent bank retreat in this area. Nonetheless, the lack of marked vegetative loss suggests relatively static channel conditions.

According to the channel evolution model of Cluer and Thorne (2013), the channel in the surveyed area is a Stage 2 channelized channel, which is characterized by anthropogenic manipulation of the channel. Of most importance to this restoration project is that fact that channelization has reduced the wetted area and channel complexity relative to flow. The higher bank heights are potentially unstable in certain locales (as described above), and the extent, connectivity, and functionality of the riparian area, floodplain, and any adjacent wetlands is generally reduced.

6.3.12 Cross Section and Longitudinal Profile Surveys

Appendix B shows graphical illustrations of the cross sections and longitudinal profile that were surveyed within the project site.

6.3.12.1 Channel Geometry Metrics

Table 6-3 shows the relevant geomorphic characteristics of the cross sections. Table 6-4 summarizes the average channel bed elevation, channel gradient, water surface slope (as calculated on January 30, 2021 when discharge was 3.18 cfs) and sinuosity for the longitudinal profile.

Table 6-2. Pajaro River Cross Section Characteristics

Geomorphic Attribute	Cross Section / Reach							
	XS-1 / Reach 1a	XS-2 / Reach 1a	XS-3 / Reach 1b	XS-4 / Reach 2a	XS-5 / Reach 2a	XS-6 / Reach 2a	XS-7 / Reach 2b	XS-8 / Reach 3
Bankfull Width (feet)	40.0	19.0	43.0	32.1	52.0	44.5	38.0	42.0
Average Bankfull Depth (feet)	0.91	1.54	2.39	3.13	2.15	2.33	2.18	1.88
Maximum Bankfull Depth (feet)	1.60	1.84	3.00	4.72	2.81	2.82	2.90	2.55
Bankfull W/D	43.8	12.4	18.1	10.3	24.1	19.1	17.4	22.3
Active Channel Width (feet)	18.0	15.0	34.8	23.5	47.0	34.5	32.5	32.7

Geomorphic Attribute	Cross Section / Reach							
	XS-1 / Reach 1a	XS-2 / Reach 1a	XS-3 / Reach 1b	XS-4 / Reach 2a	XS-5 / Reach 2a	XS-6 / Reach 2a	XS-7 / Reach 2b	XS-8 / Reach 3
Average Active Channel Depth (feet)	0.78	0.84	0.94	1.11	1.25	0.59	1.32	0.48
Maximum Active Channel Depth (feet)	1.03	0.96	1.20	1.97	1.67	0.77	1.72	0.99
W/D (entire cross section)	24.6	25.8	23.0	16.6	17.7	22.2	24.4	8.5

Table 6-3. Longitudinal Profile Average Channel Bed Elevation, Channel Gradient, and Sinuosity (2021)

Longitudinal Profile Length (ft)	Average Channel Bed Elevation (ft)	Bed Slope	Water Surface Slope	Sinuosity
3,830	138.02	0.0009	0.0007	1.1

Cross Sections

As discussed in Section 6.3.5, *Bankfull Width and Depth and Wetted Width*, variation in bankfull width in the downstream direction is fairly minimal, equating to a relatively similar channel geometry with an average bankfull with of approximately 40 feet. As illustrated in Appendix B, most cross sections are typified by high banks on each end of the transect that slope down to the bank toes. Inset floodplain benches and other evidence of topographic variability within the cross sections was minimal, except for cross section XS-1 where this an inset bench on the left portion of the channel about 20 feet long. In general, width-to-depth values (for both the bankfull areas and the entire cross sections) are indicative of somewhat narrower and deeper channels.

As shown in Table 6-3, active channel width measurements ranged from 15.0 to 47.0 feet (average of 29.8 feet), while (average) active channel depths ranged from 0.48 to 1.32 feet (average of 0.90 feet). The measured wetted widths and depths recorded on January 30, 2021, were very close (nearly identical) to the active channel widths and depths for the project site, thus suggesting that the channel was fully activated but not at bankfull capacity at that time. The exception to this is cross section XS-8, the most downstream cross section near the confluence with Llagas Creek (where the water surface was closer to the bankfull surface as a result of the backwatering effect).

Longitudinal Profile

One longitudinal profile was established within the project site (total length of 3,830 feet with a channel bed slope of 0.0009, and an average channel bed elevation of 138.02 feet [Table 6-4]). The upstream thalweg elevation at Station 0 was 139.38 feet and the most downstream thalweg elevation at Station 3,830 was 135.91 feet, representing the absolute top and bottom elevations with an elevation change of 3.47 feet over the course of the profile. Although there are certain locations where the channel gradient changes (i.e., steepens) within a short longitudinal distance, the changes in elevation are generally less than 1 foot and in general the channel bed decreases at in an evenly spaced manner throughout the length of the entire profile. Sinuosity (the ratio of actual channel distance between identified points compared to straight/down-valley distance[6]) is slightly sinuous. Photographs 6-6 through 6-10 are representative images of the longitudinal profile, showing the different channel morphologic characteristics throughout the project site.

Photograph 6-6. Looking upstream at bridge over Frazier Lake Road (STA 0) (November 19, 2020).

Photograph 6-7. Looking upstream at STA 1,000 (November 19, 2020).

[6] The following represent possible ratios that define sinuosity: straight (1); slightly sinuous (1.1-1.3); sinuous (1.4-1.7); meandering (1.8 and above).

Photograph 6-8. Looking upstream at STA 2,400 (November 19, 2020).

Photograph 6-9. Looking downstream at STA 2,626 (November 19, 2020).

Photograph 6-10. Looking north at right bank levee associated with Llagas Creek at downstream end of longitudinal profile (STA 3,830) (November 17, 2020).

Chapter 7
Groundwater Monitoring

7.1 Introduction

Well locations were selected as a means to obtain quantitative groundwater data in areas proposed for revegetation.

7.2 Historic Conditions

As discussed in Chapter 5, *Hydrologic Assessment*, historic groundwater levels in the Soap Lake Plain were naturally recharged by distributary channels from the nearby hills of the Diablo Range. Strong subsurface flow connected scattered pools, which were sufficiently persistent and consistent to serve as summer refugia for native fish (Grossinger et al. 2008: 33, 48, 67). The high groundwater levels, along with high summer evaporation rates, were cited as sources of the alkaline soil conditions in the Soap Lake region (Phillip Williams & Associates et al. 2008: 4).

In the Gilroy-Hollister Valley Groundwater Basin, two subbasins make up the historical Soap Lake Plain: North San Benito Subbasin to the south in San Benito County and Llagas Subbasin to the north in Santa Clara County (Figure 7-1). The Pajaro River forms the boundary between the two subbasins and the two counties. Historically, the river would meander across the fine-grained sediments in the valley and deposit coarse-grained sediments. The combination of fine sediments and the coarse-grained sediments created "leaks" in the valley where the groundwater moves vertically through the coarse-grained sediments (Wendell 2013: 2–4).

The project site is part of a historical 35-square-mile area of flowing artesian wells. Development of the groundwater basin with pumping wells has dramatically changed groundwater flow patterns and the area is no longer discharges a significant amount of groundwater to the surface. In 1890, approximately 117 wells were reported as flowing, compared to just seven in 1950. Groundwater now flows towards a major groundwater pumping depression in Hollister, approximately 9.5 miles southeast of the project site (Wendell, 2013: 2–4).

7.3 Current Conditions

Wendell et al. (2013) estimated the average groundwater pumping in the subbasin at 5,775 AF per year, with variations in the recent past from 11,500 AF in 2000 and 6,300 AF in 2010. Since 1987, groundwater levels have been rising due to reduced pumped demand as a result of water imports. Across the watershed, the groundwater level is commonly less than 20 feet below the ground surface. Seasonal high depths can reach just 4 feet below the surface near the Pajaro River, with seasonal fluctuations of about 5 feet (Wendell 2013: 2–4).

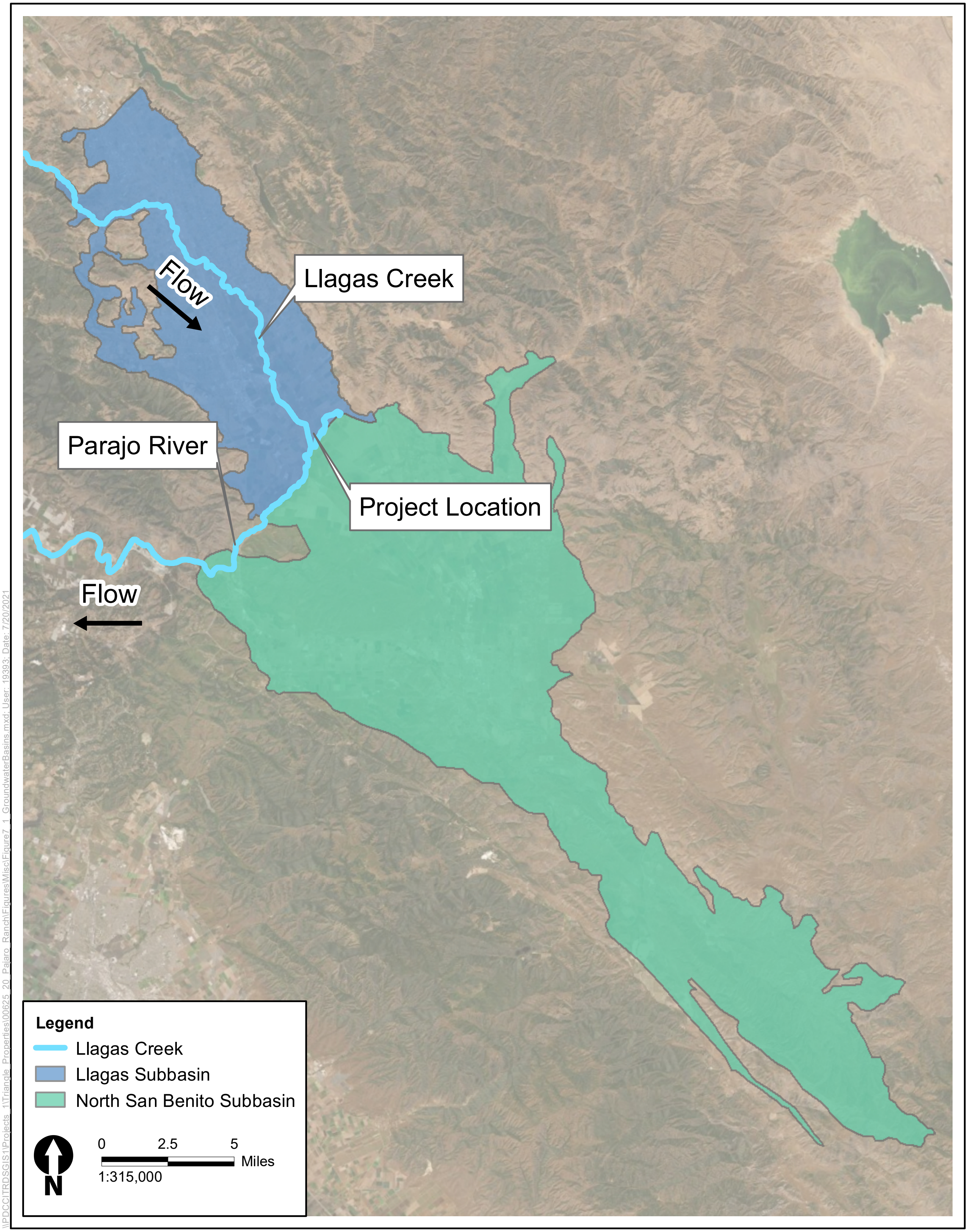

Figure 7-1
Groundwater Basins

H.T. Harvey & Associates investigated soil and groundwater conditions at the project site in March 2007. They found that groundwater was closest to the surface near the confluence of the Pajaro River and Llagas Creek. The shallow groundwater is likely due to the convergence of the two drainages over an area with flat topography and clay soils. They also found that groundwater was fresher on the Montes property near the confluence (i.e., 1-2 ppt salinity) than any area upstream of Frazier Lake Road. Again, this may be the influence of the two drainageways converging, or it could be an effect of irrigation. The Montes property is cultivated and irrigated regularly, whereas the upstream properties are not (Phillip Williams & Associates et al. 2008: 50–51).

FlowWest made several observations during their hydrologic monitoring of the project site in 2016. In particular, the southern end of the project site ponds readily due to sheet flow running north to south across the agricultural field. A storm of just 0.75 to 1.0 inch would develop ponding in a 24-hour period depending on antecedent conditions and potential break-out flows from the Pajaro River (FlowWest. 2016: 6).

Further investigation of current groundwater conditions was conducted by ICF in fall/winter 2020–2021 and is detailed in the following sections.

7.4 Methods

7.4.1 Groundwater Well Installation

Six groundwater monitoring wells were installed in the study area on November 19, 2020. The locations of the installed wells are shown in Figure 7-2. The wells were located on the valley floor adjacent to the agricultural field approximately 50 feet north of the Pajaro River channel. Well SW-1 is the most eastern (upstream) well, while well SW-5 is the most western (downstream) well and is closest of the wells to Llagas Creek. Wells SW-2a and SW-2b were installed along a transect perpendicular to the Pajaro River channel to determine whether groundwater levels varied with proximity to the Pajaro River (well SW-2b is closest to the Pajaro River channel).

The shallow groundwater wells were installed in the same boreholes that were excavated for the soil profile assessment (see Chapter 8, *Soil Assessment*, for a discussion of the soil assessment.) The wells were installed according to the methods outlined in the Natural Resources Conservation Service (NRCS) report *Installing Monitoring Wells in Soils* (Sprecher 2008) (Figure 7-3). The wells consisted of 1-inch-diamter (inside), slotted (0.020 inch) Schedule 40 polyvinyl chloride (PVC) pipes (casings), with vented bottom. Each well casing was installed in 2.25-inch-diameter augured holes to a depth of 72 to 74 inches below grade. Unlike the lower 60 inches of the slotted PVC pipes, the upper approximately 12 inches of the casing section that was below grade and the 12 inches that was above grade (i.e., the riser) were not slotted. To prevent the slots from becoming clogged by fine-textured soils particles, a #3 sand filter packing was placed between the casing and the auger hole wall to about 12 inches below grade. Bentonite (chip type) was placed in the remaining approximately 12 inches of the bore hole and a mixture of Bentonite chips and native clay soil was mounded around the casing at ground level to prevent surface water from infiltrating into the sand pack. Each well's PVC casing was trimmed at exactly 12 inches (30.5 centimeters [cm]) above the ground surface and vented by drilling a hole through the casing immediately below the cap. A torque cap was installed to prevent water and debris from falling into the well casing.

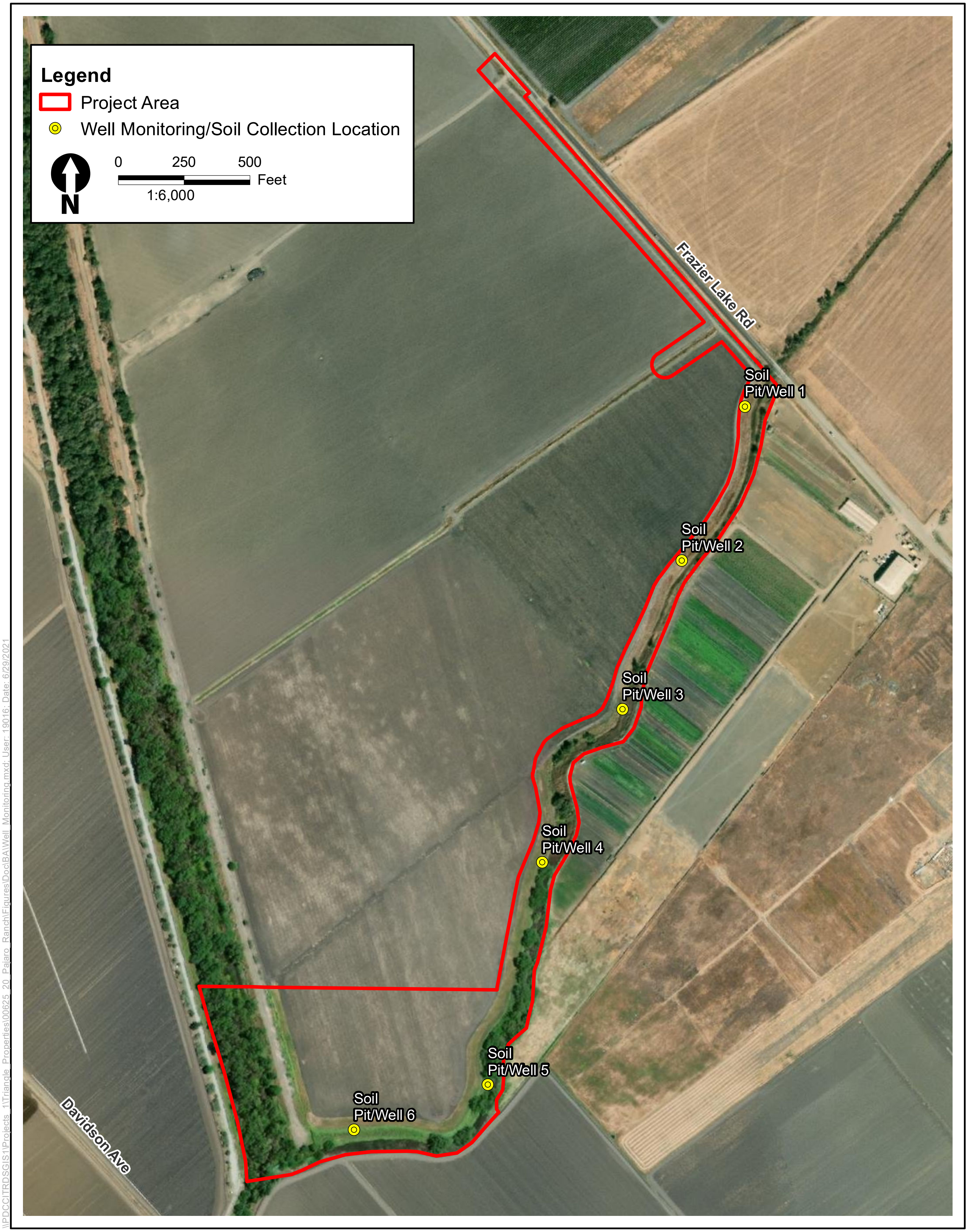

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Figure 7-2
Well Monitoring/Soil Collection Locations

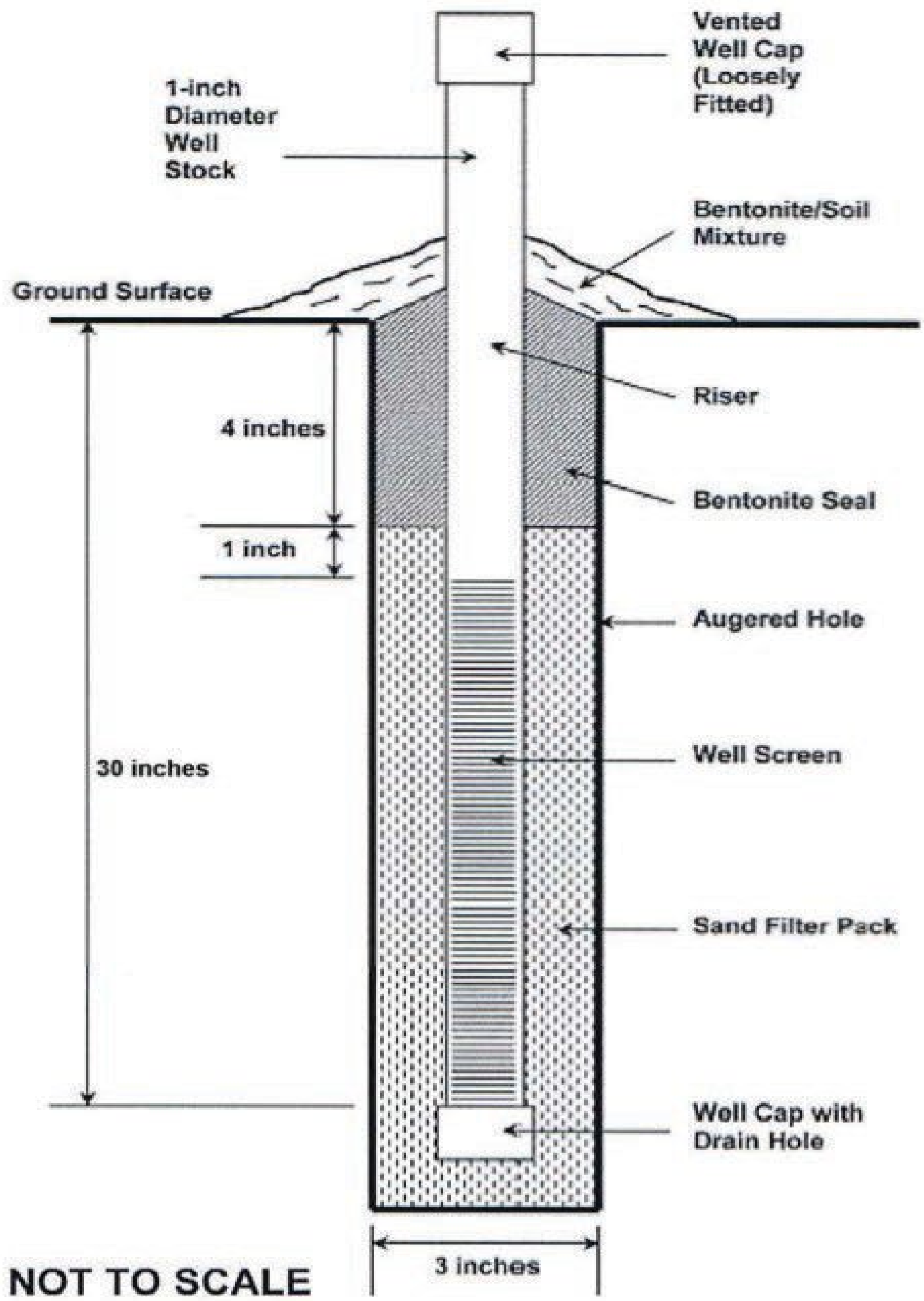

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Figure 7-3
Baseline Groundwater Monitoring Well, Typical (Sprecher 2008)

Wooden stakes marked with brightly colored flagging were installed adjacent to each well to minimize the risk of agricultural machinery and workers damaging the riser of the well casing, and to aide in locating the wells where vegetation growth was anticipated to obscure the wells (Figure 7–4).

The height of each well casing above the ground was recorded, the groundwater wells were photographed and labeled individually with a permanent marker, and the GPS coordinates of each well were recorded using an Apple iPad.

7.4.2 Depth to Groundwater Monitoring

At each well, the depth to groundwater was measured (nearest 0.5 cm) using an electronic well tape. The steel probe was inserted into the well and slowly lowered until the audible alarm sounded, and the reading on the tape (in centimeters) was taken from the top of the well riser. The measurements were recorded on data collection forms prepared for the baseline study, and the depth to groundwater was calculated by subtracting the height of the riser (30.5 cm) from the depth to groundwater reading.

In addition to the depth-to-groundwater monitoring, incidental observations of any ponding/flooding at the well locations and surface water conditions in the Pajaro River were made during each monitoring visit. These observations were also recorded for each well on the prepared data collection forms.

7.4.3 Precipitation

The daily precipitation record for water year 2021 was obtained from the Gilroy gage (Station 211) operated by the California Irrigation Management Information System (CIMIS). The gage (Latitude 37.015026, Longitude -121.537040) is located at 185 feet elevation and 3.7 miles northwest of the study area. The precipitation data were graphed with the well data to assess the total annual precipitation for the groundwater well monitoring period and to compare daily precipitation with the groundwater monitoring.

