City of Albuquerque Open Space Division

Wetlands Action Plan

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Prepared by

Rio Grande Return for the City of Albuquerque Open Space Division and New Mexico Environment Department

RIO GRANDE RETURN

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COVER PHOTO: Drone imagery of Candelaria Nature Preserve, view to the Northeast, by Esha Chiocchio Photography, 2023.

EXECUTIVE SUMMARY

This Wetlands Action Plan covers five wetland properties along the Rio Grande that are owned and managed by City of Albuquerque (CABQ) Open Space Division (OSD): Alameda Wetland, Open Space Visitor Center (OSVC) Wetland, San Antonio Oxbow Wetlands, Candelaria Nature Preserve Wetlands, and Tingley Wetlands. To varying degrees these wetlands are all constructed and maintained by humans rather than being natural. Collectively, the wetlands represent ponds, marshes, wet meadows and ephemeral marshes that were once more common along the Rio Grande and are now rare because the river is constrained by flood control and agricultural irrigation infrastructure. The wetlands are important to wildlife and as well as socially and culturally for recreation and education.

The wetlands are experiencing many threats and impairments including: drought and concerns about ongoing water availability, incursion of non-native plants, beaver activity that impedes flow and promotes a monoculture of cattails (Typha spp.), water quality issues, threat of wildfire, lack of funding for infrastructure improvements, and insufficient staffing for maintenance and monitoring. However, with planning and collaboration with partners who jointly manage the properties and have common interests, actions can be taken that improve the functioning and value of the wetlands. Several stakeholder organizations participated in the development of this WAP and are identified herein, as are current and potential funding sources. Opportunities to improve management, scientific research and data collection, and environmental education are also identified.

WAP recommendations include wetland protection, restoration and management activities that cover multiple sites, and also recommendations for each site. General recommendations include: 1) incorporating ecological disturbance into management mechanically or by pulsed flow to mimic riverine processes, 2) reviewing and clarifying water rights declarations, 3) installing beaver coexistence structures, 4) installing and monitoring flow measurement devices, and 5) implementing a water quality monitoring program.

Recommended actions for the individual sites cover the following topics.

Alameda Wetland: water availability, drying and flow management, stagnation, non-native vegetation, management plan, city staffing, pond liner, environmental education.

OSVC Wetland: water availability, drying, management plan, water infrastructure, habitat management, city staffing, water metering, non-native vegetation, recreation, environmental education, data.

San Antonio Oxbow Wetlands: drying and flow management, beaver activity, diversity of habitat, pollutant, research, advisory committee, recreation, non-native vegetation, flow management.

Candelaria Nature Preserve Wetlands: funding for infrastructure, water availability, site specific (soils).

Tingley Wetlands: beaver activity, non-native vegetation, flow management, research/data, recreational trampling, wetland expansion, environmental education.

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LIST OF ACRONYMS

Acronym	Full Name
AIH	Aquatic Invertebrate Habitat
ABCWUA	Albuquerque Bernailillo County Water Utility Authority
AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
AMO	Atlantic Multidecadal Oscillation
AU	Assessment Unit
BISON-M	Biota Information System of New Mexico
BEMP	Bosque Ecosystem Monitoring Program
BSS	Bank and Shoreline Stabilization
CABQ	City of Albuquerque
CNPRMP	Candelaria Nature Preserve Resource Management Plan
CS	Carbon Sequestration
CWA	Clean Water Act
DO	Dissolved oxygen
EPA	Environmental Protection Agency
FH	Fish Habitat
GIS	Geographic Information System
GR	Groundwater Recharge
HGM	Hydrogeomorphic
IPCC	Intergovernmental Panel on Climate Change
MRGCD	Middle Rio Grande Conservancy District
NWI	National Wetland Inventory
NAWCA	North American Wetlands Conservation Act
NM	New Mexico
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NHNM	Natural Heritage New Mexico
NMHPD	New Mexico Historic Preservation Division
NMISC	New Mexico Interstate Stream Commission

NMOSE	New Mexico Office of State Engineer
NRCS	Natural Resource Conservation Service
NT	Nutrient Transformation
OSD	Open Space Division
OSVC	Open Space Visitor Center
OWH	Other Wildlife Habitat
RGNCSP	Rio Grande Nature Center State Park
SM	Streamflow Maintenance
SR	Sediment and Other Particulate Retention
SWD	Surface Water Detention
SWQB	Surface Water Quality Bureau
TES	Terrestrial Ecosystem Survey
TMDL	Total Maximum Daily Load
US	United States
UNM	University of New Mexico
USACE	United States Army Corps of Engineers
USBOR	United States Bureau Of Reclamation
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
WAP	Wetland Action Plan
WBIRD	Water Bird Habitat
WSS	Web Soil Survey

1. Introduction

The purpose of this Wetlands Action Plan (WAP) is to define strategies for protecting and restoring five wetland properties owned and managed by the City of Albuquerque (CABQ) Open Space Division (OSD). These wetlands are designed and managed for multiple uses including wildlife habitat for diverse species, recreation, and environmental research and education. This WAP provides a summary of actions that can be undertaken to improve the wetlands for all desired uses. OSD's primary objective for their wetlands is to conduct a deeper assessment of current conditions and identify strategies to maintain them into the future in consideration of climate change, drought and water curtailments. Clear strategies are needed for dealing with invasive species (plant and animal) and for keeping the wetlands wet since most of them rely on surface irrigation. Additional objectives include: development and implementation of a water conservation program; development and implementation of water quality monitoring efforts; biological and functional assessments for the wetlands; wetland vegetation restoration; improvements to flow regimes; and future educational and outreach efforts.

The WAP will be beneficial considering staff turnover, resource availability, and continuity of management by providing management guidance, documenting a history of what has occurred, and identifying availability of additional funds. By generating this document through a stakeholder-supported process, each wetland will benefit, partner responsibilities will be clarified, and the overall reach of the Rio Grande will be improved.

SWQB provides guidance to facilitate watershed groups throughout New Mexico to develop "Wetlands Action Plans" as an additional component to a Watershed-Based Plan. A "Wetlands Action Plan" is a planning document designed specifically to address wetlands within the boundaries of a specific watershed. In this case the WAP does not address all wetlands within a watershed and there is no corresponding Watershed-Based Plan for the watershed. This WAP covers wetlands on five specific OSD properties: Alameda Wetland, OSVC Wetland, San Antonio Oxbow Wetlands, Candelaria Nature Preserve Wetlands (including Rio Grande Nature Center State Park Wetlands), and Tingley Wetlands (Figure 1-1).

NMED issued a contract with Rio Grande Return to complete this WAP on behalf of OSD. Rio Grande Return is a 501(c) (3) non-profit organization that focuses on reviving the regenerative capacity of damaged ecosystems. Rio Grande Return restores riverscapes and ecosystems unique to the arid Southwest using low tech process-based methods to foster resilience, adaptive capacity and stewardship in these important land and water resources.

Wetlands are “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (USEPA, 2024). This is the regulatory definition of wetlands that has been used by the US Environmental Protection Agency (USEPA) and US Army Corps of Engineers (USACE) since the 1970s. Wetlands generally include swamps, marshes, bogs, fens and similar areas; lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface of the land. Wetlands must have one or more of the following attributes: (1) at least periodically, the land predominantly supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The OSD wetlands have these inherent characteristics although they are maintained almost entirely by anthropogenic water inputs.

The health of wetlands in many cases is inherently bound to its surrounding environment and water resources, therefore, the condition of riparian areas and water sources are also contained in the WAP. This WAP supplements the management documents that were created for the specific wetlands.

This WAP covers the following categories:

- An introduction about the purpose of the WAP.
- A general description of the watershed including climate, soils, geology and groundwater, surface water, water quality, vegetation, wildlife, and land use (Section 2).
- A resource analysis of five priority wetlands (Section 3).
- Identification of threats, impairments and opportunities for the five wetlands (Section 4).
- A recommended action plan that identifies measures to protect, restore, and enhance opportunities for the wetlands, as well as potential funding sources to support the work (Section 5).
- A recommended plan for partnerships and public involvement that will address educational programs focusing on wetlands and continue to engage community members in protection and restoration of their wetlands (Section 6).

This WAP was developed based on currently available information and may be revised when additional information becomes available.

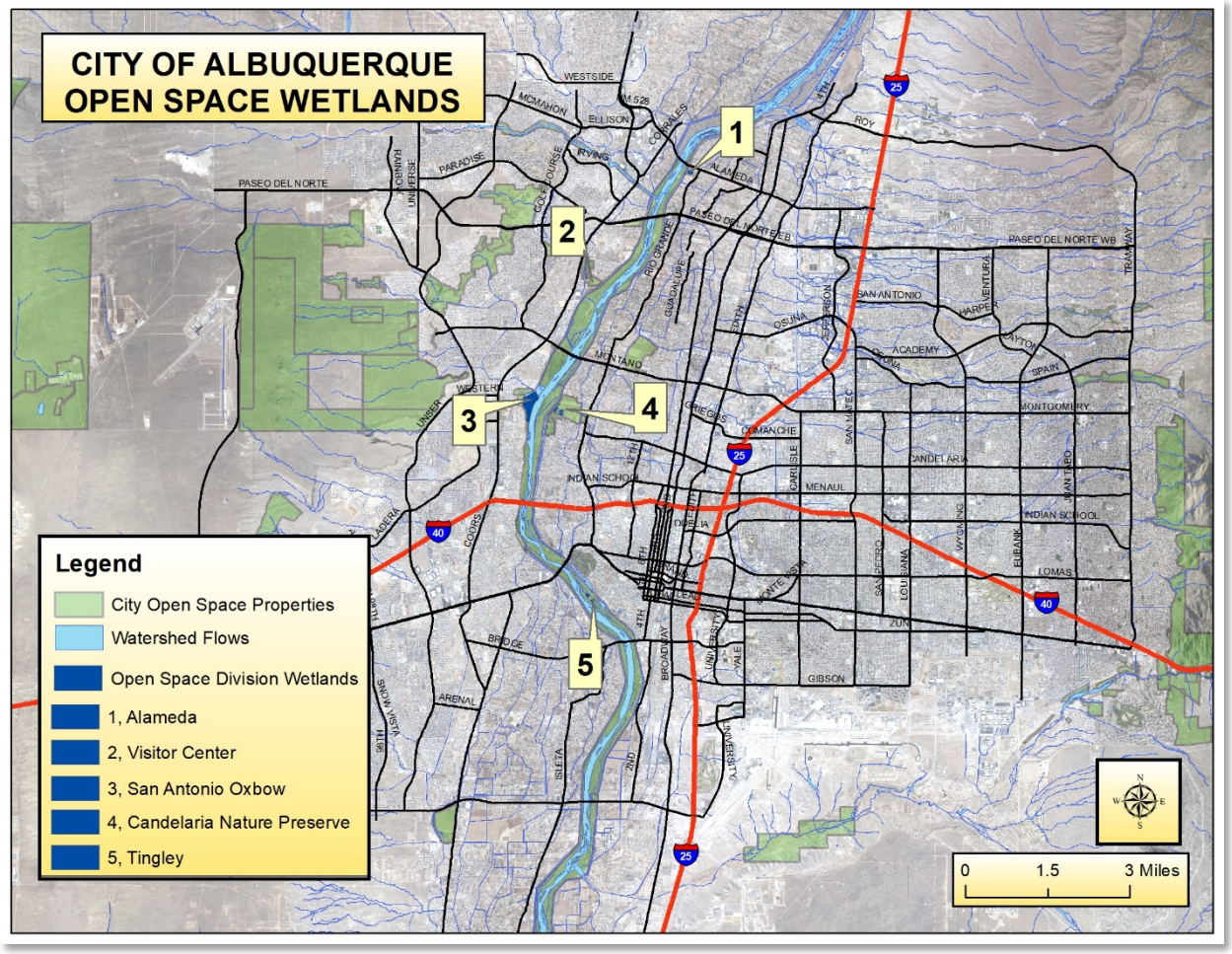


Figure 1-1. General Location Map of the five OSD wetland properties. Discussions about the individual wetlands are presented throughout this document in order from north to south.

2. Rio Grande – Albuquerque Subbasin

The five wetland properties are within the 8-digit Hydrologic Unit Code (HUC) #13020203 (Rio Grande – Albuquerque Subbasin). The wetlands are all located within .5 miles of the Rio Grande in urban Albuquerque, and on the historic floodplain of the river.