7.5 Results

Table 7-1 shows the measured depth to groundwater results for the study area. The table also shows the change in groundwater levels that occurred between successive measurements, as well as the maximum change that occurred over the entire monitoring period, calculated as the difference between the minimum reading (representing the shallowest groundwater level) and the maximum reading (representing the deepest groundwater level); the maximum and minimum readings did not have to occur on successive readings.

Figure 7-5 shows the groundwater results for the study area in a time-series plot for WY 2021. The depth to groundwater (inches) for each well is measured off the primary Y-axis and the daily precipitation record (inches) for the Gilroy gage is plotted as a gray line and measured off the secondary Y-axis.

Figure 7-4
Groundwater Well with Lathe and Flagging

All wells exhibited similar patterns with groundwater depths, showing a marked increase in groundwater levels from early January to late January after 4.36 inches of precipitation fell in the week prior to the well measurements in late January, followed by a mostly steady decline in groundwater levels through May (Figure 7-5). There were, however, some exceptions in the declining trends during spring, For example, minor increases in groundwater levels were noted in some wells following precipitation events in March and late April.

At no time was standing water observed on the ground surface at any of the well locations on the days that monitoring was conducted. Over the course of the monitoring period, the shallowest groundwater level observed was 28.9 inches on January 30, 2021 at well SW-5 (Figure 7-5). Well SW-5 exhibited the greatest change in groundwater levels over the course of the monitoring period (Table 7-1). Well SW-2a, which is located farther north of the Pajaro River channel than well SW-2b, exhibited consistently shallower groundwater levels than well SW-2b (Figure 7-5). No other longitudinal trends in groundwater levels were observed at the well locations over the course of the monitoring period.

7.6 Discussion

Well SW-5 contained the shallowest groundwater as the most downstream well, matching previous observations (Phillip Williams & Associates et al. 2008) that the groundwater is closest to the surface near the Llagas Creek–Pajaro River confluence.

Perpendicular to the Pajaro River, well SW-2b typically had slightly lower groundwater elevations than its neighboring well SW-2a. This may be explained by the vertical leakage described by Wendell (2013) where surface and subsurface water can easily infiltrate through coarse-grained layers deposited by the river. As well SW-2b is closer to the river than well SW-2a and had a larger maximum change, the groundwater may fluctuate due to storm flow in the channel and draining through subsurface deposits.

All groundwater levels fall near the seasonal depth of 4 feet as observed by Wendell (2013). The maximum depth to water during the period of observation ranged from 5.2 to 5.76 feet below ground surface. The precipitation record from Station 211 indicates that since the record began in 2009, 2020 had the third-lowest precipitation total. This may explain why no groundwater was present during well installation on November 19, 2020. Since data was only collected for the first 6 months of 2021, the total precipitation was compared over the same time period of the other years in the station record. In this period of time, 2021 had the fourth-lowest precipitation total compared to the rest of the record. This may explain why the maximum depth to water for each well was 1 to 2 feet deeper than seasonal observations by Wendell (2013).

There was one major precipitation event at the end of January in 2021, but all other events had precipitation depths less than one-sixth of that first storm. The storm in January likely caused the large decrease in depth to water recorded shortly after by the six wells. The low precipitation of the following months may explain why the depth to water continuously increased after the large storm.

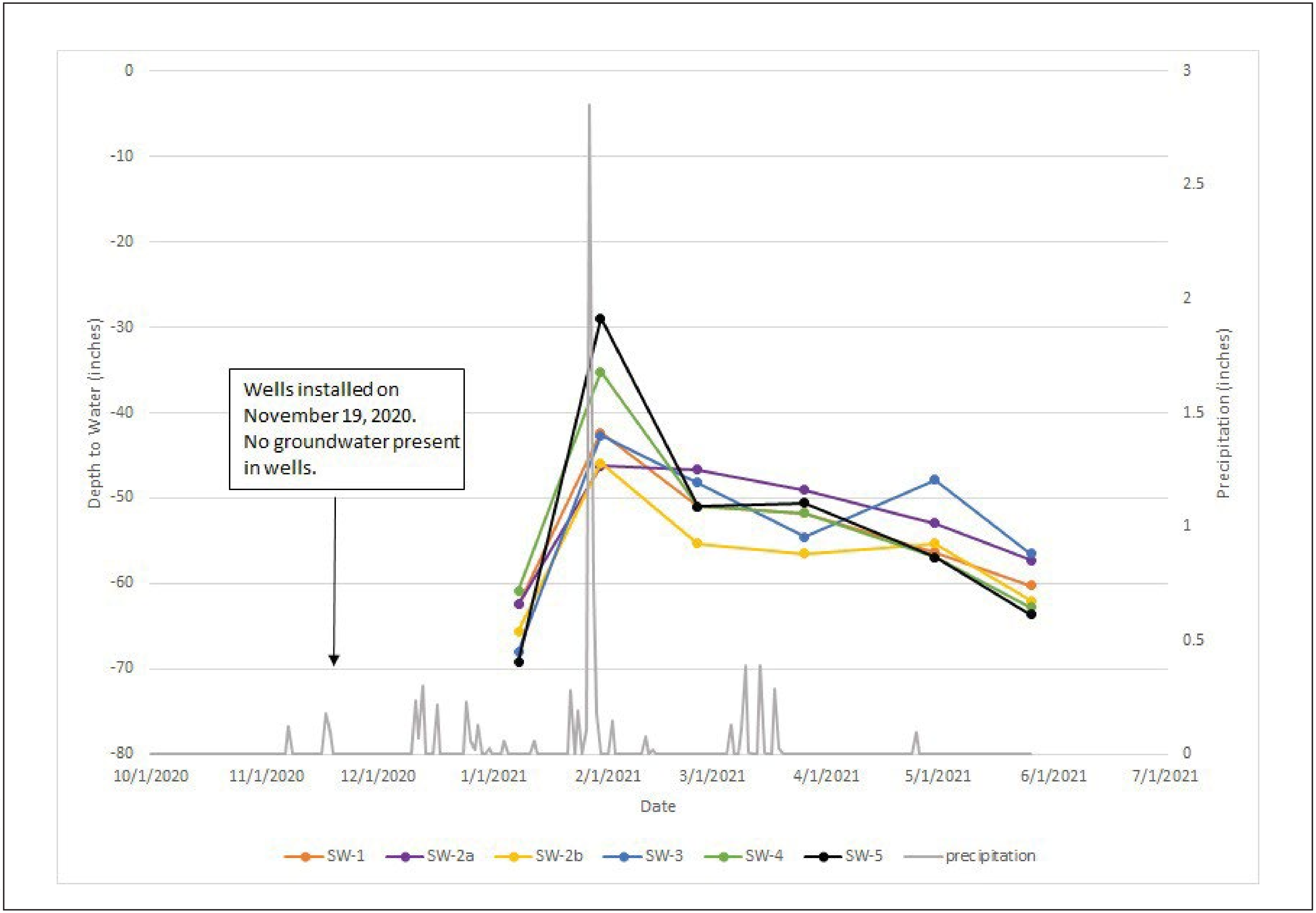

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Figure 7-5
2020-2021 Groundwater Levels

Chapter 8
Soil Assessment

8.1 Introduction

The NRCS (California Soil Resource Laboratory 2021) has mapped the soil within the project site as Willows clay, 0% slopes, MLRA 14.[7] The Willows series consists of very deep, very dark gray or olive gray (moist colors), sodic soils that formed in alluvium in flood basins.

Most areas of the Willows series formed under poorly to very poorly drained conditions, within the project site, the soil drainage class may be somewhat poorly drained or moderately well drained because of the presence of the Pajaro River. The soil survey data indicate that intermittent water tables are at depths of 24 to 60 inches and that in some areas the water tables have been lowered by drainage and water control structures. Qualitatively, the permeability is very slow. The saturated hydraulic conductivity (Ksat) is 3.6 millimeters per hour (mm/hr) in the upper 19 inches and varies between 0.36 and 4.32 mm/hr in the remainder of the profile. (California Soil Resource Laboratory 2021)

In a typical profile, the soil has a 4-inch-thick, clay “A” horizon and various clay and silty clay “B” horizons to a depth of 72 inches or more. The soil structure is mostly prismatic (California Soil Resource Laboratory 2021). As a Vertisol, the high content of smectic clay minerals causes the soil to shrink and swell as a result of seasonal changes in soil moisture content, resulting in soil cracks to form at the surface in the summer and fall.

The bulk density ranges from 1.59 grams per cubic centimeter (g/cm^3) in the surface layer and up to 1.72 g/cm^3 deeper in the profile (California Soil Resource Laboratory 2021).

The organic matter content is approximately 2% in the upper 12 inches and decreases to approximately 0.6% at a depth of 84 inches (California Soil Resource Laboratory 2021).

Soil pH is approximately 7.6 (i.e., slightly alkaline) in the upper 12 inches and increases to 8.4 (i.e., the high end of moderately alkaline) at a depth of 84 inches. The electrical conductivity is low (>= 1.3 dS/m) throughout the profile, but the sodium absorption ratio[8] (SAR) ranges from 13 to 16 below 19 inches depth (California Soil Resource Laboratory 2021). Soils with a SAR of 13 or higher designates the soil as being “sodic”, such that the high percentage of sodium on the exchange complex may cause the clay particles and organic matter to disperse, thereby resulting a general degradation of soil structure and in reduced (Ksat) and aeration.

8.2 Methods

As described in Chapter 7, Section 7.4.1, *Groundwater Well Installation*, soil profiles were described in conjunction with the monitoring well borehole excavation. Therefore, the locations of the six soil

[7] This description of the soil applies only to the area (i.e., valley floor) beyond the top of bank of the river and does not reflect soil characteristics on the channel banks or channel bed.
[8] SAR is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from a saturated soil paste.

profiles that were described are the same as the monitoring well locations (Figure 8-1), all of which were installed on the valley floor as opposed to on the channel bank. The profiles were described to the maximum depth advanced by the hand auger (74 to 78 inches), which was typically a few inches deeper than the depth of the monitoring well because sand packing was placed beneath bottom of the monitoring well to promote drainage of water from the bottom cap of the well. A soil profile description form was used to describe profile characteristics at each well sites. The profiles were described with respect to type and thickness of horizons, texture, type of redoximorphic feature where present, qualitative moisture content. Additional information recorded included depth to water table where observed, slope gradient, land surface shape, dominant plant species within a 5-foot radius and whether the profile resembled the Willows soil series that is mapped by NRCS at the project site. Photographs were taken at selected well/soil profile locations.

Figure 8-1. Typical Deep, Wide Shrinkage Cracks at Soil Profile Description Sites (blade of spade is 16 inches long)

Soil samples were collected from the profiles at well SW-2A (0–4 inches and 43–48 inches depth ranges) and SW-4 (0–6 inches and 39–43 inches depth ranges), bagged and submitted to A&L Western Laboratory on Modesto for analysis of organic matter content, pH, electrical conductivity, cation exchange capacity, percent base saturation, SAR, macronutrients and micronutrients.

8.3 Results

8.3.1 Soil Profile Evaluation

As was expected because of the uniform landform conditions, the observed soil profiles were rather similar to the other (Appendix C) and were similar to that of the typical Willows series soil profile. All the soils were either light clay, clay, or heavy clay throughout the profile. The high shrink-swell potential of the soil was evidenced by the deep, wide cracks at the ground surface (Figure 8-1).

Redoximorphic (redox) features,[9] which can be used to infer the depth to the seasonal high water table, were observed in each of the profiles, beginning at depths ranging 31 to 60 inches (Figure 8-2). These depths correlate somewhat well to the measured depths to groundwater in the monitoring wells, particularly when considering the likely effect of drought conditions on water table depths.

Figure 8-2. Redox Concentrations (reddish splotches) in Soil at Well SW-3

In moderately to very strongly alkaline soil (i.e., 7.9 or higher), redox features consisting of iron or manganese concentrations or depletions do not readily form in saturated soils (U.S. Army Corps of Engineers 2008). Therefore, the high pH (8.4) reported for the Willows series in the deeper part of the profile and in the laboratory test results for well SW-4 (see Sample ID 39-43 in the laboratory results in Appendix D), which had a pH of 8.4 at a depth of 30 to 43 inches, may have precluded

[9] Redox features reflect long-term soil saturation characteristics, not for example, the depth-to-water table for a given rainy season.

some of the soil layers from forming redox features even if the soil had been saturated for a long duration by the seasonal high water table. The high pH may have precluded the formation of redox features in the other profiles as well. This indicates that the typical seasonal high water table *may* be closer to the surface at one or more of the profile locations than is suggested by the well monitoring results.

A water table was not observed in any of the boreholes and none of the soils appeared to be saturated.

8.3.2 Laboratory Test Results

The laboratory results[10] (Appendix D) of tests conducted on samples taken at wells SW-2A and SW-4 indicate both variations and similarities in chemical properties as affected by depth. For example, organic matter content is 3.4 to 3.9% in the surface layer but 2.0 to 2.1% at roughly 40 inches depth, although the organic matter content in all the samples is nevertheless sufficient to support microbial populations and nutrient cycling.

Soil pH is very high (which can limit nutrient availability) at depth at SW-4.

Electrical conductivity/soluble salts is comparatively high at depth at SW-2a, but not sufficiently high to significantly adversely affect growth of native plant species.

SAR is 1.2 to 4.3, but all these levels are well below the threshold that the clay particles would be prone to dispersion.

Boron levels are high (for crops) in the deeper part of the sampled profiles but are more moderate in the surface layers. Soil boron levels greater than approximately 5 to 8 parts per million (ppm) may be injurious to crops, but many native species are well adapted to boron levels greater than 5 ppm (Barth et al. 1987). Elevated soil boron levels may cause chlorosis along the margins of leaves; when boron toxicity is severe, leaves may blacken and then die between the veins.

In both profiles, excess lime is comparatively high at depth than in the surface layer. High levels of lime may tie up major and minor elements, making them less available to the plant.

Cation exchange capacity is 31 to 52 milliequivalents/100 grams, but all these levels are ample for nutrient retention.

[10] For reference, the narrative ratings of nutrient levels and toxicities (e.g., “M” and “VH”) provided in the laboratory test results are directed to agricultural crop production and therefore do not necessarily apply to native species.

Chapter 9

Cultural Resources Assessment

9.1 Introduction

In support of the project's Section 106 of the National Historic Preservation Act (NHPA), ICF performed a cultural resources records review at the Northwest Information Center, as well as a review of historical aerial imagery and topographic mapping. The information gathered was used to assess the potential for encountering cultural resources during project-related ground disturbance. Below is the results of this research as well as the assessment of cultural resources sensitivity.

9.2 Methods

A records search was conducted at the North Central Information Center (NCIC) of the California Historical Information System (CHRIS) at Sacramento State University in Sacramento, California. The NCIC maintains the State of California's official records of previous cultural resource studies and recorded cultural resources for Placer County. The records search consulted the CHRIS base maps of previously recorded cultural resources for the study area, which comprises the project site and a 0.25-mile buffer (i.e., the area of potential effects [APE] for the cultural resources assessment). Additional sources of information, including previously conducted cultural resources surveys, historic aerial photographs, and historic maps (USGS and General Land Office), were reviewed to determine areas that have a high sensitivity for the presence of historic and prehistoric sites.

The following resources were reviewed.

- National Register Information System website (National Park Service 2021)
- Office of Historic Preservation, California Historical Landmarks website (Office of Historic Preservation 2021)
- Directory of Properties in the Historical Resources Inventory (Office of Historic Preservation 1999)
- California Points of Historical Interest (Office of Historic Preservation 1992 and updates)
- Historic Property Data File for Placer County (Office of Historic Preservation 2012a)
- General Land Office land patent records (U.S. Bureau of Land Management 2021)
- Historic Aerial Photographs (NETR Online 2021)
- USGS National Geologic Map Database (U.S. Geological Survey 2021)

9.3 Results

9.3.1 Literature Review

Six studies have been conducted in the vicinity of the project site. The nearest to the project site was a survey conducted by King and Hickman (1973a), which included a pedestrian survey and subsurface testing; however, it is unclear from the survey report whether or not the current project site was included in the field survey. King and Hickman (1973b) included a prehistoric archaeological sensitivity model for a large swath of the Santa Clara Valley, which was based on a field survey (King and Hickman 1973a) and typical land use patterns in the area. The model mapped out zones ranked by their perceived sensitivity for prehistoric sites (Low, Moderate, and High). The current project site is designated as being in a High Sensitivity Zone. Table 9-1 provides details of studies previously conducted in the project vicinity.

Table 9-1. Surveys Conducted in the Area of Potential Effects

Author/Date	Investigation Type/NADB#	Title	Cultural Resources in APE	Survey Distance and Direction to Project
King and Hickman 1973	Survey Report-#S-004286	*Archaeological Impact Evaluation: the Llagas Creek Project.*	No	Possibly within the APE
King and Hickman 1973	Arch. Impact Evaluation- #S-005222	*The Southern Santa Clara Valley, California: A General Plan For Archaeology*	No	Encompasses the APE
Cartier et al. 1981	Survey Report-#S-008478	*Cultural Resource Evaluation of the Llagas Creek Watershed*	No	0.2 mile (NW)
Woodward-Clyde Consultants 1984	Survey Report-#S-006355	*A Cultural Resource Evaluation of the Proposed Thermonetics Co-Generation Project Area, Gilroy, California*	No	Adjacent to APE (W)
Dondero et al. 1991	Survey Report-#S-032512	*Historic Property Survey Report for Proposed Route 152 Corridor Relocation Project within the City Limits of Gilroy, Santa Clara County, and Unincorporated Rural Areas of San Benito and Santa Clara Counties.*	No	1.25 mile (E)
Pacific Legacy 2003	Survey Report-#S-027938	*Cultural Resources Survey for the Pajaro Valley Water Management Agency Import Pipeline and Water Recycling Facilities.*	No	0.1 mile (S)

No previously recorded archaeological sites were identified in the current project site (Table 9-2). The nearest prehistoric site consisted of a small lithic scatter with bowl mortar pieces discovered in a furrow. The pieces were likely brought to the surface as a result of agricultural ground disturbances. The nearest historic resources consist of built resources, such as farmhouses and the historic-aged Miller Canal (P-35-000182). Table 9-2 provides details of previously recorded archaeological resources within the APE.

Table 9-2. Known Archaeological Sites in the APE

Trinomial/ Forest Service Site Number	Site Type	Description	NRHP Eligibility Status	Distance and Direction to site
P-35-000182 CA-SBN-191H and P-43-002854 CA-SCL-927H	Historic Canal	3.25-mile-long canal constructed before 1887 between San Felipe Lake and the Pajaro River.	Determined not eligible	0.5 mile (S)
P-43-001791	Lithic Isolate	Two lithic bowl mortar pieces found in a furrow.	Not determined	0.3 mile (W)
P-43-002857	Built Resource	20th century wood-framed vernacular.	Appears not eligible	0.4 mile (W)
P-43-002860	Built Resource	Ellis House; Greek Revival/Queen Anne style composite house.	Appears not eligible	0.5 mile (N)
P-43-002861	Built Resource	20th century wood-framed vernacular.	Appears not eligible	0.5 mile (NE)

9.3.2 USGS Geologic Database and Historic Mapping

The USGS map viewer was accessed on July 1, 2021. The project site is located in the Santa Clara Valley, a north–south-running valley, bordered on the west by the Santa Cruz Mountains and on the east by the hills of the Diablo Range. The project site is at the valley floor, on a flat, stable floodplain at the convergence of Llagas Creek and the Pajaro River. As such, the surface geology consists of Holocene aged alluvial sands, gravels, and clays likely deposited from the nearby Pajaro River. These sediments have the potential to yield prehistoric and historic resources, although prehistoric resources would likely be found below the surface due to river deposition (Dibblee and Minch 2006).

A survey of the historic topographic maps and aerial imagery of the area showed that since 1915 (earliest topo observed) the paths of Llagas Creek and the Pajaro River has remained unchanged in the last 100 years. The primary historic land use of the project site appears to be entirely agricultural and historic resources identified would likely be associated with agriculture (NETR 2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g, 2021h, 2021i, 2021j, 2021k, 2021l, 2021m, 2021n.).

9.4 Conclusions

The project site appears to have **high potential** for encountering both surficial and subsurface cultural resources**,** due to the relatively close proximity to habitable areas near resources that were commonly collected by Native American tribes, as well as the project site's proximity to known cultural resources. Although the project site was included in a large survey in 1973, it is unclear what testing took place within the actual project site.

Chapter 10
Land Use

10.1 Introduction

This chapter describes the historic land use at the project site and surrounding areas, current land use, and regional context of the project site.

10.2 Historic Conditions

South Santa Clara Valley has likely been inhabited for over 13,500 years, starting with indigenous people who were well established in villages when the Spanish made contact in 1769. The Mission, Ranching, and Agriculture eras (1769 to 1874) applied the first pressures on water resources and native habitat through cattle and sheep farming/ranching and planting of orchards. Beginning in 1864, artesian wells were rapidly drilled and lowland areas were drained to support more intense agricultural. Willows patches were cleared to make room for agriculture (Grossinger et al. 2008: 42–49.) The project site has been in continuous agricultural production since at least 1939 (Santa Clara Valley Open Space Authority 2021.)

Millers Canal, built in 1874, connected San Felipe Lake to the Pajaro River downstream of the project site, bypassing the wetlands in the Pajaro River headwaters and reducing the amount of flow and dynamics through the project site.

Small-scale manipulation of streams and waterways by local land owners was occurring throughout the ranching and agriculture eras. Flood control and urban expansion began on a large-scale effort in the 1930s with the construction of North Fork Pacheco Reservoir in 1939. Levee construction and main-channel excavation of Llagas Creek began in the 1970s.

10.3 Current Conditions

The project site is located on the South PRAP and combined with the North PRAP; the total land under protection is 284 acres (Figure 10-1). The PRAP is owned by OSA and is maintained as a working agricultural preserve with most of the acreage in traditional, annual row crop production. A portion of the preserve near the project site is being set up for organic row crop production. The majority of surrounding parcels are also farmed for annual row crops. Currently, the PRAP is not open to the public.

The Nature Conservancy owns the parcels along the Pajaro River directly upstream (east) of the project site. Point Blue, with the help of volunteers, has begun the process of restoring native habitat along this portion of the river.

Valley Water owns and manages the Llagas Creek corridor and associated parcels. Llagas Creek is maintained for flood-control purposes and is bounded by levees with approximately 275 feet between the east and west levee tops. Llagas Creek contains one of the widest riparian canopies in South Valley.

The Gilroy wastewater treatment facility is upstream (approximately 0.75 mile) of Bloomfield Avenue, adjacent to Llagas Creek. There are over 500 acres of percolation ponds for treatment of various stages of wastewater effluent. Many of these treatment ponds serve as habitat for various animals, particularly migrating and resident waterfowl and shorebirds.

10.4 Regional Importance

The project site is located in a regionally significant area for wildlife movement, agricultural preservation, groundwater recharge and regional recreational opportunities.

As mentioned previously, the project site is located in an area of critical linkage for wildlife habitat connectivity. This area and the Coyote Valley area, approximately 16 miles to the north, are the last significant areas able to be conserved between the two mountain ranges. The upper Pajaro River provides the southernmost connection between the Santa Cruz Mountains and the Diablo Range and also supports a connection between the Santa Cruz Mountains and the Gabilan Range to the south. Protecting a few thousand acres of farms, ranches, and open spaces along the Pajaro River would help connect hundreds of core habitat areas in the surrounding mountain ranges (Santa Clara Valley Open Space Authority 2014.)