2-1. Physical History and Geography

Flood control and irrigation management and delivery infrastructure built during the 20^{tih} century along the Middle Rio Grande modified a river system that had formerly been a wide, shallow, multithreaded anastomosing system. The construction of levees, jetty jacks and dams restricted lateral movement and flow, resulting in a narrower channelized system (Grassel, 2002). Since completion of Cochiti Dam in November 1973, peak annual discharge of the Rio Grande has dropped from an average 225 m^3/s to an annual mean of 150 m^3/s at USGS gauge 08330000 at Albuquerque, New Mexico (Shah and Dahm, 2008). Lack of saturation and disturbance due to regulated spring floods has resulted in floodplain drying and reduced recruitment of Cottonwood (*Populus)* species, the native woody plant that is a characteristic of the large rivers of the western portion of the United States (Friedman et al., 1995; Katz and Shafroth, 2003). In the semiarid southwest, the Rio Grande cottonwood gallery forest, or "bosque," is visually dominated by *Populus deltoides* var. *wislizenii*, with a diverse woody understory community historically including Coyote willow (*Salix exigua)*, Seep willow (*Baccharis glutinosa*), False indigo bush (*Amorpha fruticosa*) and (New Mexico Desert-olive) *Forestiera neomexicana.* Figure 1-2 shows a representative photo of the bosque. Non-native woody species have been introduced to the area, two of which have become the third and fourth most abundant woody plant species along the rivers of the western US: Salt cedar (*Tamarix* species) and Russian olive (*Elaeagnus angustifolia*) (Friedman et al. 1995). In its relatively short history as a dammed river, the Rio Grande has become a highly modified and intensively regulated water body, and the associated bosque ecosystem structure and function are consequentially altered.

Figure 2-1. Representative photo of Albuquerque bosque.

2-2. Historical Human Use of the Bosque

Human settlement of the Middle Rio Grande likely began with Chacoan ancestors of the modern Native American Pueblo communities who now live there (Phillips, Hall, and Black, 2011). Prolonged droughts repeatedly led to migrations of people with knowledge of subsistence agriculture to find new sources of reliable water (Debuys, 2011). The migrants' already sophisticated irrigation practices were adapted to the spring snowmelt flooding that saturates the floodplain and summer monsoonal rains that provide relief from the dry heat of June. Today, the Pueblo communities of New Mexico are geographically concentrated along the Rio Grande and traditional subsistence agriculture is supported by irrigation from the river.

Western colonization of the region by Spanish Conquistadors began in the middle of the 16th century. Land was granted to early settlers by the Spanish Crown. These settlers established villages adjacent to many Pueblo communities along the Rio Grande for

easy access to river water, which was needed to support their many agricultural endeavors. Spanish settlers introduced a system of irrigation and communal water governance known as “acequia agriculture” that relies on diverting flow from a perennial stream into a system of commonly owned ditches on the floodplain. The diverted water is shared among the members of the acequia. Livestock brought by the Spanish generated widespread and long-lasting disruption to the existing vegetational regime, including impacts to the Middle Rio Grande bosque (Dunmire, 2013). New Mexico became a territory of the United States with the Treaty of Guadalupe Hidalgo of 1848, initiating the next influx of colonization, this time by American settlers of European and African descent – homesteaders, miners, and ranchers. The recent history of the Middle Rio Grande was largely influenced by east-west interstate corridors: the Atchison, Topeka and Santa Fe Railway in 1880, Route 66 in 1937 and Interstate 40, completed in 1984.

2-3. Habitat Restoration in the Middle Rio Grande

The Bosque Biological Management Plan of 1993 intended to set the stage for a new era in Rio Grande management – to be the “first step toward restoring the Bosque’s health” (Crawford et al., 1993). The plan was authored by a conservation committee appointed by US Senator Pete Domenici and was primarily directed at resource managers and decision makers, with the purpose of alerting them to the system’s condition, identifying the challenges to its biological quality and integrity, and outlining a path forward. The plan laid out methods for conservation and recommended procedures for an active change to biological management that might accomplish the conservation goals. The complexity of the management situation in the Middle Rio Grande was not lost on the authors, who were primarily research biologists.[1] The authors stressed the need for an integrated management approach with a central coordinating structure and an active, representative council of managers and concerned citizens. To make their case, the authors used data to develop a scenario of future conditions with no active change in biological management. Twenty-one recommendations were offered in the plan, including a structure for coordinating the implementation and maintenance of the plan. In the final report of the Rio Grande Bosque Conservation Committee (1993) (but not in the management plan), an adaptive management strategy was recommended to address the matrix of governance and administrative structure.

The 1993 management plan demonstrated a growing awareness that the Middle Rio Grande bosque’s condition was seriously impaired and worsening under the pressure of

[1] This plan reflects a time in ecology when systems theory was readily integrated into discussions of conservation planning and research ecologists were becoming more involved with natural resource management. See Noss, O’Connell and Murphy, 1997.

the growing human population. That awareness was soon underscored when two Rio Grande species were listed as federally protected under the Endangered Species Act: the Rio Grande silvery minnow (*Hybognathus amarus*) in 1994 and the Southwestern willow flycatcher (*Empidonax traillii extimus*) in 1995. The Rio Grande silvery minnow's listing was attributed to dramatic alterations to the natural hydrograph and the Southwestern willow flycatcher's listing was due to loss, fragmentation or modification of habitat. The listing of these endangered species changed the institutional landscape of natural resource management in the Middle Rio Grande, with likely the most significant development being the Middle Rio Grande Endangered Species Act Collaborative Program (Collaborative Program) The Collaborative Program was established in 2000 to "strive for the survival and recovery of threatened and endangered species in the Middle Rio Grande while simultaneously protecting existing and future water uses in compliance with state and federal law, including compact delivery obligations" (Collaborative Program website, November 1, 2015). There are currently 16 signatories to the Memorandum of Understanding, representing local, state, tribal, and federal levels of government, agencies, and interested groups. Administrative duties reside with the Bureau of Reclamation. The Collaborative Program is the major source of funding for habitat restoration, non-native species management, species population surveys, water quality, hydrology, and geomorphology research, and silvery minnow egg collection and propagation in the Middle Rio Grande.