The project site is located in the Santa Clara County's most extensive farming area where 97% of the County's seed crops, 87% of the vegetable crops, and over 50% of both floral and nursery crops are produced. Farmland has declined in the County by 45% in the last 20 years, and half of the remaining farmland is considered at risk of development over the next 30 years. The farmlands at and around the project site are also located within a critical groundwater recharge area (Santa Clara Valley Open Space Authority 2014.)

Recreational importance is also high at the project site. The Bay Area Ridge Trail is proposed to traverse through the PRAP and also along Llagas Creek in two different configurations to help complete the southernmost loop between the existing portions of the trail at Mount Madonna County Park on the west side of the valley and Coyote Bear County Park on the east side (Bay Area Ridge Trail Council 2021.) The section of proposed Bay Area Ridge Trail along Llagas Creek at the PRAP is also the proposed alignment for an extension of the San Juan Bautista de Anza Trail. Lastly, there is a proposed local county trail that connects directly to the project site (Santa Clara Valley Open Space Authority 2014.)

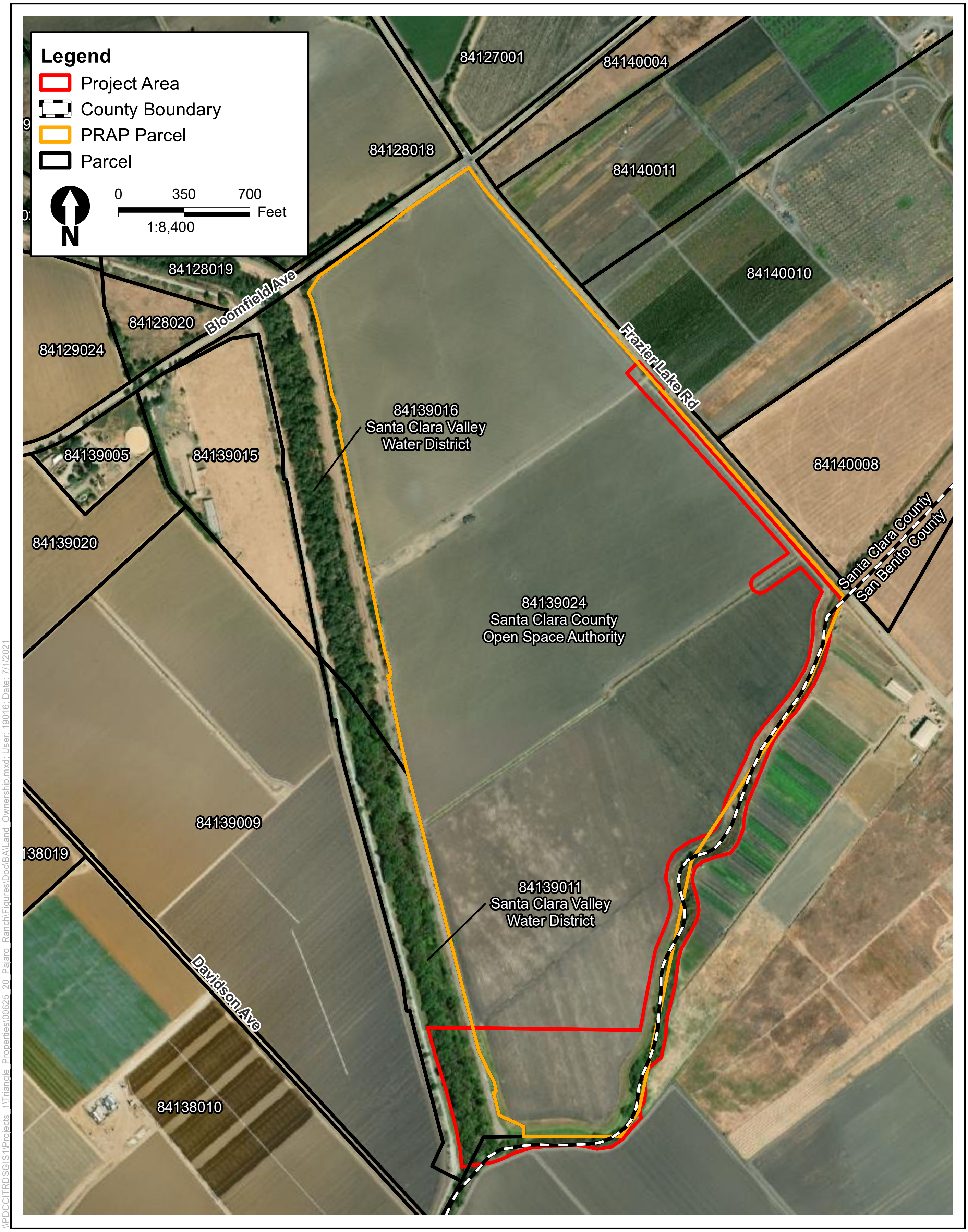

Figure 10-1
Jurisdiction/Land Ownership

Chapter 11
Climate Change

11.1 Introduction

This chapter describes projected climate change impacts at the project site and surrounding region. Understanding how climate change can affect project plans will help in designing climate-smart solutions and restoration efforts that can succeed under future conditions.

11.2 Anticipated Changes to Climate

Because the project site lies along the border between Santa Clara and San Benito Counties, the discussion on anticipated changes to climate and climate impacts draws from the San Francisco Bay Area and Central Coast regional reports of California's Fourth Climate Change Assessment (2018). Table 11-1 shows climate projections from Cal-Adapt for temperature, precipitation, and wildfire variables under Representative Concentration Pathway (RCP) 8.5[11] for these two counties.

Table 11-1. Cal-Adapt Climate Projections by Mid-Century (2035–2064) for Santa Clara and San Benito Counties Compared to Baseline (1961–1990)

Climate Hazard	Variable	Santa Clara Projected Change	San Benito Projected Change
Temperature	Annual average maximum temperature *(average of hottest daily temperatures in a year)*	+4.2°F *(from baseline of 68.6°F)*	+4.7°F *(from baseline of 70.4°F)*
	Extreme heat days *(days above 92.7°F)*	+11 days *(from baseline of 4 days)*	+17 days *(from baseline of 4 days)*
Precipitation	Maximum 1-day precipitation *(greatest amount of daily rain/snow over 24-hr period)*	+0.186 inches *(from baseline of 1.770 inches)*	+0.120 inches *(from baseline of 1.383 inches)*
	Maximum length of dry spell *(precipitation <1mm)*	+10 days *(from baseline of 112 days)*	+9 days *(from baseline of 126 days)*
Wildfire	Annual average area burned *(area projected to be at risk)*	+692.3 acres *(from baseline of 6265.5 acres)*	-915.5 acres *(from baseline of 10891.5 acres)*

Source: Cal-Adapt 2021

°F = degrees Fahrenheit

[11] Representative Concentration Pathway (RCP) 4.5 and 8.5 represent greenhouse gas emission scenarios that take into account global mitigation efforts (for RCP 4.5) or assume "business as usual" (for RCP 8.5). This discussion uses an RCP 8.5 scenario to consider a future in which climate emissions are not further mitigated beyond business as usual.

Temperatures are expected to increase at the project site by mid-century, with much higher increases anticipated under RCP 8.5 compared to RCP 4.5 (Ackerly 2018). In Santa Clara and San Benito Counties, annual average maximum temperature may increase by about 6 to 7%. The area may also see increases in extreme temperatures and the number of hot days and warm nights (Langridge 2018). In Santa Clara and San Benito Counties, the number of extreme heat days may double or quadruple by mid-century.

Climate change may also result in changes to precipitation patterns. It is generally difficult to determine changes in annual average precipitation due to large natural variability. However, precipitation extremes (very wet events and very dry events) are likely to become more intense (Ackerly 2018). The wettest day of the year may become wetter relative to historic conditions (Langridge 2018), and atmospheric rivers, which are storms that bring most of the annual precipitation to the region, are expected to carry more water in the future. On the other extreme, dry periods and droughts may also become more frequent and extreme. Precipitation whiplash events (extremely dry events that switch suddenly to extremely wet events) may also increase in frequency (Ackerly 2018). By mid-century, maximum 1-day precipitation may increase in the area by 9 to 10%, while the maximum length of dry spells may increase by 7 to 10%. The timing of historic precipitation patterns may also change, as higher temperatures and an increase in the amount of precipitation falling as rain rather than snow could create earlier and heavier runoff and streamflow and reductions of flow in the dry season (Pajaro River Watershed 2019).

Changes in wildfire risk due to climate change, including fire severity and frequency change, are also difficult to project due to unforeseeable changes in other factors that affect wildfire risk, such as human activity and land use. In general, wildfire risk is likely to increase with heightened dryness and higher temperatures, both of which are expected under climate change. The size of future fires also increases with air temperature in the month of ignition and low precipitation in the preceding 12 months (Ackerly 2018, Langridge 2018). By mid-century, the region could experience an 8% decrease of 11% increase in annual average area burned.

Wildfire regimes may also interact with precipitation patterns to create cascading effects, such as landslides and sediment transport that flows into rivers and water bodies. High-intensity rain events after fire can increase runoff and streamflow, while low-intensity or growing season rain can stimulate post-fire regrowth and hydrologic recovery. However, under climate change, it is more likely that high-intensity rainfall would occur after a fire or drought would inhibit vegetation recovery (Langridge 2018).

11.3 Climate Change Impacts

The climate change projections described above could result in changes to relevant indicators in the area.

Timing changes in precipitation and runoff could have impacts on the hydrology of the region. In the Sierra Nevada, earlier snowmelt could remove water storage needed by California later in the year. This could result in increased flood risk during the rainy season, increased aridity during the dry season, and reoccurring and persistent hydrological drought, leading to impacts on both ecosystems and human systems that rely on water, such as the agricultural sector (Ackerly 2018). Furthermore, sea level rise induced by climate change could create issues of salinity intrusion into groundwater. While the project site is far enough inland that sea level rise is unlikely to affect it, salinity in groundwater has been an ongoing issue in the upper watershed of the Pajaro River Watershed, and sea level rise presents an opportunity for saltwater intrusion in coastal areas of the watershed (Pajaro River Watershed 2019).

Increased temperatures, dryness, and fire frequencies could lead to changes in historic vegetation makeup. Conditions may become less favorable for cool and moist adapted forests, cool adapted montane chaparral, and coastal sage scrub, leading to their decline. Meanwhile, conditions may become more favorable for coast live oak forests and chamise chaparral shrubland. Grasslands, which are more likely to tolerate climate change impacts, may also expand. Vegetation could become more exposed to heat or dryness outside of historic variability, which could increase tree mortality and fire vulnerability (Ackerly 2018; Langridge 2018). In riparian ecosystems, increased fire may reduce canopy cover, increase water temperatures, and produce more sediment, while increased length of summer drought can reduce plant biomass. These impacts could result in changed food webs and narrower stream corridors and wetland zones, potentially reducing the benefits that riparian areas provide (Langridge 2018).

Climate change impacts on wetlands are also significant. California has already lost more than 90% of its historical wetlands (CalEPA and CNRA 2021). Globally, under climate change both tidal wetlands and freshwater wetlands face increasing declines due to increasing temperature, drought, and flooding, which creates difficulties for wetland management (Junk 2013).

Climate change may also affect wildlife species and their habitats, as increased temperatures could change the timing of seasonal events like flowering, hatching, and migration. Warmer temperatures have already caused some species to shift to higher latitudes or elevations, and species that are unable to shift further have lost habitat and become more vulnerable to extinction (Langridge 2018). Exacerbating this, climate change could increase the spread of disease and invasive species in both terrestrial and aquatic environments (Ackerly 2018).

Specific climate change impacts on notable species discussed in context of the restoration project include the following.

- Climate change could alter hydrology patterns, affecting riparian-dependent species like the least Bell's vireo (Gardali et al. 2012).
- Climate change could affect the ability of amphibians like the California red-legged frog to thermo-regulate; restoration of breeding sites for these species may require vegetation management that allows amphibians to retreat from high temperatures (Langridge 2018).
- Climate change, and increasing temperature in particular, may alter milkweed chemical composition and make it too toxic for monarch butterflies to eat, potentially resulting in butterfly declines in the future (Faldyn et al. 2018).

Chapter 12
Restoration Opportunities and Constraints

12.1 Introduction

This chapter identifies the restoration opportunities and constraints for the proposed habitat improvements for the project site. Refer to Figure 12-1 for a general location and Figure 12-2 for typical sections of each of the habitat improvements discussed below.

12.2 Habitat Improvement 1: Planting Riparian Vegetation

This habitat improvement would consist of planting riparian vegetation on the existing north channel bank and adjacent floodplain terrace in locations where riparian vegetation is presently absent or occurs sparsely along the channel bank. Riparian vegetation would also be planted on the floodplain terrace, adjacent to existing riparian habitat, to widen the riparian corridor.

This habitat improvement would be designed and implemented to minimize effects on existing vegetation. Although implementation of riparian woodland would result in the permanent conversion of some agricultural land to riparian woodland this land cover type is not limiting on the project site and the conversion of agricultural lands to riparian woodland would increase overall habitat complexity on the project site and provide a landscape buffer between agricultural land uses and the Pajaro River.

The riparian plant palettes and seed mixes would be developed based on available soil and groundwater data. It is anticipated that willow riparian would be planted on the open channel banks where soil conditions and proximity to groundwater favor willow species. Willow riparian woodland would transition to mixed-riparian woodland on the floodplain terrace where heavier clay soils are more prevalent and depth to seasonal groundwater is greater. Special emphasis would be placed on including plant species that host native pollinators (e.g., monarch butterfly).

12.2.1 Habitat Improvement 1 Opportunities and Constraints

12.2.1.1 Biological

As discussed in Section 11.3, *Habitat Improvement 2: Lowering Channel Banks and Creating Floodplain Benches*, the added riparian habitat would also be expected to increase the amount and complexity of shaded riverine aquatic (SRA) cover, an important component of salmonid habitat, by increasing the coverage and quality of overhanging and instream cover in the form of branches, roots, and downed wood. SRA habitat would also benefit aquatic wildlife species. Adding riparian habitat along the open channel would result in an increase habitat complexity by enhancing riparian canopy, structure, and diversity on the project site which would improve habitat values for terrestrial wildlife including resident, wintering and neotropical songbirds.

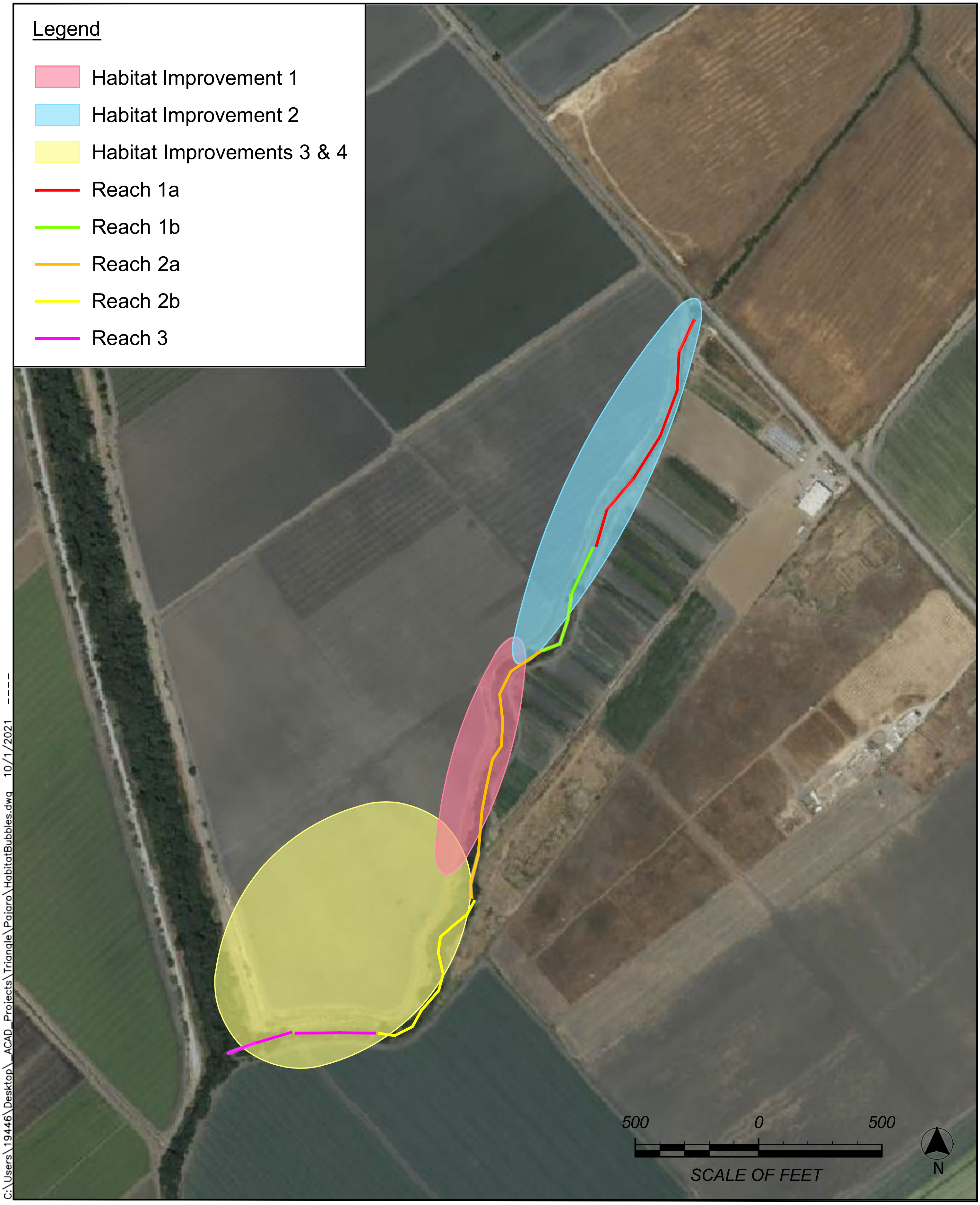

Figure 12-1
General Locations of Habitat Improvements

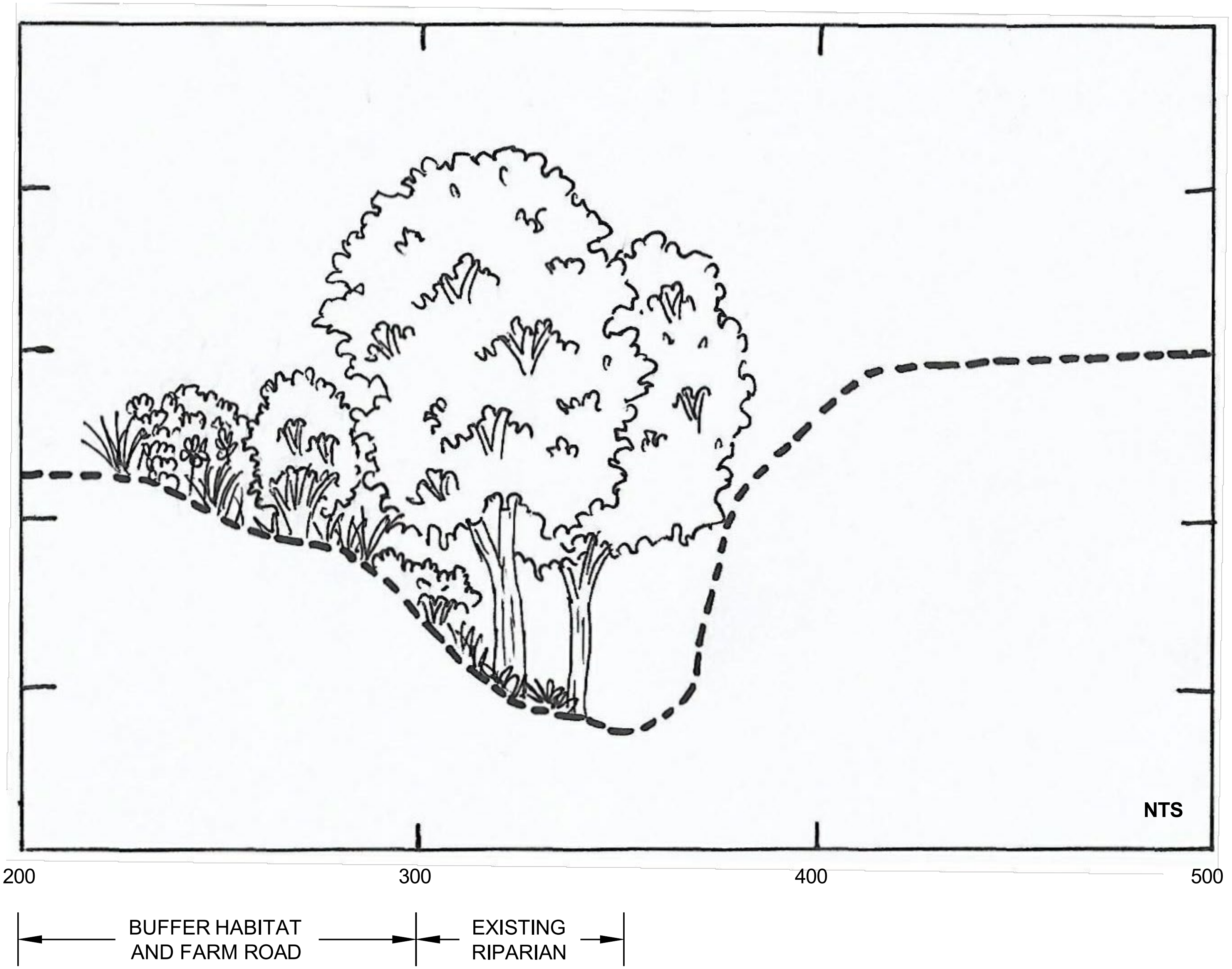

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Figure 12-2a
Habitat Improvement 1
Planting Riparian Vegetation

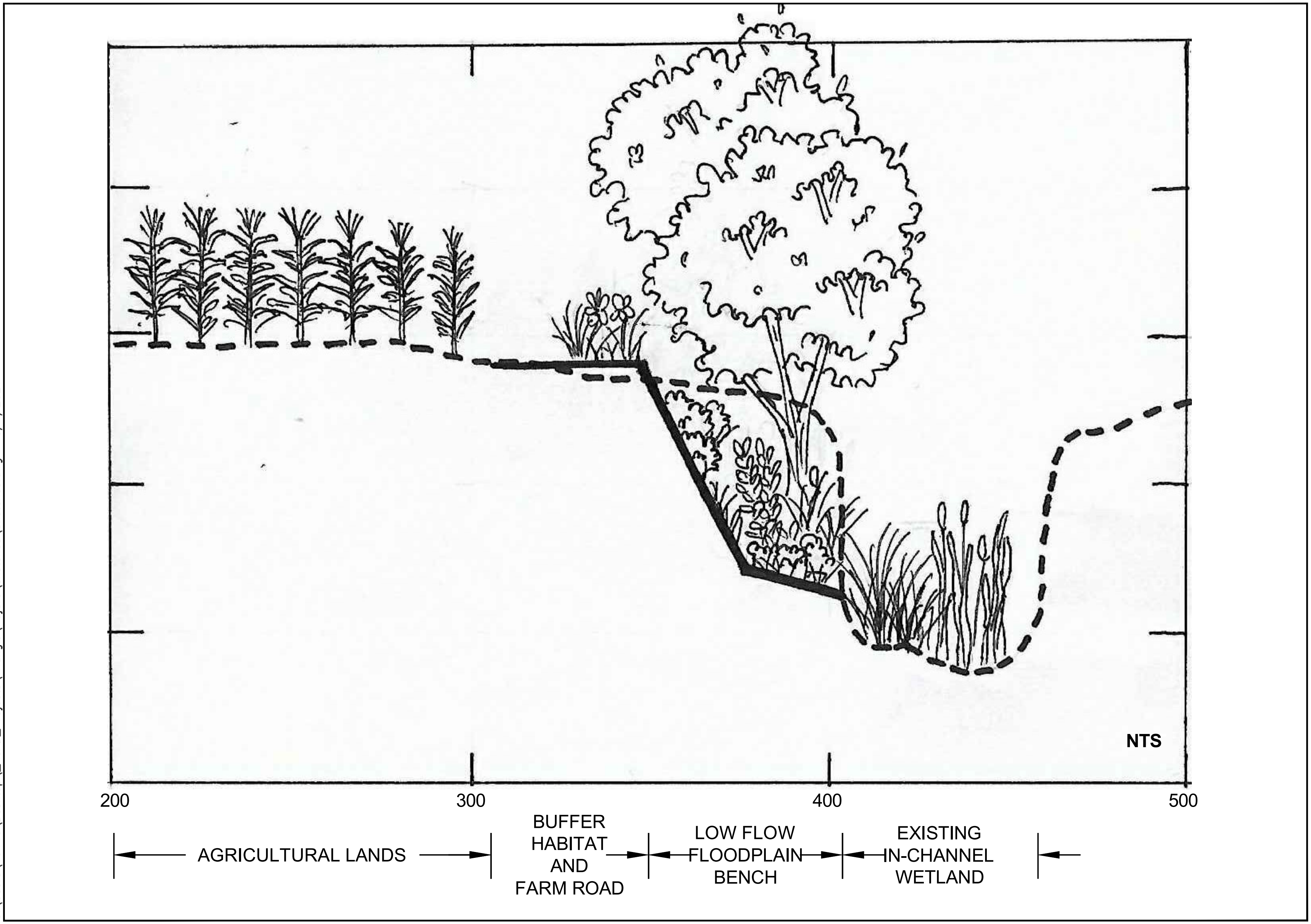

Figure 12-2b
Habitat Improvement 2
Recontouring Channel Banks and Creating Floodplain Benches

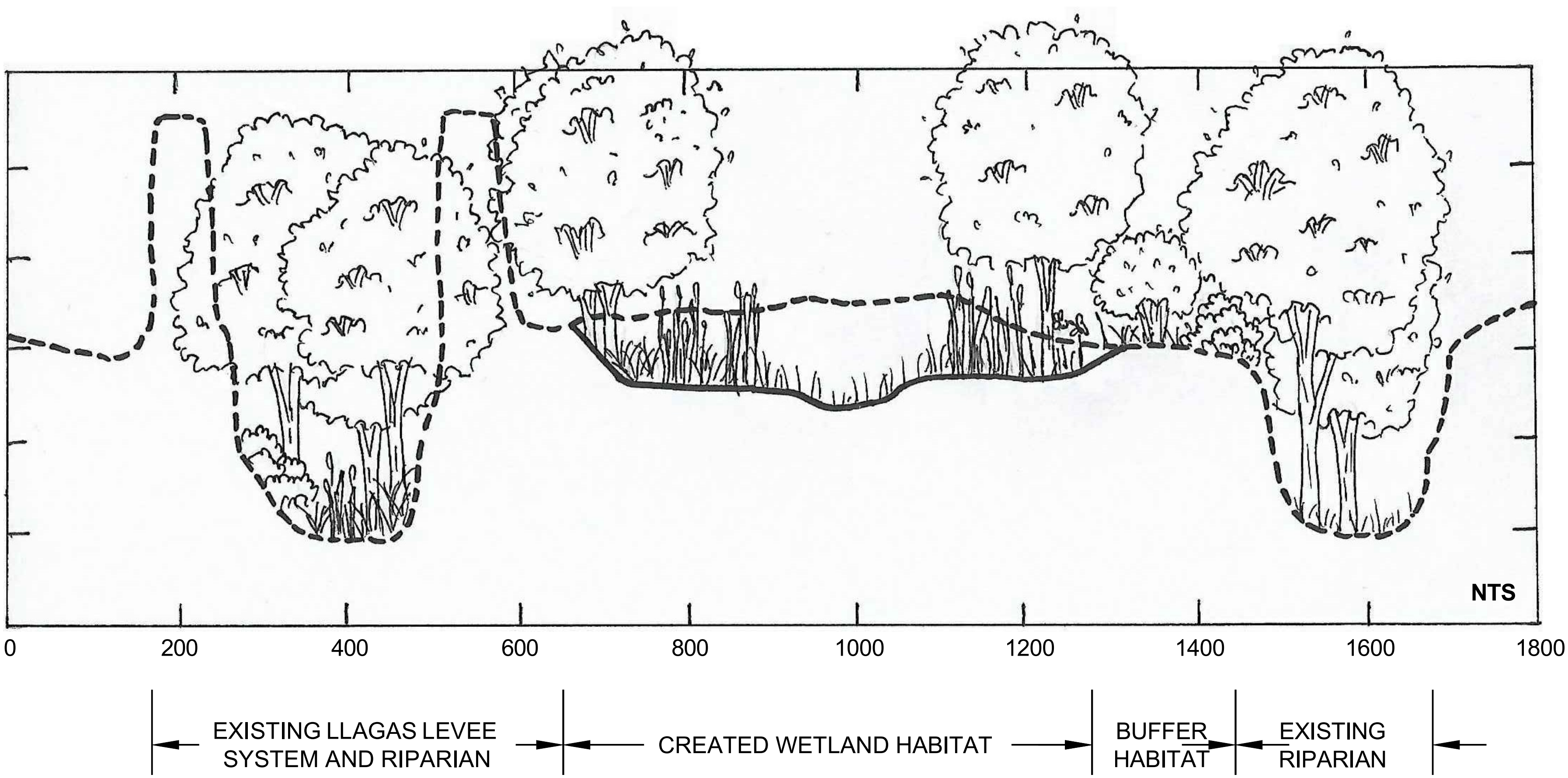

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Figure 12-2c
Habitat Improvement 3
Creating an Off-Channel Seasonal Wetland

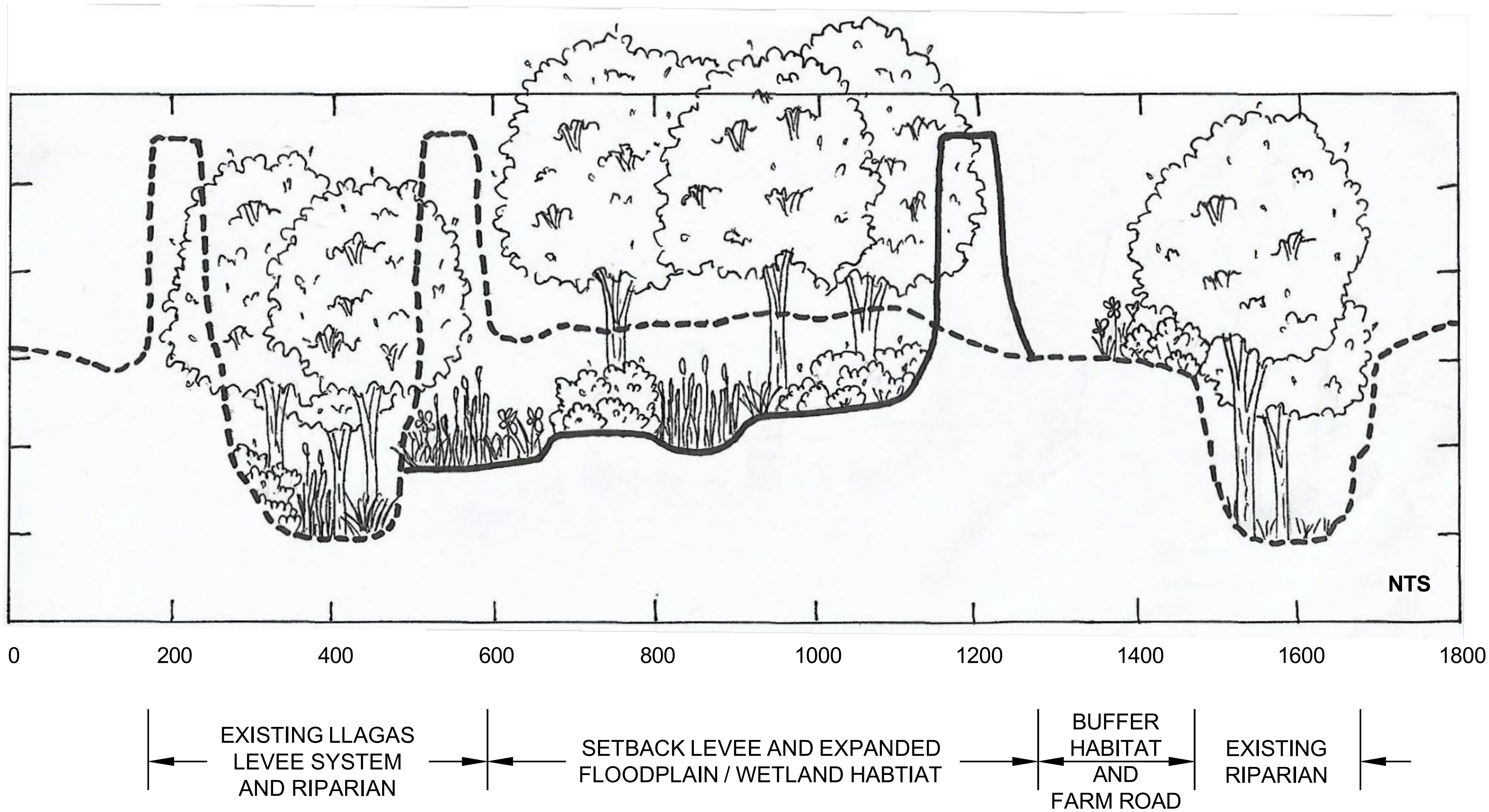

Figure 12-2d
Habitat Improvement 4
Creating a Setback Levee and In-Channel Wetland Habitat

As discussed in Chapter 2, *Project Goals and Objectives*, the project would provide habitat connectivity and greater biodiversity in a landscape that primarily consists of annual row crops and discontinuous riparian corridor. Specifically, the project would improve landscape linkages between the Santa Cruz Mountains and the Diablo Range along the Pajaro River. Findings from the South Santa Clara Velley Historic Ecology Study indicated that changes in the shape and distribution of the remaining willow riparian habitat in the South Valley portion of the Pajaro River watershed have likely caused an even greater decline in functional habitat for many species associated with the interior of riparian areas, such as lease Bell's vireo. The ratio of habitat perimeter to area has increased over 700% with the existing habitat being primarily in the form of narrow linear strips alongside stream channels (Grossinger et al. 2008).

Adding riparian habitat along the open channel would be expected to increase riparian canopy and therefore shading of the Pajaro River channel. Increased stream shading would reduce the area of open water habitats exposed to solar radiation, thereby potentially reducing stream warming and the magnitude of diurnal water temperature fluctuations. Increased stream shading could also reduce the abundance of emergent wetland vegetation which tends to be most abundant where the stream is not shaded, thus improving habitat conditions for fish by decreasing the amount of aquatic vegetation that presently obstructs fish movement. The added riparian habitat would also be expected to increase the amount and complexity of SRA cover, an important component of salmonid habitat, by increasing the coverage and quality of overhanging and instream cover in the form of branches, roots, and downed wood. Expansion of the riparian habitat onto adjacent upland areas also could increase the insulating effect of riparian habitat on water temperatures, thereby reducing stream warming and diurnal water temperature fluctuations.

Increasing the structural diversity of the riparian areas including additional early successional habitat would provide additional nesting and foraging habitat for least Bell’s vireo and foraging habitat for tricolored blackbird. Increasing the width of the riparian corridor would provide additional upland habitat for covered species that use both aquatic and upland habitat types to complete their lifecycles. California red-legged frog and California tiger salamander require slow-moving aquatic habitats for breeding with adjacent upland habitats for foraging and hibernating; while western pond turtle require adjacent upland habitat for nesting.

Adding specific host plant species would be expected to attract beneficial native pollinator species. Particular species such as milkweed could be planted in significant amounts to support monarch butterflies during migration and breeding.

12.2.1.2 Groundwater

Based on a previous study, the shallow groundwater and low salinity levels at the southern end of the project site are opportune for expanding willow riparian habitat. Groundwater was found to be closer to the surface (3–4 feet) and (1–2 ppt salinity) on the project site, near the confluence with Llagas Creek (Phillip Williams & Associates et al. 2008:50).

As you move away from the confluence groundwater becomes less available for plants. Without grading down of the project site or set back of a levee, 2 to 3 years of supplemental irrigation would need to be considered until plantings can reach the groundwater table. Precipitation over the course of construction and planting would play a significant role in groundwater availability for young saplings (Phillip Williams & Associates, 2008).

Future groundwater availability may decrease at the project site due to increased groundwater pumping elsewhere in the shared BolsaNorth San Benito Subbasin (the aquifer that provides water to the project site and South Valley) (Wendell 2013: 1).

12.2.1.3 Soils

Based in NRCS soil survey data, ICF's six soil profile descriptions and laboratory test results for two of the soil profiles, the soil opportunities at the project site include the following:

- The upper 3 to 5 inches of the profile has the most favorable structure and organic matter content and should be salvaged, stockpiled and replaced on the subgrade of the restoration area. The next 6 to 10 inches is also favorable for salvaging as topsoil but has less favorable structure for root penetration.
- On account of the type of clay mineral in the soil and the high clay content, the soil has a high capacity to retain nutrients (i.e., has a high cation exchange capacity).
- Other than a high to very high pH, there appear to be no significant chemical properties that would limit plant growth. However, it is recommended that the planting palette consist of species that are adapted to alkaline soils.

Conversely, the soil has several constraints that make it a less-than-optimal soil for willow riparian scrub restoration, as described below.

- Clay soils with a dry bulk density greater than approximately 1.47 g/cm^3 can restrict plant root growth. The NRCS soil survey data shows that the Willows series typically has a bulk density of 1.59 g/cm^3 in the surface layer and up to 1.72 g/cm^3 deeper in the profile (California Soil Resource Laboratory 2021). Therefore, root growth deep into the soil may be limited by this condition, although it is expected that some roots may be able to penetrate deep into the profile by preferentially extending between the "peds" (e.g., structural prisms) where the localized bulk density may be lower.
- The soil's high shrink-swell potential could damage plant roots as it the soil expands in the winter and shrinks in the late spring/summer.
- If soil salvage, stockpiling and other earthwork is conducted when the soil is moist or saturated, it would be subject to excessive compaction, which would make it less favorable for root growth. Therefore, it is recommended that earthwork be conducted when the soil is dry.

12.2.1.4 Water Quality

Increasing the width of the riparian corridor, and in some locations creating a riparian corridor, would increase the aerial coverage of the canopy. The canopy reduces the impact of water droplets onto the ground surface below, which in turn, reduces the amount of erosion and sediment flowing into the river.

12.2.1.5 Community Involvement

Planting in easily accessible locations lends itself nicely to being implemented by students and volunteers as community supported restoration. Community involvement helps generate a feeling of empowerment through stewardship and support for the project and future projects. Classroom curriculum can also be built around the volunteer activities. Point Blue's Students and Teachers

Restoring A Watershed Program, a collaborative network of students and teachers leading their communities to restore ecosystems, would facilitate community involvement in this project in coordination with the Open Space Authority. Further community involvement entails a field-site tour facilitated by the Pajaro Compass, a network of conservation-minded stakeholders.

12.2.1.6 Climate Change

Increased frequency and severity of drought and dryness, particularly during summer months, could limit vegetation growth or increase competition for water resources amongst water-needy species, causing them to stress or die. Increased wildfire risk may also clear vegetation, particularly if an extremely wet year (which creates rapid vegetation growth) is followed by an extremely dry year (which kills vegetation, creating fuel for fires). Restoration managers may need to consider these changed future conditions when developing plant palettes and seed mixes and manage vegetation so that it does not grow too densely and create a fire concern.

The project could increase resilience to climate change as planting of vegetation could hold soil in place and reduce erosion. This would help keep the riparian corridor stable during flooding or heavy streamflow events. Vegetation could also provide a canopy cover, offering shade to wildlife during extreme heat and helping to keep warming water temperatures cooler by shielding the channel from the sun. Riparian vegetation could also serve as habitat for species facing habitat decline due to climate impacts, such as extreme heat and drought.

12.3 Habitat Improvement 2: Lowering Recontouring Channel Banks and Creating Floodplain Benches

This habitat improvement would consist of in-channel grading along the north bank in portions of Reaches 1 and 2 to widen the channel cross-section and created in-channel low floodplain benches that have a higher frequency of inundation. New channel banks would be graded at a gentler slope along the backside of the expanded benches to allow for increased planting areas and greater bank stability. These surfaces would then be planted with riparian vegetation as described in Habitat Improvement 1.

12.3.1 Habitat Improvement 2 Opportunities and Constraints

12.3.1.1 Biological

As discussed for Habitat Improvement 1, adding riparian habitat along the open channel would result in an increase habitat complexity by enhancing riparian canopy, structure, and diversity on the project site which would improve habitat values for terrestrial wildlife including resident, wintering and neotropical songbirds. The project also would provide habitat connectivity and greater biodiversity in a landscape that primarily consists of annual row crops and discontinuous riparian corridor.

The restoration project would be designed and implemented to minimize effects on existing vegetation. No riparian trees would be removed; however, some limb removal or pruning may be required to facilitate site grading. To widen the Pajaro River, some earthwork would be required within the ordinary highwater mark could result in temporary effects on riparian understory, emergent wetland, and ruderal habitats, as well as the root zones of some riparian trees. All disturbed habitats would be revegetated following completion of grading activities.

In-channel grading, widening of the channel, and creating in-channel low-flow benches would increase open-water habitat for fish but could result in short term increases in water temperature from exposure of a greater water surface area to solar radiation. Warmer water temperatures combined with an increase in open water habitat could benefit nonnative, warmwater fish species over native species until planted riparian vegetation on the low-flow benches and channel slopes shade the Pajaro River channel and reverse stream warming. Increasing the amount of riparian vegetation and SRA cover in these areas would have the same benefits to fish from increases in SRA cover and stream shading as described in Habitat Improvement 1.

The creation and planting of floodplain benches would increase the structural diversity of the riparian areas including early successional habitat that could benefit least Bell's vireo by providing additional nesting and foraging habitat, and benefit tricolored blackbird by providing additional foraging habitat. Lowering channel banks would allow California red-legged frog and western pond turtle to easier vacate the channel during higher flow events, provide California red-legged frog and western pond turtle better access to forage in uplands, and provide western pond turtle better access to uplands to nest. Widening the channel and creating the in-channel low-flow benches would cause a slowing of the water flow through these areas. The slower flow would be beneficial to target species, such as California red-legged frog and western pond turtle who prefer slow-moving water. During high flow, red-legged frog egg masses can become dislodged and tadpoles, juveniles, and adults can be washed downstream. Creating areas of slower flow would increase the potential breeding habitat and provide shelter during higher flow events.

12.3.1.2 Hydraulic

Several studies have previously identified potential restoration opportunities related to the hydrologic function of the Pajaro River. Some of these potential restoration opportunities are focused on the larger watershed (i.e., Grossinger et al. 2008), but they are applicable to ecological objectives within the project site. The following site-specific opportunities related to the hydrologic function of the Pajaro River are summarized below.

Philip Williams & Associates (2004) and Philip Williams & Associates et al. (2008) recommend additional strategies with an emphasis on grading within the project site:

- Grade down the right bank levee to provide a low floodplain bench.
- Grade down the entire site to increase access to groundwater.

The primary constraint of improving hydraulic function of the Pajaro River is its natural flow regimes has been heavily altered. The upper watershed no longer provides flows to this section of the river, and groundwater levels are highly dependent on the current climatic conditions and land management strategies.

Significant alteration of the currently drainage system to pre-European conditions (especially with regard to Millers Canal) would require a much higher level of investigation, design, and coordination.

Philip Williams & Associates et al. (2008) echoes these concerns with a list of various constraints for potential restoration projects on the Pajaro, such as the following:

- The project must not increase flood hazard.
- The project must not reduce movement or survival of steelhead.
- Soil salinity, groundwater salinity, and groundwater depth would affect project design.
- As a regulated area, the project site falls under USACE and CDFW jurisdiction.

A comprehensive understanding of the project site's historical hydraulic conditions and its place within the larger watershed network was the first step in tackling the various opportunities and constraints presented here. In summary, the limited hydrologic (surface water) input from upstream sources plays a formative role in the restoration design (i.e., not designing overly large floodplain benches that depend on regular inundation via surface water). The variable range in flow and inundation is also a challenge; however, the groundwater influence should readily allow for establishment of floodplain benches and wetland creation.

In addition, the Pacheco Reservoir Expansion Project (as described in Chapter 5, *Hydrologic Assessment*) is not expected to be a constraint regarding the available hydrologic resources at the PRAP. Since this reservoir (and its upcoming expansion) is located in the upper reaches of Pacheco Creek, approximately 7.5 miles west of San Luis Reservoir and 13 miles northeast of the PRAP, its present-day and future operations would have a very small effect on the amount of available water to the project site. Because there would be more storage capacity in the Pacheco Reservoir after its expansion, downstream flooding would, hypothetically, be somewhat attenuated during the rare cases in which San Felipe Lake overflows and connects to the various unnamed channels that drain toward the PRAP. However, the local hydrologic conditions that would be supporting the overtopping of San Felipe Lake would most likely also ensure that the feeder streams upstream of the PRAP (to its immediate northeast) would also be delivering excessive amounts of water input to the project site.

12.3.1.3 Geomorphic

According to the channel evolution model of Cluer and Thorne (2013), the channel in the surveyed area is a Stage 2 channelized channel, which is characterized by anthropogenic manipulation of the channel. Of most importance to this restoration project is that channelization has reduced the wetted area and channel complexity relative to flow. The higher bank heights are potentially unstable in certain locales (as described above), and the extent, connectivity, and functionality of the riparian area, floodplain, and any adjacent wetlands is generally reduced. By excavating the right bank and adding a low floodplain bench (or inset bench), the connection to the floodplain would be maximized.

12.3.1.4 Climate Change

Because of climate change, the channel may experience a large variability in flow. During the rainy season, the combination of heavier precipitation events and earlier snowmelt may increase flooding risk in rivers and streams. This could cause floodplains to flood more often than historically expected (Ackerly 2018). During drought conditions, precipitation and streamflow could decrease, while drought contingency policies may limit surface water availability for use in agriculture, and thus, reduce runoff (Department of Water Resources 2021). If this occurs, flows from upstream agriculture may be reduced in the channel.

The widening of the floodplain bench could, however, create more room for the channel to expand during heavy precipitation and streamflow events. This could help reduce severe flooding impacts on the riparian ecosystem and surrounding areas. As mentioned in Habitat Improvement 1, creating room for more riparian growth could offer other benefits, such as canopy cover, a shield from the sun for the stream, and increased habitat area.

12.4 Habitat Improvement 3: Creating an Off-Channel Seasonal Wetland

This habitat improvement would consist of constructing an off-channel seasonal wetland on the floodplain terrace in Reaches 3 and 4 near the confluence with Llagas Creek.