2-4. Climate

The average annual high temperature in the Albuquerque Subbasin is 72.0°F (22.2°C), and the average annual minimum temperature is 40.5°F (4.7°C) (Station 290231) (Western Regional Climate Center, 2024). Average annual precipitation is 9.6 inches (244 mm), with most of the precipitation occurring during monsoon summer rainfall events. The North American monsoon is associated with moist air transported from the Pacific Ocean, the Gulf of California, and the Gulf of Mexico into the southwestern United States, generally resulting in brief and torrential precipitation events during the summer months (National Weather Service, 2024). The summer monsoon contributes a large proportion of annual precipitation. Secondary precipitation accumulations occur during winter when moisture from the Pacific Ocean moves eastward and brings frontal storms. Warming temperatures have already produced observable changes in the hydrologic cycle and sea level.

In the context of rapid global climate change, the Middle Rio Grande valley is positioned to experience significant social and ecological disruptions (MRG Climate Vulnerability study, Benson, Llewellyn, Morrison, and Stone, unpublished report), with implications for regional and natural resource planning.

Key takeaways for climate change predictions from a New Mexico Bureau of Geology and Mineral Resources report titled Climate Change in New Mexico Over the Next 50 Years: Impacts on Water Resources (Dunbar et al., 2022) include:

- Temperature is predicted to increase across the state of New Mexico between 5° and 7°F over the next 50 years.
- Predictions around precipitation are unclear but precipitation is not expected to increase.
- Soil moisture is expected to decrease and with it an increase in stressed vegetation.
- More severe droughts are predicted.
- Snowpack and runoff are predicted to decline substantially, generating diminished headwater streamflow.
- Warmer temperatures will also cause lower river flows due to increased evaporation as rivers flow downstream.
- The impacts of climate change on New Mexico's resources are overwhelmingly negative.

Overall, climate predictions indicate that less water will be available for the OSD wetlands whereas water availability is already an issue.

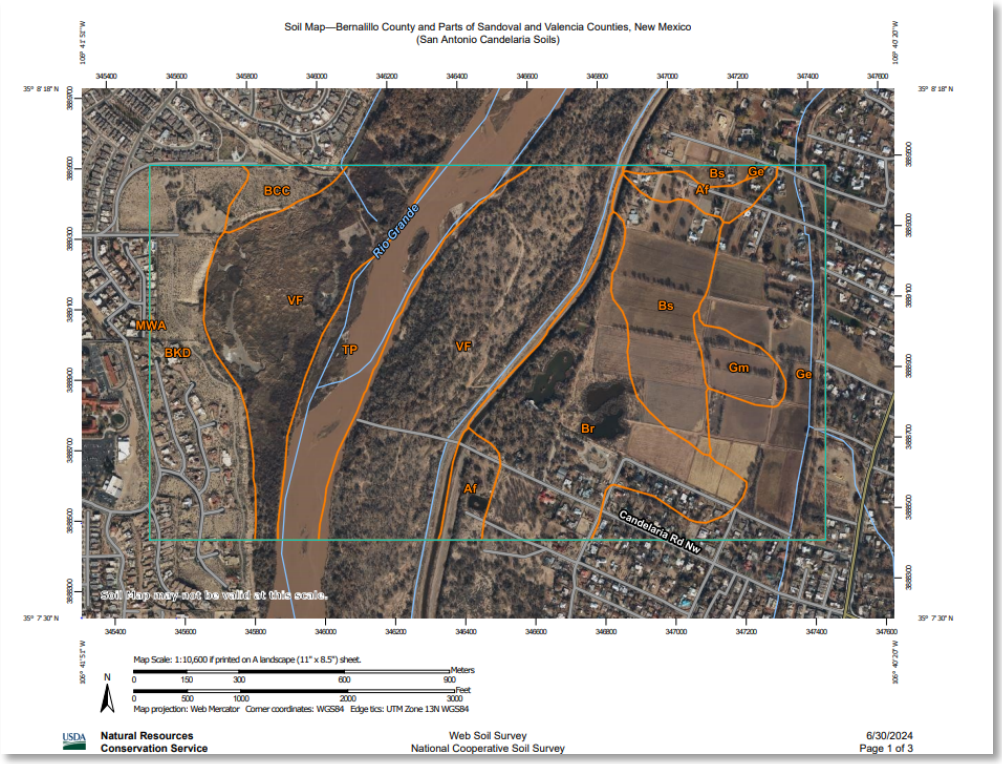
2-5. Soils

The current floodplain of the Rio Grande consists of fine-grained alluvial silts, sands, and gravels. A 2016 field survey along the bosque between Central Ave and Campbell Road reported little variation in soil texture across the site and characterized the soils as sandy loams (GeoSystems Analysis, 2016). According to the Natural Resource Conservation Service Soil Web Mapper (NRCS, 2024), nine soils units are present within the OSD wetland areas, described below.

VF soils are present throughout the Tingley and San Antonio Oxbow wetlands. VF consists of Vinton and Brazito and Torrifluvents soils. Vinton and Brazito soils are deep sandy and loamy well-drained soils formed from mixed alluvium, prone to occasional flooding, and are not considered hydric. Torrifluvents are poorly drained sandy loam soils formed from mixed alluvium, which are prone to flooding and are considered hydric.

Candelaria Nature Preserve has four soil types. The western half of the preserve consists of Brazito fine sandy loam (Br), poorly drained, and Brazito silty clay loam (Bs), well-drained. The eastern half of the preserve is Gila clay loam (Ge) and Glendale clay. Gila clay loam formed from alluvium, well-drained, and is not considered hydric. Glendale clay loam is made from alluvium, well-drained, and is not considered hydric.

Note that understanding and consideration of soils at Candelaria is important for the wetlands that have not yet been constructed (Figure 2-2).



Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Af	Agua loam MLRA 42	16.8	3.3%
BCC	Bluepoint loamy fine sand, 1 to 9 percent slopes	8.6	1.7%
BKD	Bluepoint-Kokan association, hilly	62.5	12.3%
Br	Brazito fine sandy loam MLRA 42	76.4	15.0%
Bs	Brazito silty clay loam MLRA 42	42.1	8.3%
Ge	Gila clay loam MLRA 42	78.6	15.5%
Gm	Glendale clay loam, 0 to 1 percent slopes MLRA 42.1	9.8	1.9%
MWA	Madurez-Wink associatin, gently sloping	0.1	0.0%
TP	Torrifluvents, frequently flooded	45.2	8.9%
VF	Vinton and Brazito soils, occasionally flooded	168.6	33.2%
Totals for Area of Interest		**508.6**	**100.0%**

Figure 2-2. Web Soil Survey Map and corresponding map unit legend showing soils at Candelaria Nature Preserve (fields on right) and San Antonio Oxbow (on left). From NRCS, 2024.