Possible strategies to achieve an off-channel seasonal wetland include:

- Excavation of the lower portion of the project site to a range of approximately 139 to 142 feet would likely create depths that sustain seasonal wetlands on the right bank floodplain (FlowWest 2016:10). This strategy would be possible due to the presence of groundwater during wet cycles of the year.
- Several alternative connection points from the right bank of the Pajaro River, or a combination of connection points to facilitate entry of surface water into the seasonal wetlands, are available. These include: the upstream end of the Toe Drain Channel at the upstream end of Reach 2b; the general location of the flapgate culvert along the Toe Drain Channel in Reach 3; and a direct connection to Llagas Creek. The connection points would essentially be breaches or cuts within the right bank of the Pajaro River, set at desired elevations (lower or higher connection elevations could provide for more/less frequent inundation and more/less retention of overflow.). This strategy would be possible and not create a significant erosion hazard due to the lack of excessive velocities as observed by others (FlowWest 2016:10).
- Wetland swales or similar conveyance channels originating from the connection points/breaches would have their own respective habitat value. The number of channels would depend on the number of breaches/connection points. A single breach could consist of a slightly sinuous wetland channel that would flow directly into a large wetland complex; conversely a multitude of channels originating from various breaches on the right bank could create an anastomosing channel network ("island-like") with separate wetlands with distinct elevation surfaces. The overall complexity in elevation, size, and shape would be a function of the finish grade and the number of connection points/breaches. This strategy would be possible and not create a significant erosion hazard due to the lack of excessive velocities as observed by others (FlowWest 2016: 10) and due to the presence of groundwater during wet cycles of the year.

This habitat improvement would be designed and implemented to minimize effects on existing vegetation and no riparian vegetation would be affected by this improvement. Although implementation of seasonal wetland would result in the permanent conversion of some agricultural land to riparian woodland this land cover type is not limiting on the project site and the conversion of agricultural land to seasonal wetland and would increase overall habitat complexity on the project site.

12.4.1 Habitat Improvement 3 Opportunities and Constraints

12.4.1.1 Biological

Development of a seasonal off-channel wetland could create seasonal rearing habitat for native and nonnative fish species. Seasonal wetlands have been shown to be a significant source of phytoplankton and zooplankton which are important prey items for fish, especially larvae. Because this habitat would be seasonal and the expected timing of inundation would occur during the winter or early spring, this habitat would be expected to benefit native fish species over nonnative species since the timing of inundation of this habitat would be more in line with the timing of spawning and early rearing of native species (winter and spring) than nonnative fish species (late spring and summer). Benefits to fish from the seasonal wetland may also extend to fish in the Pajaro River downstream from the seasonal wetland as the wetland drains and releases these prey items to the Pajaro River. Constraints associated with the off-channel wetland include a potential for fish to become stranded in the wetland as the wetland drains and the connection between the wetland and the Pajaro River becomes impassable or is severed before fish are triggered by environmental cues to leave the wetland. However, the potential for adult and juvenile (smolt) steelhead to enter the seasonal wetland would be expected to be very low because the Pajaro River in the vicinity of the project site is not on the migration route to upstream habitats in the Pajaro River or Llagas Creek basins and adult and juvenile steelhead in this reach of the Pajaro River would be expected to be found in main channel areas as they migrate upstream (adults) and downstream (kelts[12]and smolts). Therefore, the potential for steelhead to become stranded in the seasonal wetland is likely to be very low.

As mentioned previously, the combination of aquatic habitat adjacent to upland riparian habitat would benefit California red-legged frog and western pond turtle, along with many other non-covered species. In addition to providing cover if vacating the channel during high flow events, the conversion of agricultural fields to natural wetland habitat would increase potential foraging and nesting habitat for these species. The plant palette for the wetland and surrounding upland would likely vary from the in-channel habitat, providing greater biodiversity and options for breeding and foraging. The plant palette can be developed to include additional host species of native pollinators and invertebrates, such as the monarch butterfly. The wetland would also provide much-needed foraging and resting location for migrating and resident birds including waterfowl and shorebirds; the additional seasonal wetland habitat would increase potential foraging habitat for least Bell's vireo and tricolored blackbird. Much of the historic wetland complexes in the vicinity of the PRAP have been drained and converted. South Santa Clara Valley has experienced a 90% reduction in valley freshwater marsh and a substantial reduction in each of the major wetland types (Grossinger et al. 2008).

12.4.1.2 Geomorphic

Excavation of the lower portion of the project site (near the confluence with Llagas Creek) and/or greater connectivity between this floodplain and the Pajaro River would encourage more frequent and deeper inundation on the floodplain surface and would establish hydrologic and ecological connectivity between the floodplain, the Pajaro River, and Llagas Creek. Seasonal wetland creation and riparian habitat complexity improvement in this area could also provide a flood "relief valve"

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[12] Kelts are adult steelhead that have successfully spawned and are returning to the ocean.

that could help reduce downstream flooding risk (downstream of the Pajaro River's confluence with Llagas Creek) and provide a water quality benefit through sequestration of agricultural and other nonpoint source pollutants that likely exist in Llagas Creek and Pajaro River runoff (FlowWest 2016: 7).

Geomorphic constraints are similar to those described above under *Hydraulic Constraints and Opportunities*. The primary constraint is the alteration of the hydrologic regime, which limits the input of water from upstream sources.

Other constraints include the following:

- **Existing land use/available acreage:** Up to 40 acres of the PRAP can be converted from agriculture to other uses, such as native wetland habitat restoration and enhancement. The 40 acres include restoration and recreational components, the needs of which must be balanced during the restoration design.
- **Existing ownership:** Access to the left (south) bank of the Pajaro River at the project site is currently not available. This portion of the project site is located in San Benito County and is privately owned. This limits the amount instream restoration activities that could occur as part of the project, and does not allow for any habitat improvements on the left bank at the project site beyond the property owned by OSA.
- **Limited channel gradient and limited habitat for fish:** The channel bedslope of the Pajaro River at the project site is 0.0009. As such, opportunities for instream habitat complexity creation (e.g., resting pool habitat and/or structures dependent upon scouring processes for maintenance) are limited. In addition, the gentle floodplain gradient is a significant factor in determining the proper way for created wetlands to efficiently drain back towards the river and/or Llagas Creek to avoid stranding of fish and other aquatic organisms.

12.4.1.3 Groundwater

Groundwater studies at the project site were initiated in December 2020 and are ongoing. The project has collected valuable preliminary groundwater data, but there is not enough data to establish the project site groundwater characteristics. Groundwater studies at nearby sites have been completed in more detail.

It could be assumed that hydrogeologic characteristics of surrounding properties are consistent with the project site, and that ample subsurface flows would support restoration goals. Conditions downstream at the Carnardero Preserve indicate proposed wetlands could potentially receive discharge flow from the alluvial fan deposit below the site. Seasonal groundwater at the Carnardero Preserve was found to be consistent, with slightly shallower depths (3–5 feet) during winter and spring compared to summer and fall. Waters in this area are naturally funneled toward the Carnardero Preserve due to the constriction of Pajaro Gap, where thick river sediments in the north meet a bedrock channel to the south. The Carnadero Preserve has ample surface and subsurface water supplies due to the backwater effects on drainage from the Pajaro Gap constriction (Nelson 2004:2,5). While the subsurface conditions at the PRAP are more unknown (and may differ from those at the Carnardero Preserve), it is assumed that groundwater influence would play an important role in the overall restoration efforts by sustaining the vegetation communities.

The flood control levee on Llagas Creek may prevent the project site from reaching optimal surface and or subsurface conditions conducive to wetland establishment. Evaluation of drainage conditions at Tequisquita Slough and Pacheco Creek indicate the project site may not necessarily revert completely to 1940 conditions due to channelization and levee construction along Pacheco Creek. With these restrictions, groundwater elevations may need to be higher than levels prior to pumping to achieve the site's historical condition. (Phillip Williams & Associates, 2007).

Previous studies at the project site found that ponding occurred at the confluence during storms of just 0.75 to 1.0 inch (FlowWest 2016:10), a smaller amount necessary than the 1-year, 24-hour storm for the project site (1.79 inches) (Perica et al. 2014).

12.4.1.4 Water Quality

Wetland plants and soils help filter out pollutants that are found in water runoff. Water containing pollutants collects within the wetland basin, and as it slows down, the sediment and large particles to which pollutants are bonded, settle to the bottom of the wetland. The pollutants are absorbed into the soil and then up through the roots of wetland plants where they are contained and prevented from being carried downstream into larger water bodies. While portions of the adjacent agricultural crops are intended to be grown organically and without the use of pesticides, any runoff from portions of the agricultural field that are not in organic production have the potential to produce pollutants that may enter the Pajaro River. The Pajaro River is classified as an impaired-by-pollution water body. Pollutant types found in the river include mercury and other metals; pesticides, pathogens, organics; low dissolved oxygen; nutrients; sediment; turbidity; and water pH (Santa Clara Valley Open Space Authority 2014). Seasonal wetland habitat provides the best method for removing the pollutants from runoff prior to entering the river. However, all of the other habitat improvements provide some degree of pollutant uptake through the plant material associated with the habitat improvement.

12.4.1.5 Climate Change

Given expected decline of freshwater wetlands under climate change (Junk 2013), creating an in-channel wetland would support California Wetlands Conservation Policies focused on no net loss of wetlands. However, managing and restoring wetlands is also expected to become more difficult as functionality may be impaired by drought, increasing temperature, or flooding events.

Under climate change, the region may experience more extreme dry events, such as drought. Because the wetland would be fed primarily through rainfall, reduced precipitation could result in the wetland not receiving as much rain as the wetland requires for restoration benefits to be realized.

Creation of the wetland could provide ecosystem services that boost resilience under climate change. This includes enhanced infiltration and flood control during heavy precipitation and streamflow events. Furthermore, creating a wetland could help compensate for the loss of this habitat type, which is declining at increased rates because of climate change.

12.5 Habitat Improvement 4: Creating a Setback Levee and In-Channel Wetland Habitat

This habitat improvement would consist of constructing a setback levee in Reach 3 at the confluence of the Pajaro River and Llagas Creek. Within the area of the setback levee the north bank of the river and adjacent floodplain would be lowered to construct in-channel seasonal wetland and low-flow channel habitat. The in-channel wetland would be planted and seeded with native, herbaceous seasonal wetland species. The graded channel bank and adjacent floodplain would be planted with riparian vegetation.

This habitat improvement would be designed and implemented to minimize effects on existing vegetation and no riparian vegetation would be affected by this improvement. No riparian trees would be removed; however, some limb removal or pruning may be required to facilitate site grading depending on final placement of this feature. Although implementation of in-channel wetland and riparian habitat would result in the permanent conversion of some agricultural land this land cover type is not limiting on the project site and the conversion of agricultural land to seasonal wetland and would increase overall habitat complexity on the project site.

12.5.1 Habitat Improvement 4 Opportunities and Constraints

12.5.1.1 Biological

The creation of a setback levee with in-channel wetland and low flow habitat would result in more frequent and deeper inundation of the floodplain, which could benefit native aquatic wildlife species including least Bell's vireo, tricolored blackbird, California red-legged frog, and western pond turtle by increasing seasonal foraging habitat and refuge habitat during high flows in Llagas Creek and the Pajaro River. The additional in-channel emergent seasonal wetland habitat would enhance existing emergent wetland in Reaches 3 and 4. It would also lessen the effects of downstream flooding during high flow/precipitation events via more localized floodplain storage.

As discussed for Habitat Improvement 1, adding riparian habitat along the open channel would result in an increase habitat complexity by enhancing riparian canopy, structure, and diversity on the project site, which would improve habitat values for terrestrial wildlife including resident, wintering and neotropical songbirds. The project also would provide habitat connectivity and greater biodiversity in a landscape that primarily consists of annual row crops and discontinuous riparian corridor. The benefits to covered species would be similar to those of Habitat Improvements 2 and 3.

The creation of a setback levee with in-channel wetland and low flow habitat would result in more frequent and deeper inundation of the floodplain, which could benefit native fish species by increasing seasonal foraging habitat and refuge habitat during high flows in Llagas Creek. However, the created in-channel wetland and low flow habitats could increase fish stranding as these areas drain if the connection between the wetland areas and Pajaro River or Llagas Creek channels become impassable or severed before fish are triggered by environmental queues to leave the wetland. The proximity of the proposed setback levee and created in-channel wetland to Llagas Creek, which supports migration habitat for steelhead, could increase stranding risk for steelhead, though the risk would be expected to be low because steelhead would be expected to be quickly moving upstream (adults) or downstream (kelts and smolts) past the project site while migrating. Additionally, design considerations can be incorporated that would allow slow, positive drainage of the wetland complex back into the river and avoid the creation of depressions to significantly reduce stranding risk. The creation of floodplain habitat and the in-channel wetland would be expected to improve foraging habitat for fish for the same reasons described above for off-channel seasonal wetlands. Increasing the amount of riparian vegetation and SRA cover in these areas would have the same benefits to fish from increases in SRA cover and stream shading as described above for adding riparian habitat along the open channel and upland areas.

12.5.1.2 Hydraulic

The hydraulic opportunities and constraints are similar to those described under Habitat Improvement 2 with the addition of allowing natural stream dynamics at the larger confluence to form habitat types and natural plant colonization. The larger, less confined floodplain would offer the greatest reduction in downstream flooding of all of the habitat improvements.

12.5.1.3 Geomorphic

Excavation of the lower portion of the project site (near the confluence with Llagas Creek) and/or greater connectivity between this floodplain and the Pajaro River would encourage more frequent and deeper inundation on the floodplain surface and would establish hydrologic and ecological connectivity between the floodplain, the Pajaro River, and Llagas Creek. Seasonal wetland creation and riparian habitat complexity improvement in this area could also provide a flood “relief valve” that could help reduce downstream flooding risk (downstream of the Pajaro River’s confluence with Llagas Creek) and provide a water quality benefit through sequestration of agricultural and other nonpoint source pollutants that likely exist in Llagas Creek and Pajaro River runoff (FlowWest 2016: 7).

12.5.1.4 Groundwater

Previous studies at the project site found that ponding occurred at the confluence during storms of just 0.75 to 1.0 inch (FlowWest 2016:10), a smaller amount necessary than the 1-year, 24-hour storm for the project site (1.79 inches) (Perica et al. 2014).

12.5.1.5 Climate Change

As described above, anticipated challenges for wetland functionality under climate change can create difficulties for maintaining and restoring wetlands due to drought, increasing temperature, or flooding events (Junk 2013).

Similar to the off-channel wetland, reduced precipitation could make it difficult to keep the wetland wet during drought (Moomaw et al. 2018). While this wetland does receive water from the channel, reduced precipitation would also affect the amount of runoff in the channel and, thus, the flows that reach the in-channel wetland.

An in-channel wetland could also help with flood control by allowing a place for input water from the setback levee to flow out and infiltrate. Furthermore, compared to the off-channel wetland, the in-channel wetland may be more resilient to climate change because it could feed off both precipitation and streamflow from the channel, rather than precipitation alone.

Chapter 13
Summary and Next Steps

13.1 Summary

The Pajaro River at the project site is a lowland, groundwater-driven, alluvial watercourse with a homogenous channel bed with significant instream vegetation, and it functions as more of a wetland than a riverine environment. The opportunities for improving riparian habitat and complexity and create seasonal wetlands are abundant, but are limited by the amount (i.e., acreage) of available farmland for wetland conversion and the temporally sporadic hydrologic regime.

Four habitat improvements are being considered:

- Planting riparian vegetation, stand-alone and as part of the other habitat improvements.
- Lowering the channel banks and creating floodplain benches.
- Creating an off-channel seasonal wetland.
- Creating a setback levee and in-channel wetland habitat.

Habitat improvements implemented at the project site would increase the habitat value and complexity, have the potential to support VHP covered species, provide valuable links in regional terrestrial migration corridors, and provide opportunities for passive recreation and community involvement.

13.2 Next Steps

In July 2021, the feasibility report was presented at a stakeholder meeting. The goal of the stakeholder meeting was to refine the goals and objectives as needed and further refine the habitat improvements. Comments gathered from the Stakeholder meeting can be found in Appendix E. Refinements to habitat improvement would include the assignment of target acreages, precise locations and configurations, and plant palettes. After the habitat improvements have been refined, construction documents would be developed for Phase 1 and 2 Habitat Improvements 1 and 2. Funding is available to start implementing the Phase 1 plantings; however, additional funding would be sought for Phase 2 implementation. Additional Phase 2 funding may include direct funding by the project team. Phase 3 habitat improvements require additional studies and coordination with Valley Water. Additional funding for Phase 3 studies and implementation would also be pursued. The project team will explore placing a conservation easement over the locations of the habitat improvements and enrolling them into the SCVHA's reserve system.

Chapter 14
Acknowledgment

The project team wishes to acknowledge the generous support of our partners and funders including the Pajaro River Watershed Flood Prevention Authority and their floodplain preservation grant program, the California Department of Fish and Wildlife Landscape Conservation Planning Program and their local assistance grants for Natural Community Conservation Plans, the Coastal Conservancy and Association of Bay Area Governments Metropolitan Transportation Commission and their Priority Conservation Areas grant program, the Resource Conservation District of Santa Cruz County, and Valley Water.

Chapter 15
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Appendix A
Aquatic Resources Delineation Map

Pajaro Ranch
Agricultural Preserve Project
April 2021

Legend

Delineation Area (22.40 acres)

Data Points

Upland Data Point

Wetland Data Point

OHWM Data Point

Culvert

Photo Point

Aquatic Resources

Wetlands (3.235 acre)

Emergent Wetland (0.780 acre)

Forested Wetland (2.403 acres)

Agricultural Wetland Ditch (0.052 acre)

Non-Wetland Waters (3.300 acres)

Agricultural Ditch (0.117 acre)

Perennial Stream (3.183 acres)

W = Average Width

0 50 100 200
Feet
1 inch = 200 feet

N

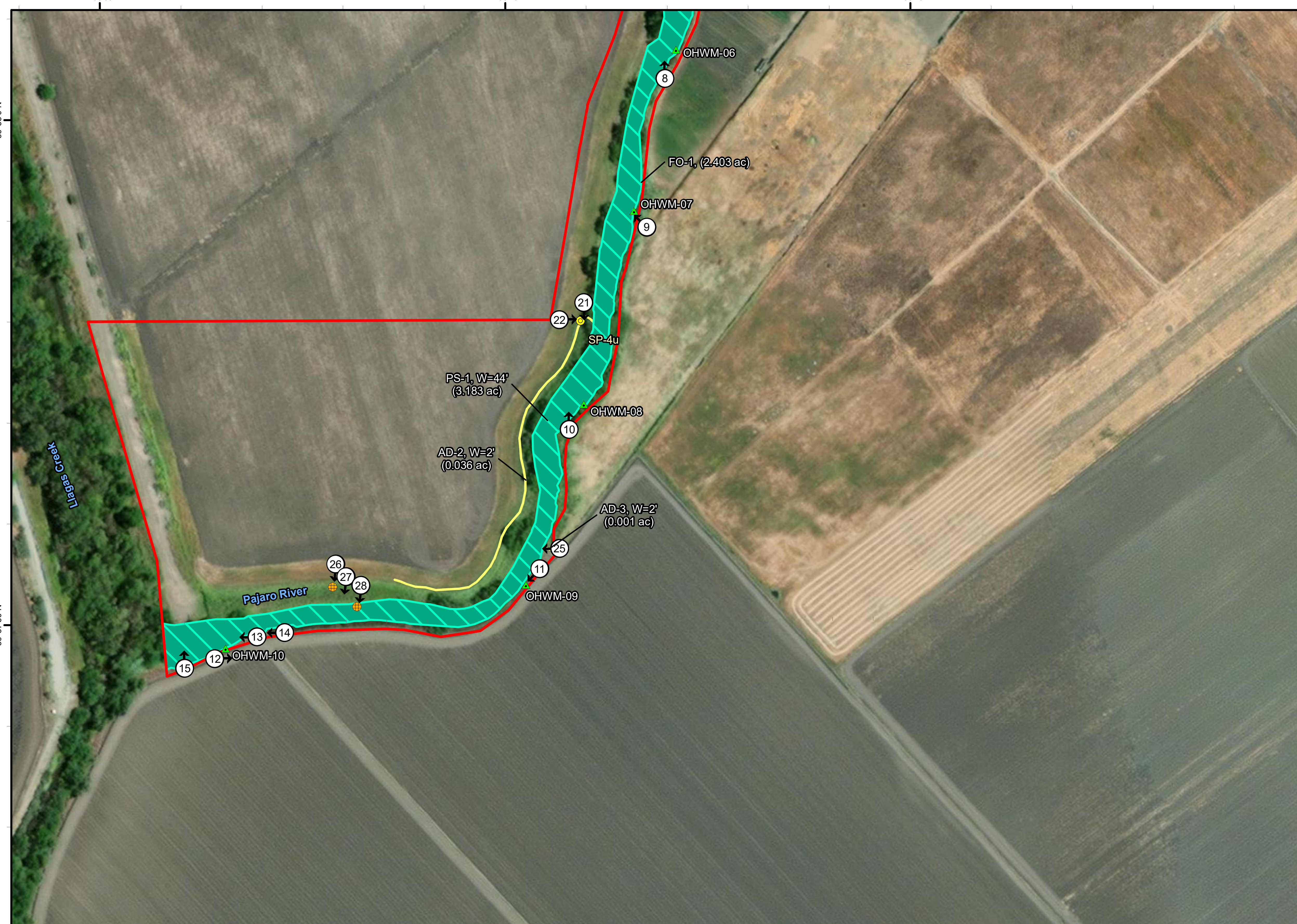
Notes:
Base Map Source: ICF 2021
Imagery Source: Maxar 2019
USGS Topo Quad: Chittenden
PLSS: Llano Del Tequisquita, Las Animas and San Ysidro (Ortega) Landgrants

Prepared By: ICF 916.737.3000
Delineated By: D. Jokerst
Delineation Date: March 11, 2021
Drawn By: A. Angier

Path: \\PDCCITRDSGIS1\Projects_1\Triangle_Properties\00625_20_Pajaro_Ranch\Figures\Doc\ARDR\Aquatic_Resources.mxd; Author: ; Date: 4/16/2021

ICF

Appendix A
Aquatic Resources Delineation Map



Pajaro Ranch
Agricultural Preserve Project
April 2021

Legend

Delineation Area (22.40 acres)

Data Points

- Upland Data Point
- Wetland Data Point
- OHWM Data Point
- Culvert
- Photo Point

Aquatic Resources

Wetlands (3.235 acre)

- Emergent Wetland (0.780 acre)
- Forested Wetland (2.403 acres)
- Agricultural Wetland Ditch (0.052 acre)

Non-Wetland Waters (3.300 acres)

- Agricultural Ditch (0.117 acre)
- Perennial Stream (3.183 acres)