Soils at OSVC Wetland are Bluepoint loamy fine sand (BCC). Bluepoint soils are derived from alluvial or eolian deposits, are somewhat excessively drained, and are not considered hydric.

Soils at Alameda Wetland are Agua loam (Af) on the northwest side and Brazito fine sandy loam (Br) on the southeast side. Agua loam is formed from alluvium, well-drained and not considered hydric. Br is described above.

No soils identified in the wetland areas are considered to be prime farmland (NRCS, 2024).

2-6. Geology and Groundwater

The Albuquerque Basin lies within the Rio Grande Rift. The rift extends north-south from central Colorado to southern New Mexico, more than 500 miles long. Fault-bordered valleys in the Rio Grande Rift were created by crustal tension in the Tertiary Period (ca. 35 million years ago). The Rio Grande Rift Valley is characterized by the accumulation of alluvial sediments, lava and ash from surrounding upland areas as a result of volcanism and erosion (Chronic, 1987). Over time ephemeral lakes occupied the rift basins, receiving water from nearby mountains. Water eroded the barriers between the basins and eventually became the ancestral Rio Grande, flowing from north to south through the basins. The ancestral Rio Grande is thought to be 1-2 million years old (NM Museum of Natural History and Science, 2024).

The Albuquerque Basin is filled with up to 14,000 feet of loosely consolidated sediments of the Oligocene-Pleistocene Santa Fe Group and these sediments form the productive aquifer for the region (Bertolini, 2002). Ground water is typically withdrawn from the upper 2,000 feet of the aquifer. In general, depth to water ranges from the surface near the Rio Grande to several hundred feet near the Sandia Mountains.

Ground water was studied at Tingley by drilling and monitoring 11 monitoring wells in the area south of the wet meadow. Ground water level fluctuations were found to correlate closely to river stage, large rain events, and possibly the east riverside drain network. Ground water in the wells had an average depth of 1.2 meters and ground water flow was southeast, generally parallel with the river (LeJeune, 2011). In a study of the bosque from Campbell to Central, ground water was measured in 35 augered holes. Depth to water varied from ponded at the surface to 16 feet deep and generally was deeper the farther the boreholes were from the river (GeoSystems Analysis, 2016).

2-7. Surface Hydrology

The Rio Grande is the primary perennial river in the Albuquerque Subbasin. Flow in the Rio Grande is heavily managed in order to comply with international (Mexico) and

interstate (Texas and Colorado) water delivery compacts and to provide irrigation water to downstream users in central and southern New Mexico. Thus, flow is controlled upstream by retention, and is managed and released from several reservoirs: Cochiti, Abiquiu, El Vado, Heron, and Jemez Canyon. Lateral movement of the river is constrained through Albuquerque by levees and lines of lateral and perpendicular jetty jacks that were installed primarily in the 1950s and 1960s to channelize the river and prevent flooding of urban infrastructure (Grassel, 2002). See Figure 2-3 for an example of jetty jacks. Channelization has reduced the occurrence and variety of wetland ecosystems that historically occurred along the Middle Rio Grande.

Figure 2-3. Photo of Jetty Jacks perpendicular to the Rio Grande.

2-8. Water Quality and Condition of Rivers

Surface water in the Rio Grande has multiple water quality impairments as indicated by the Clean Water Act Section 303d list (NMED, 2024). See Table 2-2.

Table 2-1. Surface Water Quality Impairment in the Rio Grande through Albuquerque.

Location	Pollutant	NMED Assessment Unit	First Listed	Total Maximum Daily Load (TMDL) Date
Rio Grande (Tijeras Arroyo to Alameda Bridge)	Temperature	NM-2105_51	2010	2023 (est.)
	Dissolved oxygen		2008	2023 (est.)
	PCBs – Fish Consumption Advisory		2010	
	Mercury – Fish Consumption		2010	
	E. Coli		2020	6/30/2010
	Polychlorinated Biphenyls (PCBs)		2012	2023 (est.)

The NMED Surface Water Quality Bureau completed a TMDL for E. Coli for the Rio Grande (Isleta Pueblo to Alameda Bridge Reach) which was approved by US EPA on 6/30/2010. The EPA-approved water quality standards (WQS) currently applicable to the Rio Grande are set forth in the following section of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC) (NMED, 2024):

20.6.4.105 RIO GRANDE BASIN - The main stem of the Rio Grande from the headwaters of Elephant Butte reservoir upstream to Alameda bridge (Corrales bridge) and intermittent water below the perennial reaches of the Rio Puerco that enters the main stem of the Rio Grande.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Applicable Criteria:

(1) The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

20.6.4.900 NMAC provides standards applicable to attainable or designated uses unless otherwise specified in 20.6.4.101 through 20.6.4.899 NMAC. 20.6.4.13 NMAC lists general criteria that apply to all surface waters of the state at all times, unless a specified criterion is provided elsewhere in 20.6.4 NMAC. The Pueblo of Sandia and the Pueblo of Isleta also have standards for the Rio Grande that are applicable to tribal waters within the Albuquerque Subbasin.

The Rio Grande TMDL (NMED, 2010) identifies probable point and nonpoint pollutant sources that may be contributing to observed E.Coli loads in the Rio Grande as: municipal point source discharges such as wastewater treatment facilities and storm water systems, poorly maintained or improperly installed (or missing) septic tanks, impervious surface/parking lot runoff, livestock grazing of valley pastures and riparian areas, upland livestock grazing, and wastes from pets, waterfowl, and other wildlife. The TMDL discusses several remedies to the E. Coli issues, including waste load allocations for permitted facilities, development of a watershed restoration action strategy (in current terminology this would be a Watershed-Based Plan), potential funding for wastewater treatment plant and septic system upgrades, funding for agriculture assistance, stormwater permitting controls, and an ongoing bacterial monitoring program.

The New Mexico Environment Department does not monitor water quality in the OSD wetlands. Only the San Antonio Oxbow Wetlands is connected to the Rio Grande, and that connection is very rarely through inundation by overbank flooding. There are no state numerical water quality standards for the OSD wetlands. The only applicable state standards are listed at 20.6.4.13 NMAC General Criteria that contain narrative criteria for: bottom deposits and suspended and settleable solids; floating solids, oils and grease; color; organoleptic quality; flavor of fish; odor and taste of water; plant nutrients; toxic pollutants; radioactivity; pathogens; temperature; turbidity; total dissolved solids; dissolved gases; and biological integrity.