W = Average Width

0 50 100 200
Feet
1 inch = 200 feet

N

Notes:
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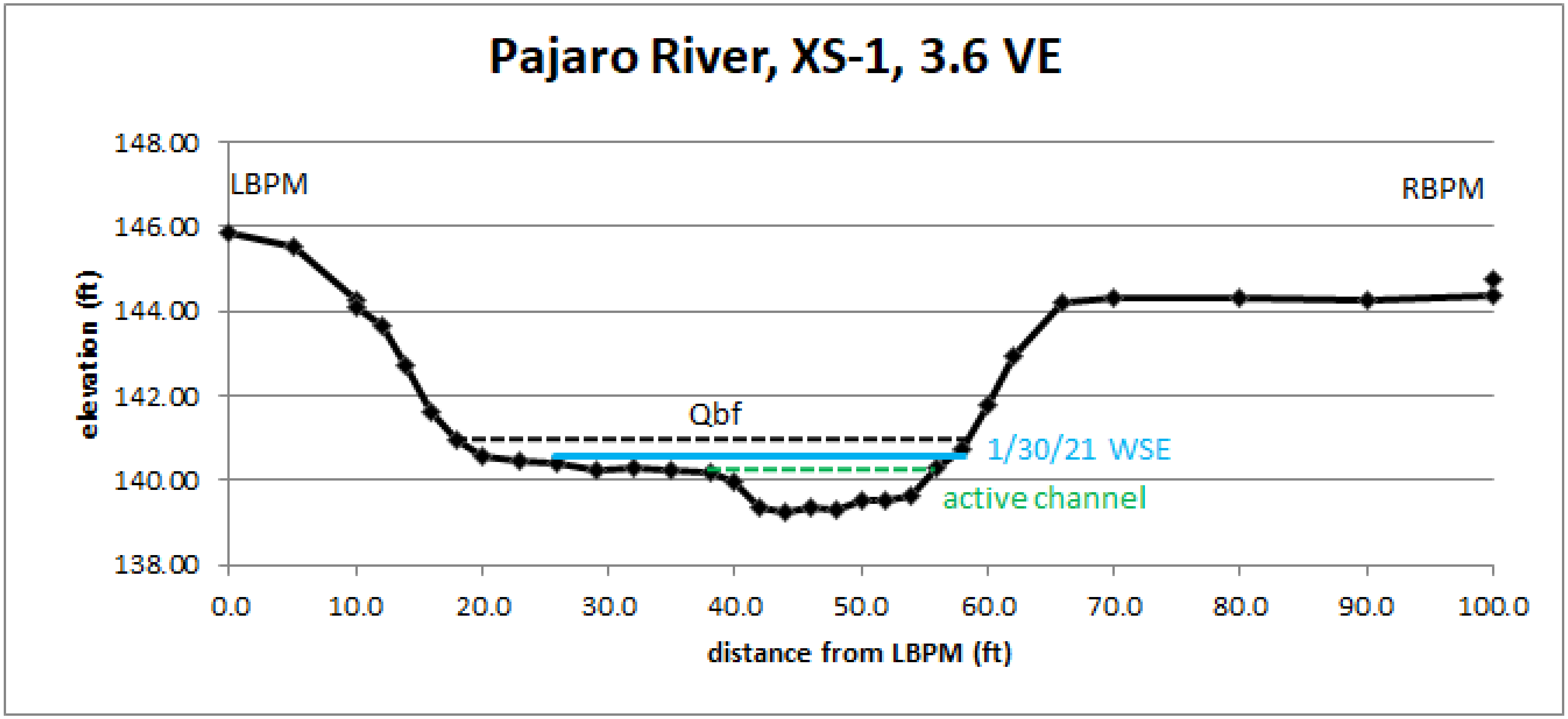
Prepared By: ICF 916.737.3000
Delineated By: D. Jokerst
Delineation Date: March 11, 2021
Drawn By: A. Angier

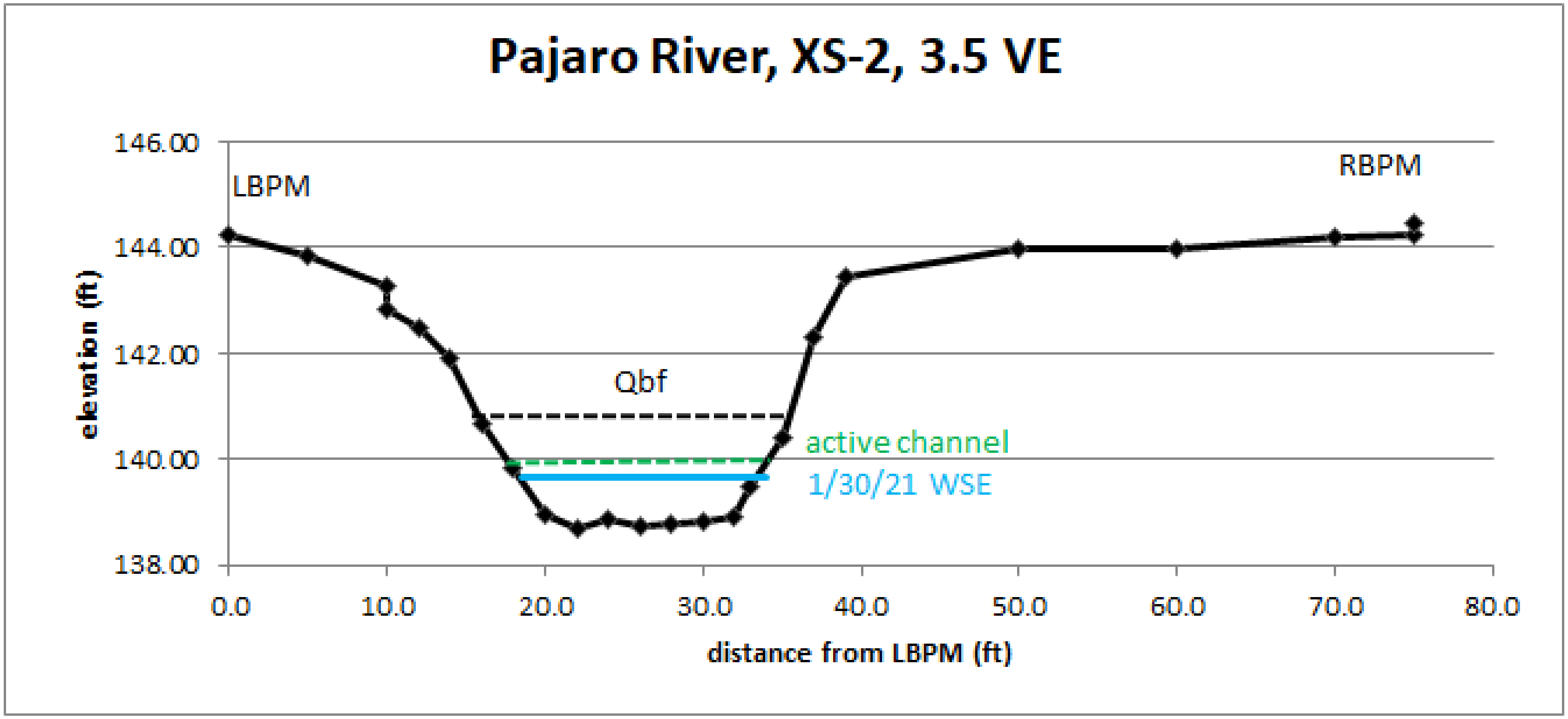
ICF

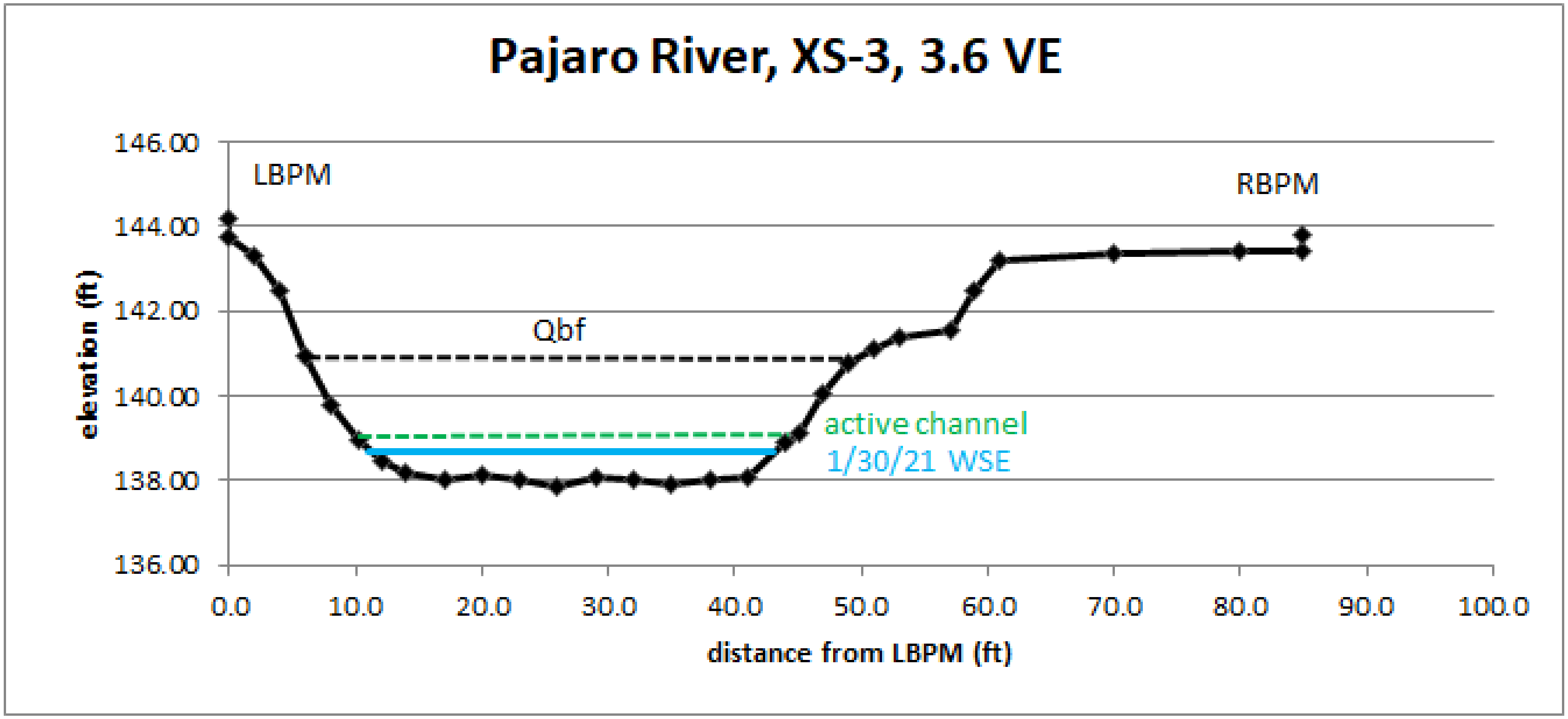
Appendix A
Aquatic Resources Delineation Map

Appendix B
Topographic Survey Data



Pajaro River, XS-1, 3.6 VE
148.00
146.00
144.00
142.00
140.00
138.00
elevation (ft)
LBPM
RBPM
Qbf
1/30/21 WSE
active channel
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
distance from LBPM (ft)


Pajaro River, XS-2, 3.5 VE
LBPM
RBPM
Qbf
active channel
1/30/21 WSE
elevation (ft)
146.00
144.00
142.00
140.00
138.00
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
distance from LBPM (ft)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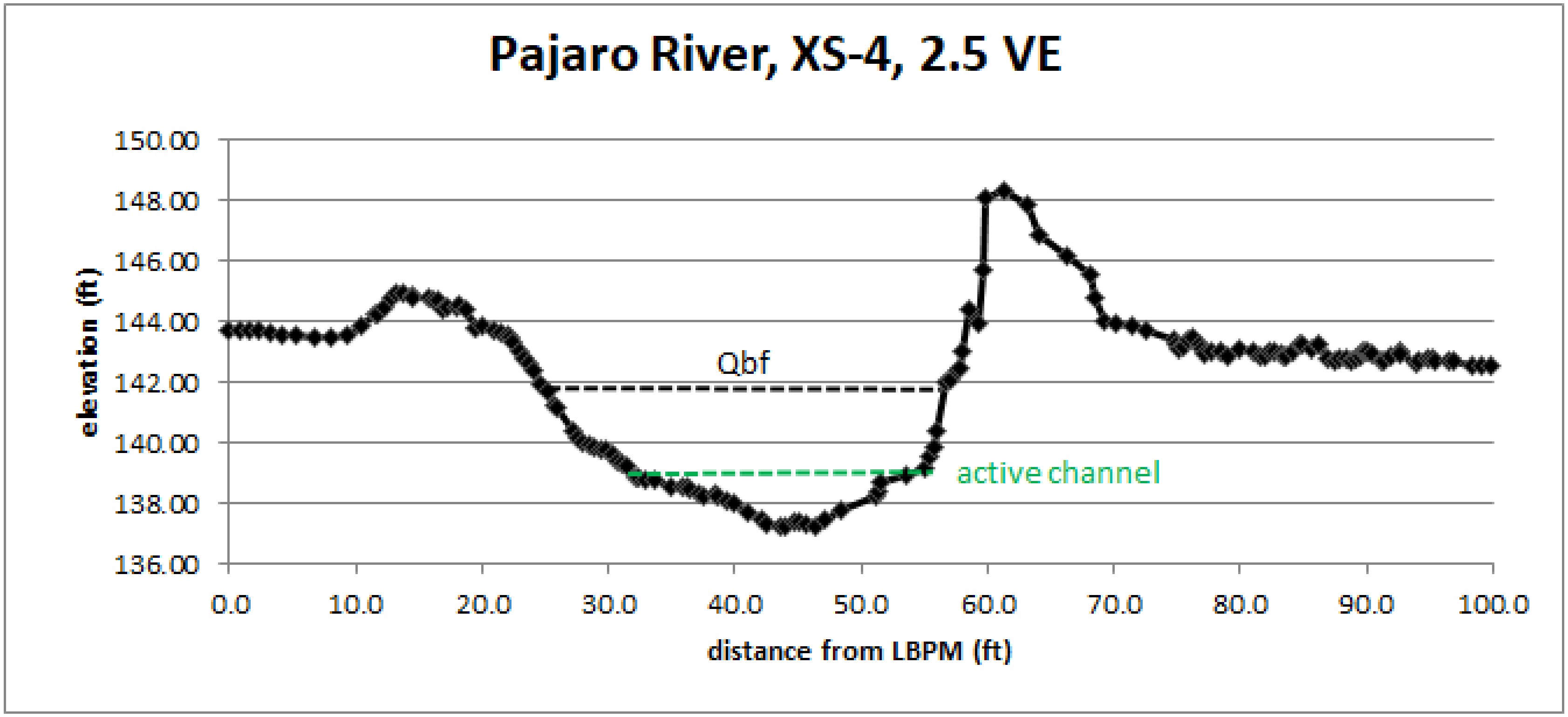
142.00
140.00
138.00
136.00
elevation (ft)
LBPM
RBPM
Qbf
active channel
1/30/21 WSE
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
distance from LBPM (ft)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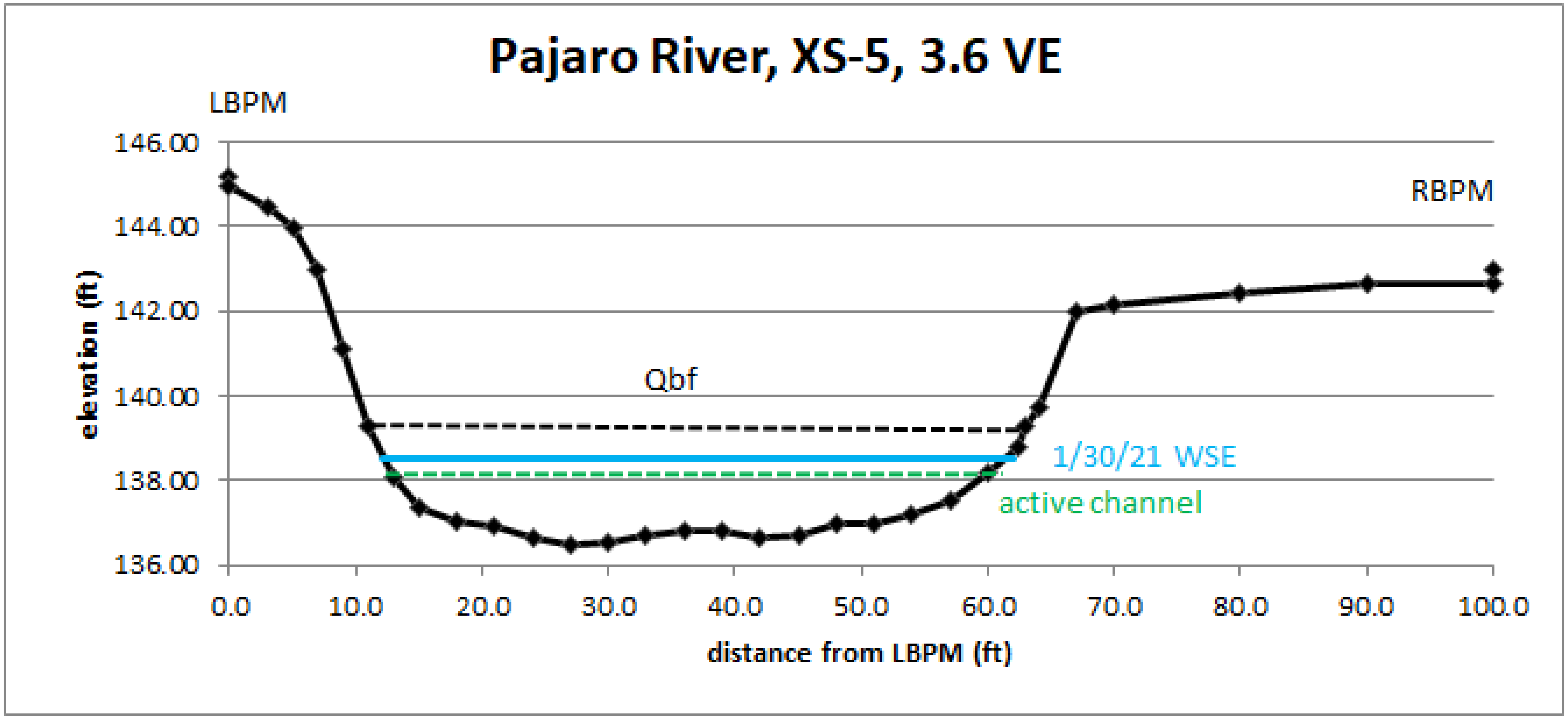
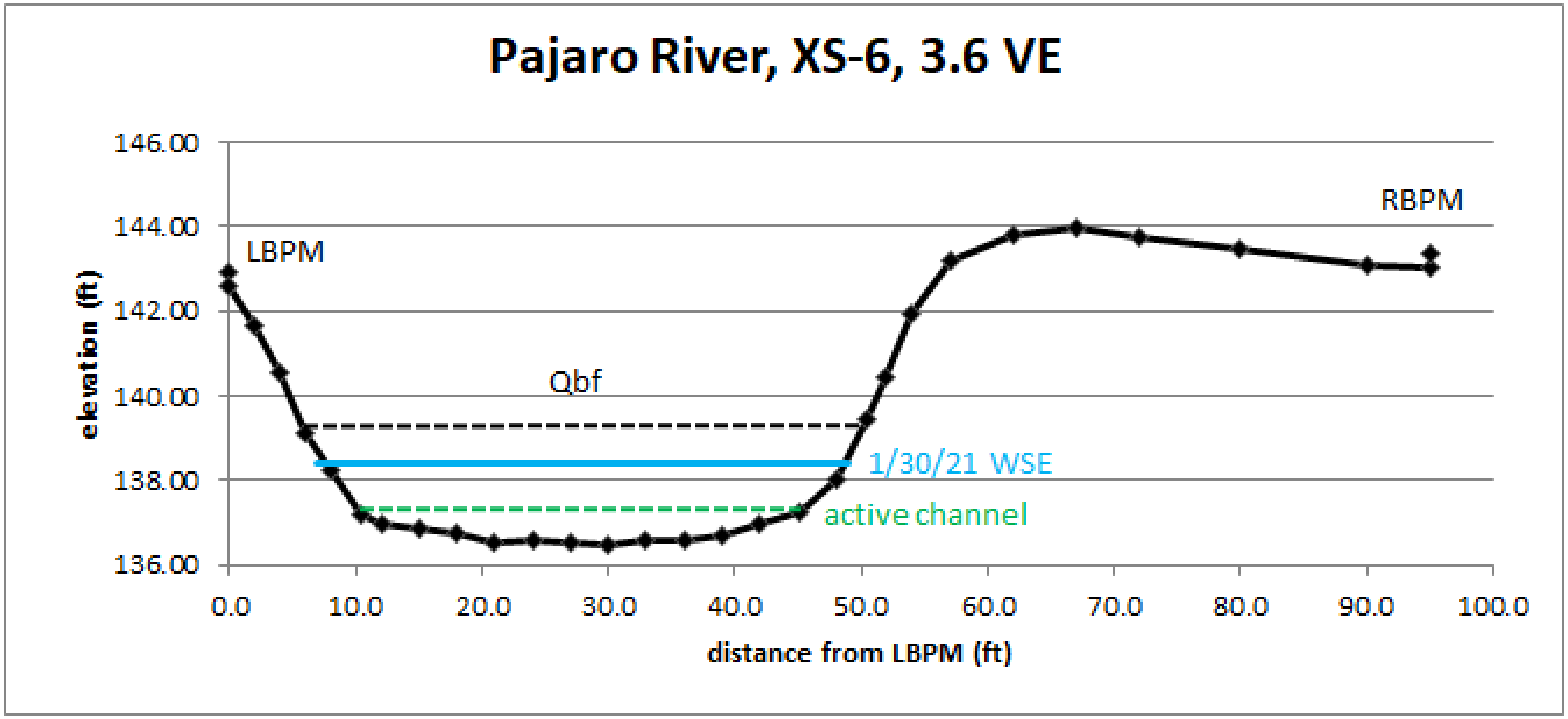
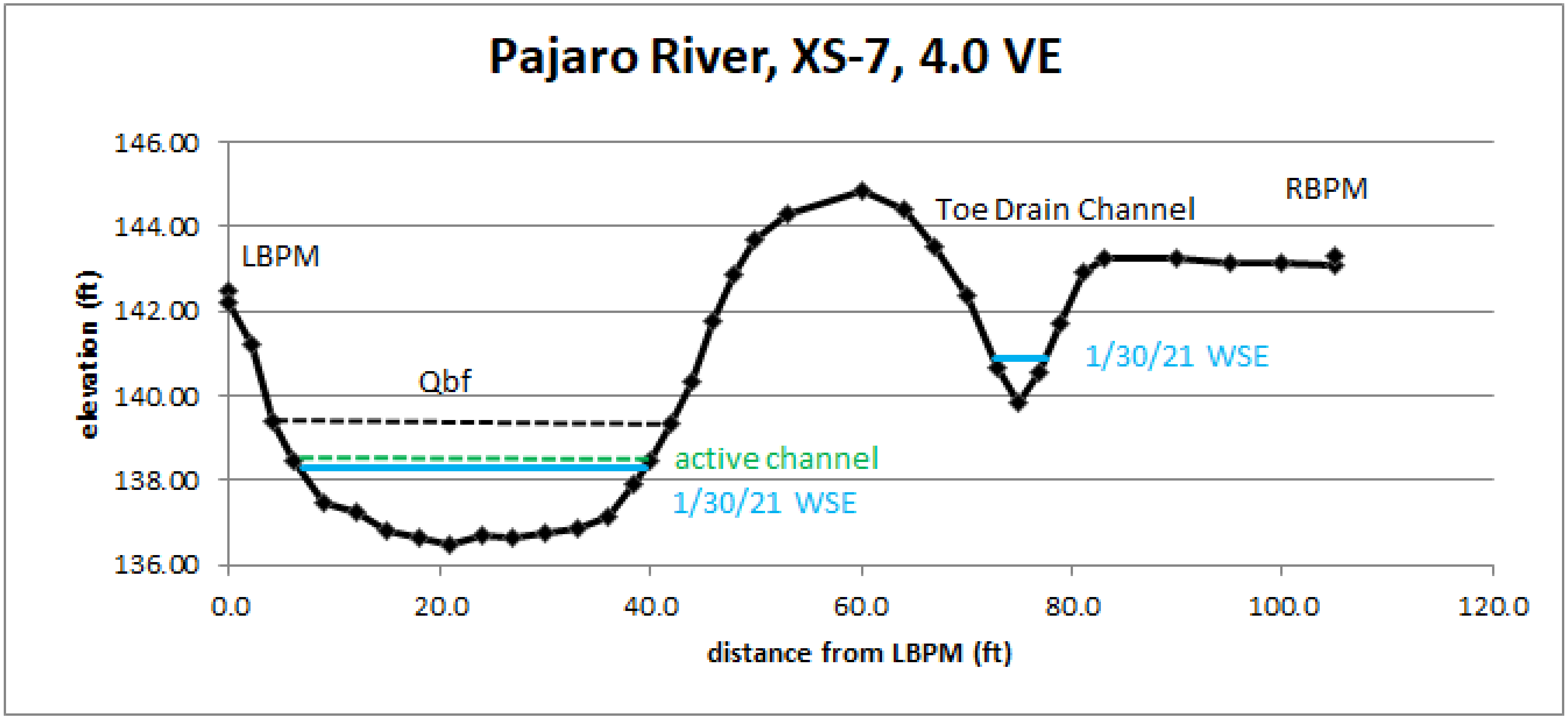
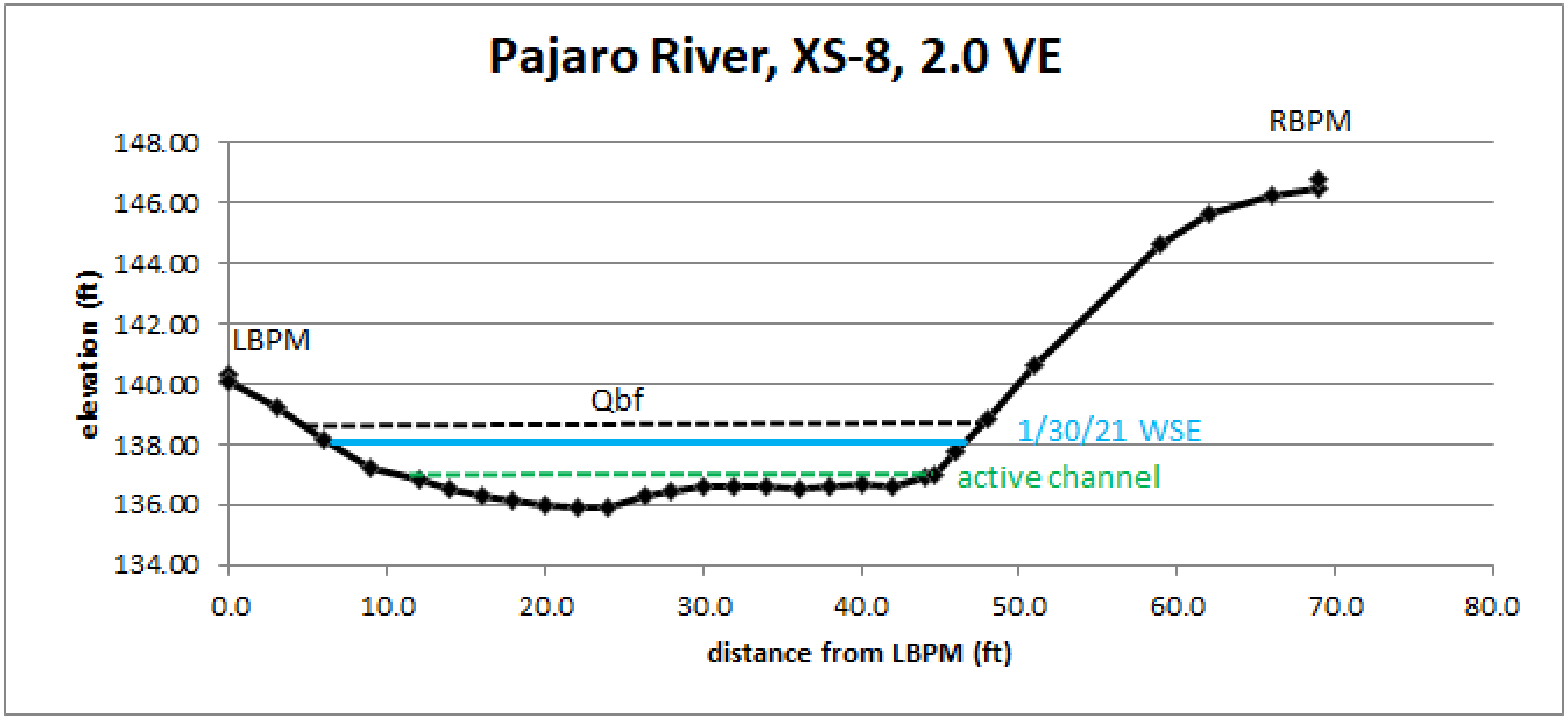
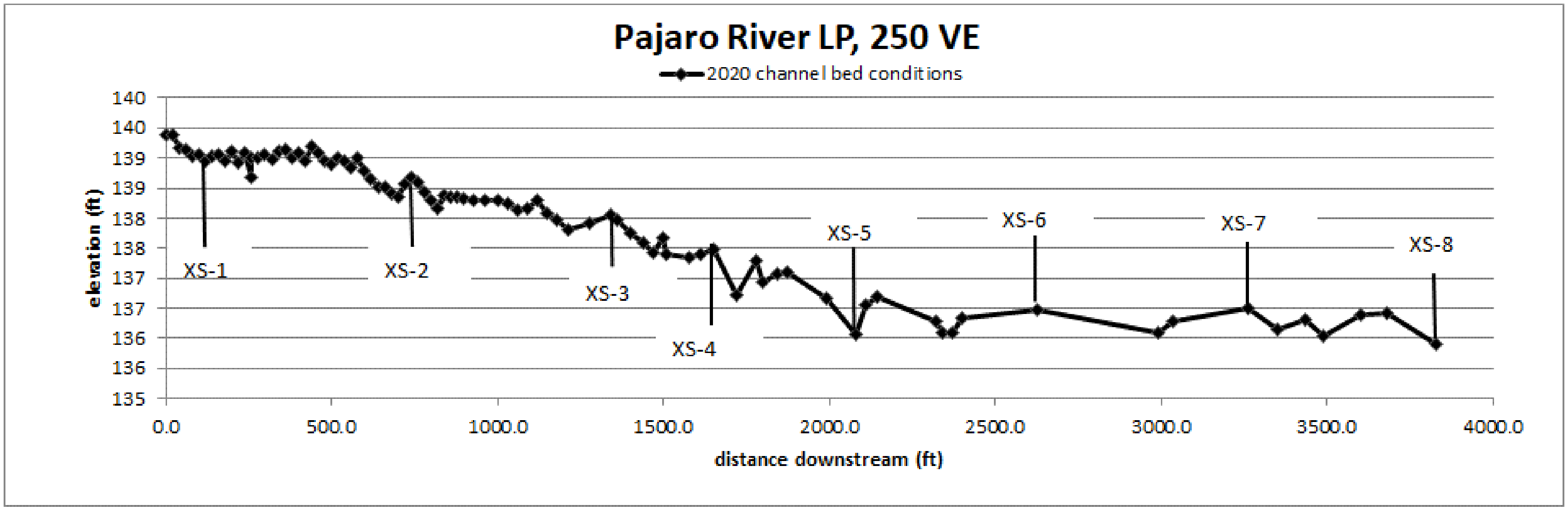
150.00
148.00
146.00
144.00
142.00
140.00
138.00
136.00
elevation (ft)
Qbf
active channel
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
distance from LBPM (ft)