2-9. Wetland Development History and Current Land Use

Each of the five wetlands addressed by this WAP has a unique history of collaborative land use, management and ownership by federal, state, county, city, and non-profit organizations. Descriptions of the five wetlands are provided below.

Alameda Wetland

Alameda Wetland is a five-acre pond owned and managed by the OSD. Bernalillo extended these wetlands in 2010 based on public input that people wanted more access to the wetlands, so the County added a small wetland extension and a boardwalk, which they manage separately. Later a solar aeration unit was added to the small wetland to improve oxygenation. See Figure 2-4 for property boundaries.

Figure 2-4. Map of CABQ and Bernalillo County showing property boundaries at Alameda Wetland. (OSD, 2017).

Alameda Wetland was created to fulfill a desire for more wetland habitat within city open spaces and allow the citizens of Albuquerque and Bernalillo County a chance to interact with a wetland in a high traffic area. The pond was constructed in 1998 with contributions from OSD, US Bureau of Reclamation, US Fish and Wildlife Service, Intel Corporation, and Phillips Petroleum. The pond is rectangular with an approximately .77-acre refugia island in the middle. Upon construction, the depth of the pond varied from 3-6 feet and the bottom of the pond was lined and compacted with soil mixed with a vegetable emulsion. Figure 2-5 shows the current condition of the liner. Planting around the pond was conducted by Hydra Aquatics and volunteers from Intel Corporation (OSD, 1998). There is an island in the center of the wetland, three wildlife viewing blinds with windows situated around the wetland, and a boardwalk across the Bernalillo County section of the pond.

Figure 2-5. Pond Liner at Alameda Wetland. Photo taken February 2023.

Currently there is a riparian vegetation buffer on the perimeter of the wetland and on the refugia island in the middle. The buffer and island are dominated by Coyote willow, with non-native encroachment of Salt cedar, Siberian elm and Russian olive. A Blue

gramma grassland leads to a mature Cottonwood forest on the east side of the open space.

The wetland is fed by a 30ac/ft water lease from MRGCD and filled via the Lane lateral of the Albuquerque Main Canal. There is both an inlet pipe and a drain (OSD, 1998). According to OSD water rights records on file, in 1997 there was a petition by MRGDC to the Office of State Engineer to construct a 25-foot deep well on the property. Well water would have then been used to fill the wetlands instead of the surface water lease. The Office of Natural Resources Trustee protested the ground water petition and it was denied or dropped, thus the leased surface water is still used to fill the wetlands.

Alameda Wetland is a hot spot for bird watchers and a regular birding location for Bird Alliance of Central New Mexico. Avian species consist of a variety of water birds, songbirds, and raptors (Figure 2-6). Mammals observed in the area include beaver, porcupine, and coyotes. There is a population of introduced red-eared slider turtles, and carp have commonly been found in the wetland (OSD, 2022).

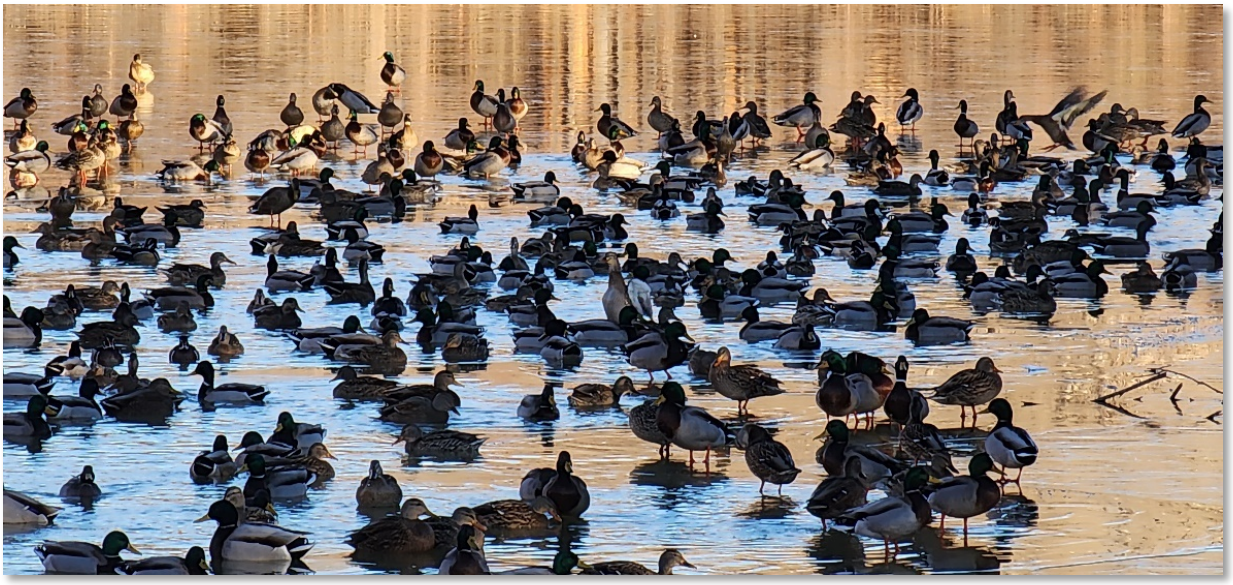


Figure 2-6. Ducks at Alameda Wetland. Photo by Jacob White.

OSVC Wetland

The wetland at the OSVC is a 1.5-acre marsh created in 2010. See Figure 2-7 for an aerial view of the wetland. The original project objective for the wetland was to develop habitat for Species of Greatest Conservation Need in a manner that enhances efficient management and maintenance of the marsh/moist soil area as sensitive to the wildlife resources that migrate year to year within the OSVC. Dewatering, habitat conversion, and channelization have reduced these habitats throughout the Middle Rio Grande

Valley. Water tables have been lowered and the area that was formerly perennial cienegas and marshes has become ephemeral or no longer exists (Martinez, 2010).

Figure 2-7. Aerial view of OSD Wetland from Google Earth.

From May 10, 2010 to May 10, 2020, CABQ and the US Fish and Wildlife Service (USFWS) had a private lands agreement for the OSVC Wetland. Funding was provided through this agreement to excavate and improve an existing wetland that CABQ managed for wildlife OSD, 2022). The OSVC serves as a major destination for citizens wanting to become familiar with local wildlife populations. Through the private lands agreement, CABQ provided the labor and equipment for work to deepen and revegetate the OSVC Wetland, whereas USFWS funds paid for native wetland vegetation (USFWS/CABQ Private Lands Agreement, 2010).