Pajaro River, XS-5, 3.6 VE
LBPM
RBPM
Qbf
1/30/21 WSE
active channel
146.00
144.00
142.00
140.00
138.00
136.00
elevation (ft)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
distance from LBPM (ft)


Pajaro River, XS-6, 3.6 VE
146.00
144.00
142.00
140.00
138.00
136.00
elevation (ft)
LBPM
RBPM
Qbf
1/30/21 WSE
active channel
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
distance from LBPM (ft)


Pajaro River, XS-7, 4.0 VE
146.00
144.00
142.00
140.00
138.00
136.00
elevation (ft)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
distance from LBPM (ft)
LBPM
Qbf
active channel
1/30/21 WSE
Toe Drain Channel
RBPM
1/30/21 WSE


Pajaro River, XS-8, 2.0 VE
RBPM
LBPM
Qbf
1/30/21 WSE
active channel
148.00
146.00
144.00
142.00
140.00
138.00
136.00
134.00
elevation (ft)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
distance from LBPM (ft)



Pajaro River LP, 250 VE
2020 channel bed conditions
140
140
139
139
138
138
137
137
136
136
135
elevation (ft)
XS-1
XS-2
XS-3
XS-4
XS-5
XS-6
XS-7
XS-8
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
4000.0
distance downstream (ft)

Appendix C

Soil Profile and Site Description Forms

S = Soil
W = Wall

ICF SOIL PROFILE AND SITE DESCRIPTION FORM: WETLAND CREATION/RESTORATION SUITABILITY ASSESSMENT

Client/Project: Pajaro Ranch Agricultural Preserve	Date: Nov. 19 2020 — Site No.: SW-1
Investigator(s): Butterworth, Kozlowski	Photo Number: 2954, 2955
Method of Excavation: backhoe sharpshooter auger	
Land Surface Shape: (slightly) planar concave convex	Landform: alluvial fan terrace swale floodplain basin
Depth to Water Table (in.): None to 75" Stabilization Time: NA	Recommended Excavation to Finish Grade (ft.): — Slope Gradient (est.) (%): 0-1
Soil Map Unit: Willows clay, 0 percent slopes	Soil Series as Observed: Willows

Dominant Plant Species (genus/species code): COMA, PIEC

General Comments: Soil pit 3' west of channel x-section monument

Depth to Restrictive Layer (in.): 0" ☐ (Check if no restrictive layer)	Soil Suitability for Creation/Restoration: low medium high n/a Comments:

Depth (in.)	Horizon	Texture[1]	Redox Features[2]	Permeability - inferred	Comments
0-5	Ap	C	None		Ap and BSSG dry, remainder of profile slightly moist to moist
5-21	BssG	C	None		
21-39	BkSSG	C	None		Carbonates in seams More gleyed than BSSG.
39-48	BnSSG1	C+	None		
48-61	BnSSG2	C+	Fe-x (Redox depletions in lower 8")		

[1]Texture and Coarse Fragment Content

Texture
- cos - coarse sand
- s - sand
- fs - fine sand
- vfs - very fine sand
- lcos - loamy coarse sand
- ls - loamy sand
- lfs - loamy fine sand
- lvfs - loamy very fine sand
- cosl - coarse sandy loam
- sl - sandy loam
- fsl - fine sandy loam
- vfsl - very fine sandy loam
- l - loam
- sil - silt loam
- si - silt
- scl - sandy clay loam
- cl - clay loam
- sicl - silty clay loam
- sc - sandy clay
- sic - silty clay
- c - clay

Coarse Fragments
- gr - gravelly
- vgr - very gravelly
- xgr - extremely gravelly
- cb - cobbly
- vcb - very cobbly
- xcb - extremely cobbly
- st - stony
- vst - very stony
- xst - extremely stony

"-" = "light" (as in a clay textural class with relatively low clay content)
"+" = "heavy" (as in a clay textural class with relatively high clay content)

[2]Redoximorphic Feature Morphology

Redox Abundance
- f - few
- c - common
- m - many

Redox Location
- M - soil matrix
- P - ped face
- PL - pore lining
- RC - root channel (ox. rhizospheres)

Redox Type
- Fe-x - iron concentration (soft mass)
- Fe-nc - iron nodule or concretion
- Mn-x - manganese concentration (soft mass)
- Mn-nc - manganese nodule or concretion
- D - depletion

Redox Contrast
- F - faint
- D - distinct
- P - prominent

ICF SOIL PROFILE AND SITE DESCRIPTION FORM: WETLAND CREATION/RESTORATION SUITABILITY ASSESSMENT

Client/Project: Pajaro Ranch Agricultural Preserve	Date: Nov. 19 2020	Site No.: SW-2A
Investigator(s): Butterworth, Kozlowski	Photo Number:	
Method of Excavation: backhoe <u>sharpshooter</u> <u>auger</u>		

Land Surface Shape: (slightly) <u>planar</u> concave convex	Landform: alluvial fan terrace swale floodplain <u>basin</u>	
Depth to Water Table (in.): None to 74" Stabilization Time: NA	Recommended Excavation to Finish Grade (ft.):	Slope Gradient (est.) (%): 0-1
Soil Map Unit: Willows clay, 0 percent slopes	Soil Series as Observed: Willows	
Dominant Plant Species (genus/species code): COMA, PIEC, LASE		
General Comments: Soil pit ~2.5 ft east of channel x-section monument.		
Depth to Restrictive Layer (in.): 0" ❑ (Check if no restrictive layer)	Soil Suitability for Creation/Restoration: low medium high n/a Comments:	

Depth (in.)	Horizon	Texture[1]	Redox Features[2]	Permeability - inferred	Comments
0-4	Ap	c	None.		Sample collected from Ap horizon. Dry
4-33	Bkss	C	None		Slightly moist
33-41	BkssG	C+	None		
41-	BnssG	C+	Redox depletions begin 57" Fe-x		Sample collected from 43-48" horizon Moist

[1]Texture and Coarse Fragment Content

Texture

cos - coarse sand
s - sand
fs - fine sand
vfs - very fine sand
lcos - loamy coarse sand
ls - loamy sand
lfs - loamy fine sand
lvfs - loamy very fine sand
cosl - coarse sandy loam
sl - sandy loam
fsl - fine sandy loam
vfsl - very fine sandy loam
l - loam
sil - silt loam
si - silt
scl - sandy clay loam
cl - clay loam
sicl - silty clay loam
sc - sandy clay
sic - silty clay
c - clay

Coarse Fragments

gr - gravelly
vgr - very gravelly
xgr - extremely gravelly
cb - cobbly
vcb - very cobbly
xcb - extremely cobbly
st - stony
vst - very stony
xst - extremely stony

"-" = "light" (as in a clay textural class with relatively low clay content)
"+" = "heavy" (as in a clay textural class with relatively high clay content)

[2]Redoximorphic Feature Morphology

Redox Abundance

f - few
c - common
m - many

Redox Location

M - soil matrix
P - ped face
PL - pore lining
RC - root channel (ox. rhizospheres)

Redox Type

Fe-x - iron concentration (soft mass)
Fe-nc - iron nodule or concretion
Mn-x - manganese concentration (soft mass)
Mn-nc - manganese nodule or concretion
D - depletion

Redox Contrast

F - faint
D - distinct
P - prominent

ICF SOIL PROFILE AND SITE DESCRIPTION FORM: WETLAND CREATION/RESTORATION SUITABILITY ASSESSMENT

Client/Project: Pajaro Ranch Agricultural Preserve	Date: Nov. 19 2020	Site No.: SW-2B
Investigator(s): Butterworth, Kozlowski	Photo Number:	
Method of Excavation: backhoe sharpshooter auger		

Land Surface Shape: (slightly) planar concave convex	Landform: alluvial fan terrace swale floodplain basin	
Depth to Water Table (in.): None to 74" Stabilization Time: NA	Recommended Excavation to Finish Grade (ft.):	Slope Gradient (est.) (%): 0-2
Soil Map Unit: Willows clay, 0 percent slopes	Soil Series as Observed: Willows	
Dominant Plant Species (genus/species code): COMA, PIEC		
General Comments: SOIL PIT 150' ± SOUTH OF MONUMENT #3 Soil pit 25' south of channel X-section monument		
Depth to Restrictive Layer (in.): 0 ☐ (Check if no restrictive layer)	Soil Suitability for Creation/Restoration: low medium high n/a Comments:	

Depth (in.)	Horizon	Texture[1]	Redox Features[2]	Permeability - inferred	Comments
0-4	Ap	c	NONE		DRY
4-60	Bkss1	c	NONE		SL. MOIST
60-	Bkss2	c+	Fe-x		SL. MOIST

[1]Texture and Coarse Fragment Content

Texture

cos - coarse sand
s - sand
fs - fine sand
vfs - very fine sand
lcos - loamy coarse sand
ls - loamy sand
lfs - loamy fine sand
lvfs - loamy very fine sand
cosl - coarse sandy loam
sl - sandy loam
fsl - fine sandy loam
vfsl - very fine sandy loam
l - loam
sil - silt loam
si - silt
scl - sandy clay loam
cl - clay loam
sicl - silty clay loam
sc - sandy clay
sic - silty clay
c - clay

Coarse Fragments

gr - gravelly
vgr - very gravelly
xgr - extremely gravelly
cb - cobbly
vcb - very cobbly
xcb - extremely cobbly
st - stony
vst - very stony
xst - extremely stony

"-" = "light" (as in a clay textural class with relatively low clay content)
"+" = "heavy" (as in a clay textural class with relatively high clay content)

[2]Redoximorphic Feature Morphology

Redox Abundance

f - few
c - common
m - many

Redox Location

M - soil matrix
P - ped face
PL - pore lining
RC - root channel (ox. rhizospheres)

Redox Type

Fe-x - iron concentration (soft mass)
Fe-nc - iron nodule or concretion
Mn-x - manganese concentration (soft mass)
Mn-nc - manganese nodule or concretion
D - depletion

Redox Contrast

F - faint
D - distinct
P - prominent

ICF SOIL PROFILE AND SITE DESCRIPTION FORM: WETLAND CREATION/RESTORATION SUITABILITY ASSESSMENT

Client/Project: Pajaro Ranch Agricultural Preserve	Date: Nov. 19 2020	Site No.: SW-3
Investigator(s): Butterworth, Kozlowski	Photo Number: 2956(?), 2957(?), 2959(?)	
Method of Excavation: backhoe sharpshooter auger		

Land Surface Shape: (slightly) planar concave convex	Landform: alluvial fan terrace swale floodplain basin	
Depth to Water Table (in.): None to 77" Stabilization Time: NA	Recommended Excavation to Finish Grade (ft.):	Slope Gradient (est.) (%): 1-2
Soil Map Unit: Willows clay, 0 percent slopes	Soil Series as Observed: Willows	
Dominant Plant Species (genus/species code): COMA, MEPO		
General Comments:		

Depth to Restrictive Layer (in.): 0 ❑ (Check if no restrictive layer) N/A	Soil Suitability for Creation/Restoration: low medium high n/a Comments:

Depth (in.)	Horizon	Texture[1]	Redox Features[2]	Permeability - inferred	Comments
0-3	A	C	None		Dry
3-31	Bkss	C	None		Slightly moist
31-73	Bkssg	C+	Fe-x		moist
73-77	Cg	C-	Fe-x		MOIST

[1]Texture and Coarse Fragment Content

Texture

cos - coarse sand
s - sand
fs - fine sand
vfs - very fine sand
lcos - loamy coarse sand
ls - loamy sand
lfs - loamy fine sand
lvfs - loamy very fine sand
cosl - coarse sandy loam
sl - sandy loam
fsl - fine sandy loam
vfsl - very fine sandy loam
l - loam
sil - silt loam
si - silt
scl - sandy clay loam
cl - clay loam
sicl - silty clay loam
sc - sandy clay
sic - silty clay
c - clay

Coarse Fragments

gr - gravelly
vgr - very gravelly
xgr - extremely gravelly
cb - cobbly
vcb - very cobbly
xcb - extremely cobbly
st - stony
vst - very stony
xst - extremely stony

[2]Redoximorphic Feature Morphology

Redox Abundance

f - few
c - common
m - many

Redox Location

M - soil matrix
P - ped face
PL - pore lining
RC - root channel (ox. rhizospheres)

Redox Type

Fe-x - iron concentration (soft mass)
Fe-nc - iron nodule or concretion
Mn-x - manganese concentration (soft mass)
Mn-nc - manganese nodule or concretion
D - depletion

Redox Contrast

F - faint
D - distinct
P - prominent

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"+" = "heavy" (as in a clay textural class with relatively high clay content)

ICF SOIL PROFILE AND SITE DESCRIPTION FORM:
WETLAND CREATION/RESTORATION SUITABILITY ASSESSMENT

Client/Project: Pajaro Ranch Agricultural Preserve	Date: Nov. 9 2020	Site No.: SW-4
Investigator(s): Butterworth, Kozlowski	Photo Number:	
Method of Excavation: backhoe sharpshooter auger		

Land Surface Shape: (slightly) planar concave convex	Landform: alluvial fan terrace swale floodplain basin	
Depth to Water Table (in.): NONE TO 78" Stabilization Time: N/A	Recommended Excavation to Finish Grade (ft.):	Slope Gradient (est.) (%): 2
Soil Map Unit: Willows clay, 0 percent slopes	Soil Series as Observed:	
Dominant Plant Species (genus/species code): COMA, PIEC, LELA		
General Comments: SITE LOCATED 3'± SOUTH OF MONUMENT 5		
Depth to Restrictive Layer (in.): 0 ❑ (Check if no restrictive layer)	Soil Suitability for Creation/Restoration: low medium high n/a Comments:	

Depth (in.)	Horizon	Texture[1]	Redox Features[2]	Permeability - inferred	Comments
0-3	A	c	NONE		DRY
3-39	Bss	c	NONE		SL. MOIST
39-48	Bk	c	NONE		SL. MOIST
48-78	Bkg	c	Fe-x *		SL. MOIST
			* WITH REDOX DEPLETIONS BEGINNING AT 65."		