There is no constructed liner under the wetland but there is in situ clay soil layer that has low permeability and acts as a natural liner. Excavated soils were placed at a slope of 3:1 on a bank levee around the marsh. Irrigation of the wetland occurs April through October, every three weeks, from the La Orilla channel, a concrete lined, gated system that has one gate for the inlet, then water flows under the west side of the entrance road to the east side (Peter Callen, pers. comm., 2024). The wetland is filled by water from an MRGCD surface water lease that is designated for all adjacent irrigated fields at the OSVC. The lease is paid semi-annually to MRGCD for this water right but in low water years the arrangement does not allow for filling the wetland (OSD, 2022).

The wetland is 1.5 acres but has two .1-acre islands in the center that do not become inundated upon filling of the pond.

Because of its proximity to the OSVC, this wetland is used as an environmental education area. There is a clear path halfway around the wetland to a wildlife viewing blind (Figure 2-8) but the path is overgrown and less inviting around the north side of the wetland. Habitat enhancements include a cavity nesting bee motel and some bird boxes.

Figure 2-8. OSD Wetlands, view southeast from near the wildlife blind.

The vegetation community on the riparian buffer around the island is predominately Coyote willow, Gooding's willow, Cottonwood and Baccharis with interspersed non-native Siberian elm and Russian olive. According to Martinez (2010), the wetland was originally planted with 1,000 Smart weed and 1,000 Wild celery (inner boundary between the two islands). 1,000 Bull rush were dispersed around the marsh. 100 Choke cherry and 100 Service berry were planted on the feeder marsh and on the NW/SW banks of the main marsh area. A wildflower mix of Globemallow, Purple aster, Plans

coreopsis, Prairie clover, Penstemon, Blue flax, Primrose, Mexican hat and Blanket flower were seeded on the perimeter of the wetland.

The inside of the wetland is sloped from north to south which leads to a more ephemeral wetland on the north end and year-round water on the south end. Due to issues regarding the filling of the wetland, OSD added a dirt berm through the center of the wetland to create two separate fill areas but this may just be inhibiting water movement and cycling. The emergent vegetation inside the pond is dominated by Bull rush and Cattails, especially on the north end (OSD, 2022).

The wetland provides a critical water source for wildlife in the surrounding area. To the east are the OSVC agricultural fields and to the north is upland habitat dominated by Fourwing saltbush. Open access corridors from the adjacent habitats to the wetland are frequently used by resident wildlife.

Wildlife in the wetland consists primarily of domestic waterfowl, Woodhouse's toad, and American bullfrog. Martinez (2010) states that the wetland would be managed to support several species that were listed at the time as Species of Greatest Conservation Need: Northern pintail; Northern bald eagle, Northern harrier, Sandhill crane, American beaver, Tiger salamander, Boreal toad, Big Bend slider, New Mexico garter, and Osprey. In May 2024, OSD staff detected a Southwestern Willow Flycatcher at the OSVC during a standard bird survey. The area is not considered prime breeding habitat but evidently is suitable for a stopover.

San Antonio Oxbow Wetlands

San Antonio Oxbow is a 54 - acre Riverine wetlands located on the west side of the Rio Grande. Figure 2-9 shows a view of San Antonio Oxbow from the bluff overlook. It is the most natural of the five OSD wetlands because it was not constructed by humans, rather it was predominantly created by the river when it was a shallow, wide, multi-channeled system. It consists of a mosaic of open water marshes, aquatic plants, woody shrubs and deciduous trees, and is representative of habitats that were historically more ubiquitous along the Middle Rio Grande. According to the San Antonio Oxbow Biological Management Plan (OSD, 1997), the oxbow wetlands were formed by a series of floods in the 1960s. Once the levees and jetty jacks were installed along the Middle Rio Grande, the river no longer shifted laterally. Now these wetlands are not connected to the river except during very high flow periods, through backwater channels. San Antonio Oxbow is protected by the city because it is recognized as rare, high-value, essential riverine habitat for a variety of wildlife.

Figure 2-9. San Antonio Oxbow Wetlands view from bluff.

San Antonio Oxbow is supplied by water from the Corrales Drain, and also receives water from ground water, stormwater runoff from San Antonio Arroyo, and occasionally the Rio Grande. The AMAFCA channel at San Antonio Arroyo is robust infrastructure that stabilizes the area and prevents excessive sedimentation of the oxbow. This location is an intersection of jurisdictions among OSD, AMAFCA, MRGCD, USACE and USBOR. Figure 2-10 shows a view of San Antonio Oxbow from river level.

Figure 2-10. San Antonio Oxbow Wetlands view from near river level.

San Antonio Oxbow Wetlands have been inhabited and shaped by beavers since approximately the 1970s, when beaver dams constructed across the Corrales Drain caused overflow and ponding in the oxbow. Public support for managing the wetlands increased at that time and culverts and pipes were installed to manage flow into and through the oxbow. In response to Sierra Club lobbying for environmental flows for the oxbow, MRGCD agreed in 1976 to provide water via the Corrales Drain (OSD, 2022).

Beavers are responsible for creating open water habitat in the oxbow, but also implicated for preventing throughflow of water, which is integral to the health of the wetlands. More movement of water would allow for a flush of accumulated sediments and aeration of stagnant water, as well as more variety of vegetation and wetland habitats (OSD, 2022). As it is, the flooded portions of the wetlands are dominated by Cattails. The margins of the wetlands are surrounded by willows with interspersed Ravenna grass. Overstory vegetation consists of primarily mature Cottonwood, Coyote willow, New Mexico olive, Russian olive, Siberian elm, and Salt cedar. The “100 acre woods” directly north of San Antonio Oxbow has a large density of invasive Salt cedar

and Russian olive that are displacing the willows, New Mexico olive, and other native vegetation species that should be thriving in the Albuquerque Bosque.

San Antonio Oxbow provides important habitat for numerous wildlife species, many of which have been studied by the Bosque School and BEMP, such as:
beaver, bobcats, raccoons, porcupines, rodents, bats, rabbits, skunks, coyotes, javelina, migratory birds and reptiles. USACE and OSD have performed surveys for Southwest Willow Flycatcher (a breeding pair was detected in 2024), and Middle Rio Grande Endangered Species Collaborative Program has performed surveys for Silvery minnow.