[1]**Texture and Coarse Fragment Content**

Texture
- cos - coarse sand
- s - sand
- fs - fine sand
- vfs - very fine sand
- lcos - loamy coarse sand
- ls - loamy sand
- lfs - loamy fine sand
- lvfs - loamy very fine sand
- cosl - coarse sandy loam
- sl - sandy loam
- fsl - fine sandy loam
- vfsl - very fine sandy loam
- l - loam
- sil - silt loam
- si - silt
- scl - sandy clay loam
- cl - clay loam
- sicl - silty clay loam
- sc - sandy clay
- sic - silty clay
- c - clay

Coarse Fragments
- gr - gravelly
- vgr - very gravelly
- xgr - extremely gravelly
- cb - cobbly
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- st - stony
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"+" = "heavy" (as in a clay textural class with relatively high clay content)

[2]**Redoximorphic Feature Morphology**

Redox Abundance
- f - few
- c - common
- m - many

Redox Location
- M - soil matrix
- P - ped face
- PL - pore lining
- RC - root channel (ox. rhizospheres)

Redox Type
- Fe-x - iron concentration (soft mass)
- Fe-nc - iron nodule or concretion
- Mn-x - manganese concentration (soft mass)
- Mn-nc - manganese nodule or concretion
- D - depletion

Redox Contrast
- F - faint
- D - distinct
- P - prominent

ICF SOIL PROFILE AND SITE DESCRIPTION FORM:
WETLAND CREATION/RESTORATION SUITABILITY ASSESSMENT

Client/Project: Pajaro Ranch Agricultural Preserve	Date: Nov. 19 2020	Site No.: SW-5
Investigator(s): Butterworth, Kozlowski	Photo Number: 2960 (?)	
Method of Excavation: backhoe sharpshooter auger		

Land Surface Shape: (slightly) planar concave convex	Landform: alluvial fan terrace swale floodplain basin	
Depth to Water Table (in.): None to 75' Stabilization Time: NA	Recommended Excavation to Finish Grade (ft.):	Slope Gradient (est.) (%): 2-3
Soil Map Unit: Willows clay, 0 percent slopes	Soil Series as Observed: Willows	
Dominant Plant Species (genus/species code): COMA, PIEC, LELA		
General Comments: Soil pit ~150' east of Llagas Creek Levee		
Depth to Restrictive Layer (in.): 0 ☐ (Check if no restrictive layer) N/A	Soil Suitability for Creation/Restoration: low medium high n/a Comments:	

Depth (in.)	Horizon	Texture[1]	Redox Features[2]	Permeability - inferred	Comments
0-2	A	C	None		Profile may have been partly truncated to construct adjacent levee. Dry
2-55	Bkss	c	None		slightly moist
55-75	BkssG	c	Fe-x and Mn-x		MOIST

[1]Texture and Coarse Fragment Content

Texture
cos - coarse sand
s - sand
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vfs - very fine sand
lcos - loamy coarse sand
ls - loamy sand
lfs - loamy fine sand
lvfs - loamy very fine sand
cosl - coarse sandy loam
sl - sandy loam
fsl - fine sandy loam
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l - loam
sil - silt loam
si - silt
scl - sandy clay loam
cl - clay loam
sicl - silty clay loam
sc - sandy clay
sic - silty clay
c - clay

Coarse Fragments
gr - gravelly
vgr - very gravelly
xgr - extremely gravelly
cb - cobbly
vcb - very cobbly
xcb - extremely cobbly
st - stony
vst - very stony
xst - extremely stony

"-" = "light" (as in a clay textural class with relatively low clay content)
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[2]Redoximorphic Feature Morphology

Redox Abundance
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m - many

Redox Location
M - soil matrix
P - ped face
PL - pore lining
RC - root channel (ox. rhizospheres)

Redox Type
Fe-x - iron concentration (soft mass)
Fe-nc - iron nodule or concretion
Mn-x - manganese concentration (soft mass)
Mn-nc - manganese nodule or concretion
D - depletion

Redox Contrast
F - faint
D - distinct
P - prominent

Appendix D

Soil Laboratory Results

Pajaro Ranch Ag Preserve - A&L Labs Sample ID to ICF Soil/Site Sample Number Crosstalk

Lab Sample ID	ICF Site/Soil Sample Number
W40-6	SW-4 0-6” (surface layer)
39-43	SW-4 39-43” (subsoil)
A4348	SW-2a 43-48” (subsoil)
2A0-4	SW-2a 0-4” (surface layer)

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 20-353-016

CLIENT NO: 0310-D

SEND TO: ICF
630 K ST SUITE 400
SACRAMENTO, CA 95814

SUBMITTED BY: JOEL BUTTERWORTH

GROWER:

DATE OF REPORT: 12/23/20

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		* % Rating	** ENR lbs/A	P1 (Weak Bray) **** * ppm	$NaHCO_3$-P (OlsenMethod) **** * ppm	K ***** * ppm	Mg *** * ppm	Ca *** * ppm	Na *** * ppm	Soil pH	Buffer Index	H meq/100g	C.E.C. meq/100g	K %	Mg %	Ca %	H %	Na %
W40-6	51633	3.4M	97	52 *	36VH	267L	1513VH	4273M	129L	7.6		0.0	35.0	1.9	35.5	60.9	0.0	1.6
39-43	51634	2.0L	69	5 *	5L	162L	2280VH	2130VL	314M	8.4		0.0	31.2	1.3	60.2	34.1	0.0	4.4
A4348	51635	2.1L	72	3 *	5L	163L	1787VH	6795M	659H	7.8		0.0	51.9	0.8	28.3	65.4	0.0	5.5
2A0-4	51636	3.9H	109	46 *	38VH	284L	1557VH	4739M	207L	7.8		0.0	38.1	1.9	33.6	62.1	0.0	2.4

* Weak Bray unreliable at M or H excess lime or pH > 7.5

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
W40-6	4VL	10L	0.5VL	3M	15M	3.0VH	2.3H	M	0.5L						
39-43	1VL	65VH	0.1VL	1VL	12M	1.6H	4.9VH	H	0.7M						
A4348	3VL	4951VH	0.1VL	1VL	14M	1.9H	7.1VH	H	3.5H						
2A0-4	3VL	136VH	0.5VL	5M	12M	3.5VH	2.7VH	M	0.9M						

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

Rogell Rogers

Rogell Rogers, CCA, PCA
A & L WESTERN LABORATORIES, INC.

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 20-353-016

CLIENT: 90310

SUBMITTED BY: JOEL BUTTERWORTH

SEND TO: ICF
630 K ST SUITE 400
SACRAMENTO, CA 95814

GROWER:

DATE OF REPORT: 12/23/20

SOIL SALINITY ANALYSIS REPORT

PAGE: 1

Sample ID	Lab Number	SAR	ESP	Na meq/L	Ca meq/L	Mg meq/L	pH	CO_3 meq/L	HCO_3 meq/L	E.C. dS/m	Cl meq/L	B ppm	Saturation %
W40-6	51633	1.2	0.5	1.7	2.3	1.7	7.6	0.0	3.0	0.5	0.8	0.4	63.9
39-43	51634	3.5	3.7	4.4	0.8	2.4	8.4	0.0	2.7	0.7	0.8	1.0	100.0
A4348	51635	4.3	4.9	19.7	20.2	21.4	7.8	0.0	1.7	3.5	2.5	1.7	91.3
2A0-4	51636	1.6	1.1	3.3	5.0	3.5	7.8	0.0	3.1	0.9	1.7	0.3	69.4

NOTES:

Rogell Rogers, CCA, PCA
A & L WESTERN LABORATORIES, INC.

Appendix E

Stakeholder Meeting Comments

SANTA CLARA VALLEY
HABITAT AGENCY

Meeting Notes

Pajaro River Riparian Habitat Restoration Project

Stakeholder Meeting

Date:	**July 29, 2021**
Time:	11:00 am – 12:15 pm
Location:	**Teams Meeting**
	Link: Click here to join the meeting
	Or audio-only call-in: tel:+13236949910,,8618774#
Attendees:	Galli Basson, Jake Smith, Andres Campusano, Jackie Latham, Megan Robinson **(Santa Clara Valley Open Space Authority)**
	Jenni Benson **(Point Blue Conservation Science)**
	Will Spangler, Edmund Sullivan, Gerry Hass **(Santa Clara Valley Habitat Agency)**
	Kevin MacKay, Kristin Lantz, Harry Oakes, Jeff Peters **(ICF)**
	Barry Baba **(Triangle Properties)**
	Zooey Diggory, Christina Pilson, Jeffrey Lewis **(Valley Water)**
	Erin McCarthy **(Santa Cruz Resource Conservation District)**
	Adrian Urias **(UC Farms)**
	Joseph Terry **(US Fish and Wildlife Service)**
	Brenda Blinn **(California Department of Fish and Wildlife)**
	Joel Casagrande **(NOAA Fisheries)**
	Mark Cassady **(Central Coast Regional Water Quality Control Board)**
	Lynn Overtree, Karminder Brown **(San Benito Agricultural Lands Trust)**
	Dawn Cunningham **(Resource Environmental Solutions [RES])**
	Ethan Inlander **(The Nature Conservancy)**
	Arielle Goodspeed **(San Benito County Planning Department)**

Meeting Objective: Share information and receive stakeholder input on the Pajaro River Riparian Habitat Restoration Project that will be used to advance project design.

Agenda:

Presentation slides download link: https://scvha-my.sharepoint.com/:b:/g/personal/will_scvhab_org/EZ8QnwZrAydCgNQiVCBbTacBxUq9ZV945akHXxvV_3VUTw?e=NPC1CN

1. Introductions (Will)

   a. Introduce project advocates
   b. Attendee welcome
   c. Agenda overview
   d. Land acknowledgement (Jenni)

2. Pajaro River Agricultural Preserve property overview (Galli)

   a. Location and historical setting
   b. Acquisition
   c. Current use and operations
   d. Improvements to date

3. Pajaro River Riparian Habitat Restoration Project overview (Will)

   a. Collaboration between OSA, Point Blue, and Habitat Agency, working with Triangle Properties and ICF
   b. Project goals and objectives
   c. Baseline studies/current conditions
   d. Habitat improvements
   e. Restoration opportunities and constraints
   f. Phases
   g. Schedule

4. Next steps (Jenni)

   a. Incorporate stakeholder feedback into final feasibility study report (Sept 2021)
      i. Please submit any additional questions/comments on the project or the draft feasibility report to Will Spangler by August 12 (will.spangler@scv-habitatagency.org)
   b. Plan and implement pilot planting for Phase 1 (fall/winter 2021)
   c. Advance Phase 1 and Phase 2 project design and permitting
   d. Plan Phase 3

5. Links

   a. Presentation slides download link:
   b. https://scvha-my.sharepoint.com/:b:/g/personal/will_scvhab_org/EZ8QnwZrAydCgNQiVCBbTacBxUq9ZV945akHXxvV_3VUTw?e=NPC1CN
   c. Draft feasibility report download link: https://scvha-my.sharepoint.com/:b:/g/personal/will_scvhab_org/Ee8R1cXB5K5OlVJnzTQaldUBLwQQCKbsi1ifqq0beu4jUA?e=VfBLl9

6. Questions and discussion notes

   a. Dawn Cunningham: Will project funding require long term monitoring, management and tracking?

      Will: yes, we will be conduct short-term monitoring and reporting in compliance with project permits and funding agreements following completion of the project, and long term monitoring under the site's management plan.

   b. Joseph Terry: is this a project seeking restoration credit for riparian, stream, and wetland habitat for the Habitat Plan and the Habitat Agency's In-lieu fee program? Will it require a conservation easement? Will it become a Reserve property?

      Galli: Yes, a conservation easement will placed over the project area. Will: Yes, we will seek Habitat Plan mitigation credit for the restoration, and after being placed under a conservation easement it will be enrolled in the Reserve system. There will be further discussions on the conservation easement between OSA, the Habitat Agency, and the regulatory agencies.

   c. Brenda Blinn: Sounds like least Bell's vireo will benefit most from the restoration, with limited opportunities for the western pond turtle and tricolored blackbird. Is there an opportunity to expand the project scope to provide multiple species benefits, specifically other Plan-covered species? What about mountain lion movement?

      Will: Dispersal to the site in a fragmented agricultural landscape is a limiting factor for species such as the California red legged frog and California tiger salamander. But the project fits in to a regional focus on wildlife connectivity and focuses on creating suitable habitat for these species with an emphasis on landscape connectivity – "build it, link it, and they will come." Kristin: Also want to note that Phase 3 in particular would benefit multiple species including CRLF and WPT. Currently the site does not provide habitat for the full life cycle of these species; project will provide habitat for the full cycles of their lifespan. Galli: Existing chain link fence is only to separate riparian corridor from active agriculture in north PRAP; wouldn't limit wildlife corridor.

   d. Brenda Blinn: Given current and future droughts, has the team reviewed hydrology and climate data and will the project account for possibly significant changes in future water regime?

      Will: Yes, we are considering climate change and will include a climate smart planting palette. Our baseline studies were conducted during severe drought and indicated that conditions are still suitable to target vegetation and habitat types. Site hydrology is already variable. Jenni: Point Blue specializes in climate smart restoration and considers models for future projections. Will plant a mosaic of species that can tolerate a range of conditions. Kristin: Will consider climate change impacts in the plant palette. Even in this very dry year, groundwater depth was approximately 50 inches, so still sufficient groundwater for riparian planting. Jeff: Site has an extremely low floodplain gradient. Flows in the channelized stream currently recede very quickly after storms, within 24 hours. Project will slow and spread flows onto floodplain and stabilize streambanks and reduce likelihood of erosion. Also during the 10 year monitoring period, adaptive management will allow for flexibility with replanting. (Final report will include a section in the final report on climate resiliency).

e. Joel Casagrade: Is the stream gradient varying or homogenous? Could western pond turtles nest along the design streambanks? Also, simply created an area for water to disperse and infiltrate is as important as specific species benefits in my opinion. Pacheco Dam water releases may affect flows through this reach, in addition to agricultural/urban runoff.
    i. Will: We can consider installing basking logs for western pond turtles, and the intention is that woody riparian vegetation of varying canopy density and structure will provide suitable habitat as well. Thank you for your comment on the water quality benefits.
f. Joel Casagrande: Will the conservation easement allow for food safety and water quality research? There is an opportunity to study how various plant palettes are compatible with agriculture
    i. Ed: yes, research can happen under the CE. Will: ensuring the compatibility of the project with adjacent agriculture will be important and we will encourage research. (Final report will include a section on future studies).
g. Erin McCarthy: Echoed concerns about agricultural and restoration coexisting I worked on the Watsonville Slough Farm Restoration, and it is a good example of compatible uses relative to food safety and conflicts with BMPs like a bioreactor for runoff that were put in place for water quality. More research is needed to determine if the threats or conflicts are real or just perceived. Site may have a good farming tenant now, but the leases are finite and a future grower might not be as flexible. Growers will need help to protect their crops. Pajaro Compass tour in October of the Watsonville Slough Farm Restoration site. Very excited about this project at Pajaro River Ag Preserve. Has faith in the team.
    i. Galli: our relationship is good with this grower, who was invited to this meeting. We will circle back with him and discuss these issues. Would love to tour Watsonville Slough Restoration site during future Pajaro Compass meeting. Need to consider protective fencing between restoration and agriculture to protect tenant, and caging restoration plants to minimize browsing and herbivory during establishment. Will: draft feasibility report includes detailed soils analysis, and there are interesting when you consider that theses soils were in intensive agriculture until just recently.
h. Chris Pilson: Has the team reached out to CSU Monterey Bay Watershed Program or other schools to participate in the project?
    i. Jenni: Not yet, and that is a great suggestion
i. Zooey Diggory: How many acres of the habitat types will the project create?
    i. Galli: OSA will consider various future uses including this restoration, recreation, and other future restoration, and can retire up to 40 acres of agricultural land in the south PRAP. Don't want to constrain ourselves, but want to take advantage of the team in pace and available funding now. Will:

this feasibility study will guide the design; note that draft figures here show approximately 30 acres across the 3 phases.

j. Zooey Diggory: VW did a feasibility study downstream of this site and came to largely the same conclusions regarding restoration potential. Good to know that the studies are consistent with the importance of laying back the banks.
k. Joseph Terry: Would the clay soils support western pond turtle nesting?
    i. Kristin: Can bring in suitable soils and basking logs.
l. Joseph Terry: Have flow changes from the Pacheco Dam Expansion Project been considered? What effects will re-operation of Pacheco Reservoir once expanded have on the restored riparian habitats?
    i. Will: location along relict Pajaro River channel is muted from Pacheco Creek flows by San Felipe Lake and that most flows are conveyed by Miller Canal; project is considered hydrologically severed from upstream watershed. We can further study PREP flow regime and potentially input into our hydrologic model.
m. Megan Robinson: No questions, great presentation
n. Zooey Diggory: Thanks so much for the informative presentation! The progress you've made is exciting!
o. Mark Cassady: I will add my name to what we heard from Joel and others in terms of the potential water quality and flooding benefits of the project.
p. Karminder Brown: Great project, looking forward to engaging some landowners, agency folks, and local elected officials from the San Benito side of the Pajaro to raise awareness about these opportunities and all the benefits. Thank you!

7. Comments received on draft feasibility study report (as of 8/23/2021)

    a. Comments from Joel Casagrande, NOAA Fisheries, 7/29/2021:

Reviewer	**Comment**	**Response**
Joel Casagrande, NOAA Fisheries	Glad to see this project moving forward. These opportunities to restore space and functions that have long since been covered up or muted are really important. They don't have to directly work for all species all the time, but instead allow for the natural process (and animal movements); these provide indirect benefits to a host of species at the site and downstream of it. I was glad to see the Halprin parcel is now an easement. Mr. Halprin was very supportive of our sampling for the 2011 report and he expressed an interest in developing an easement at the time. These connections (land and people) are great.	Thank you.
Joel Casagrande,	My comment on water quality monitoring was not that the VHA and partners should do the monitoring, but more that the conservation	We appreciate the suggestion and we welcome water quality monitoring by others at the

NOAA Fisheries	easement would allow for it if someone were interested. I spent a lot of time during my undergrad working on water quality monitoring in the Salinas Valley and can tell you it can be hard to find parcels with this proximity and setting that would allow for such research.	project site and will consider using staff resources to collect data. What would be the most important data and metrics?

b. Comments from Sarah Firestone, USACE, 8/12/2021:

Reviewer	Comment	Response
Sarah Firestone, USACE	Constructing seasonal wetlands in upland habitat may not require a permit from the Corps if all work is being done outside of waters of the U.S. (WOUS). Similarly, planting of riparian vegetation may not require a Corps permit, since this activity generally involves minimal disturbance and does not generally change the bottom elevation of WOUS.	Thank you.
Sarah Firestone, USACE	Other work within WOUS, such as lowering channel banks and creating floodplain benches, would likely require a permit from the Corps.	We will prepare a permit application during the design process.
Sarah Firestone, USACE	The proposed restoration work may be authorized under Nationwide Permit 27. Restoration activities authorized under NWP 27 do not require compensatory mitigation because these projects are anticipated to provide a net increase in acreage and/or function of WOUS.	Thank you.
Sarah Firestone, USACE	If SCVHA plans to use the proposed project as mitigation for impacts to WOUS elsewhere, they would need to obtain an approved jurisdictional determination of the site prior to starting construction activities and obtain Corps authorization for the restoration project to serve as compensatory mitigation for a specific project elsewhere. Mitigation for impacts to WOUS need to comply with the 2008 Mitigation Rule, and Corps authorization for the restoration work is not a guarantee that restoration activities will be considered acceptable mitigation for impacts from a different project.	We may request an approved jurisdictional determination and authorization to serve as compensatory mitigation or under the Habitat Agency's in-lieu fee program. How much lead time should we expect if requesting an approved jurisdictional determination before construction?

c. Comments from Jake Smith, OSA, 8/21/2021:

Reviewer	Comment	Response

Jake Smith, OSA	It would help to see a birds-eye sketch of these habitat improvement concepts and how they relate to alternatives that are being considered for Lower Llagas Creek Floodway enhancement project. Ideally we could also sketch out other uses like recreation or • Are there alternative designs that are being considered for this project (ex. levee removal in trad of levee setback)?	The project will present alternatives and include detailed 35% and 65% design drawings for the team to review. We are coordinating with Valley Water as a key stakeholder and have reviewed the draft Lower Llagas Creek Capacity Restoration Project Draft Planning Study Report from 2013.
Jake Smith, OSA	Can you include a map that shows existing landcover and uses and estimates what range of acreage could be permanently retired from ag on the property?	Design plans will include acreage
Jake Smith, OSA	Do HA easement provide enough flexibility for easement areas to be temporarily or permanently impacted by future work like lower Llagas Creek or some other major floodplain restoration/flood control project?	A conservation easement is proposed to protect the restoration site. The Habitat Agency conservation easement template allows for future habitat creation, habitat restoration, or habitat enhancement for sensitive, endangered, or threatened species within the easement area. A multibenefit restoration project such as what you may be describing would likely be consistent with the proposed conservation easement.
Jake Smith, OSA	2D floodplain modelling seems really important for project designs (especially phase 2 and 3) given the backwatering effect, lake-like conditions during high flows, and the desire to provide flood benefits. When would 2D modeling be completed?	2D floodplain modeling is anticipated to be part of future design for Phase III
Jake Smith, OSA	Include some language in the report that describes how the project fits within the context of OSA's larger vision/conservation goals for the Pajaro River Ag Preserve and how this project will be coordinated with that work. Our grant applications to FPA are good sources of info. Same for Lower Llagas Creek Floodway Project and it's draft alternatives.	Sustaining farming operations on the majority of the property, while increasing habitat, water, and floodplain benefits on up to approximately 30 acres was identified as a goal when the Open Space Authority purchased the property.
Jake Smith, OSA	Arrange a meeting with the Flood Prevention Authority before designs are developed to go over how we are defining	Thank you for your suggestion, we will engage with the FPA. We will

	converted ag land and tracking acreage to make sure we're on the same page on what counts against our 40-ac limit. It possible a lot of this land may not be considered ag land, and other actions like filter strips/buffers may not be considered retirement since the are BMP's for ag operations.	also further research the specifics about the potential 40 acre limit
Jake Smith, OSA	Include language/ideas on how farm operations could be enhanced through this restoration work. Example- areas of marginal/wet ag land that could be improved with additional soil that may need to be disposed of from the restoration work.	Soil balance will be discussed in the project design which may include placing excavated soil onsite in uplands and where beneficial to ag operations
Jake Smith, OSA	It looks like some of the alternatives may be impacted by alternatives that are being considered for the Lower Llagas Creek floodway project. It would help to know how these can be phased and coordinated to make sure there aren't conflicts. Some examples from just the draft preferred alternative: • Realignment of Jones creek into PRAP's eastern ditch along Frazier lake Rd could route flows directly into the property's upper reach of the Pajaro. It's possible that this project could change the location of the current ditch's confluence so it's not a 90 degree turn into the Pajaro. Encumbering this phase 1 area with an easement may make it challenging to relocate/improve the confluence. • A proposed flood bypass channel and secondary levee immediately east of llagas creek (proposed on prap) may route flood flows directly into the phase 2 wetland enhancement area and phase 3 levee setback area. It seems like phase 2 and 3 should be designed along with the Llagas Creek Project.	We will continue to engage with Valley Water as a key stakeholder and have reviewed the draft Lower Llagas Creek Capacity Restoration Project Draft Planning Study Report from 2013. The Habitat Agency conservation easement template allows for future habitat creation, habitat restoration, or habitat enhancement for sensitive, endangered, or threatened species within the easement area.
Jake Smith, OSA	It would help to see a map of the floodplain inundation area during these events. Do you have copies of the soap lake floodplain extent from FPA? I think it shows 10,25,50,100-yr floodplain extents.	Table 5-1 describes peak discharge at these and other recurrence intervals. We welcome any additional figures that you are aware of

Jake Smith, OSA	Have you shared your habitat mapping with VW so it can be considered while they develop maps of groundwater dependent ecosystems in their groundwater management plan update?	Habitat mapping is included in the draft feasibility study report and will be included with the project's permit applications. We can share this information if requested by others
Jake Smith, OSA	Figure 6-2: It looks like this was pulled from OSA's FlowWest Report. Add citation and any indication if the exhibit has been modified?	The accompanying text and in-text reference to the figure cites the 2016 FlowWest report; we will add a citation to the figure itself
Jake Smith, OSA	Pg. 1-1 "The purpose of this document is to present the results of a feasibility study that assessed the intended habitat improvements for the project." This section could use more details on how this report will be used to inform planning, design, and implementation of restoration work.	Please see the next sentence in the report: "This document provides an overview of the project objectives; identifies existing resources; identifies design opportunities and constraints; and presents biological, hydrologic, and geomorphic design considerations that provide the basic framework for habitat improvements."
Jake Smith, OSA	Next Steps section could benefit from more details on how each phase's study, design, implementation, and enrollment will be coordinated with VW and OSA planning efforts for the Preserve and Llagas creek.	We will continue to engage with Valley Water as a key stakeholder.