Candelaria Nature Preserve Wetlands

Candelaria Nature Preserve (CNP) is a 167-acre property adjacent (east) of Rio Grande Nature Center State Park. It was purchased by CABQ in 1978, partially with money from the federal Land and Water Conservation Fund (LWCF) for the purpose of creating a nature study area and wildlife preserve. Federal funding also carried the stipulation that the property must be used for outdoor recreation in perpetuity (OSD, 2021) Mexico Energy, Minerals and Natural Resources Department leases 38.8 acres of Candelaria Preserve for Rio Grande Nature Center State Park, and on this acreage are two synthetically lined ponds called Candelaria Wetlands. Additionally there are three ponds on the state park property: Observation Pond, Discovery Pond, North Pond. See Figure 2-11 for a map of the Candelaria/ Rio Grande Nature Center wetlands.

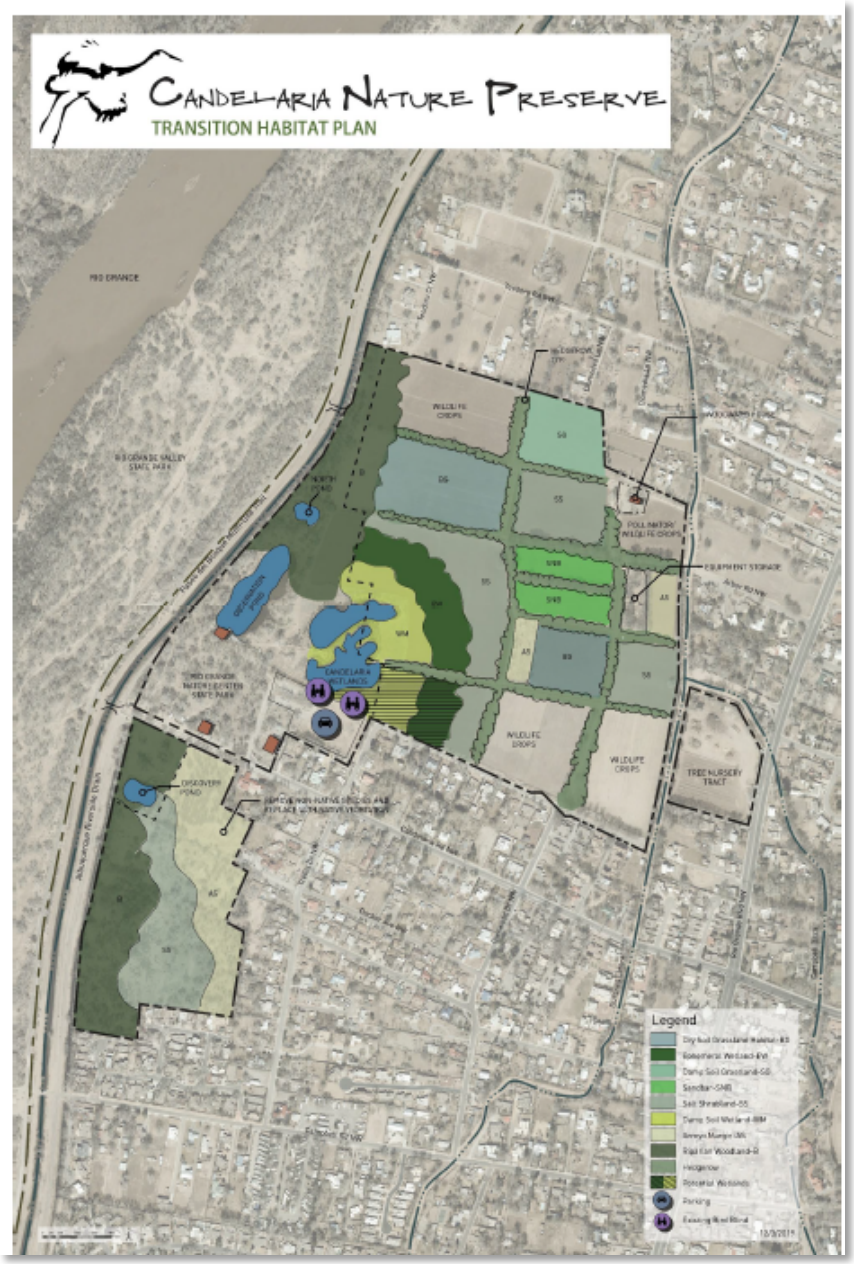


Figure 2-11. Map showing the existing wetlands ponds and planned wetlands at Candelaria/Rio Grande Nature Center from the CNP Resource Management Plan (OSD, 2021). The existing ponds are shown in blue. The planned wetlands are shown as light green and dark green arcs adjacent to the Candelaria ponds.

Table 2-4 summarizes general information about the ponds. All of these existing ponds are managed by the Rio Grande Nature Center State Park through a joint management agreement with OSD. Because these ponds are not managed directly by OSD they are

a lesser priority for this WAP and therefore have received lesser analysis and fewer recommendations overall.

Table 2-4. Existing Ponds at Rio Grande Nature Center State Park/Candelaria Nature Preserve

Pond Name	Date Built	Area (acres)	Liner	Closed or Open System	Water Source
Observation Pond	1981	2.5	Synthetic	Closed	Ground Water (150 foot well)
North Pond	1991	.42	None	Closed	Intersects Ground Water (but has water rights associated with a well)
Discovery Pond		.56	Synthetic	Closed	Ground Water (30 foot well)
Candelaria Ponds	2001	5	Synthetic	Closed	Ground Water (150 foot well-shares water source with Observation Pond)

Forty species of aquatic and moist soil plants were originally planted in the grassland areas around the ponds. (OSD, 1991). Currently willows surround all the ponds. Figure 2-12 shows the current condition of the Observation Pond.

Figure 2-12. Observation Pond at Rio Grande Nature Center State Park.

In addition to the existing ponds, the CNP Management Plan calls for the construction of 23 acres of damp soil wetlands and ephemeral wetlands. The damp soil wetlands are meant to mimic wetlands that were historically more ubiquitous along the Rio Grande in channel oxbows where the water table is close to the surface and alternates between saturated and flooded, including standing water approximately every two months throughout the year (OSD, 2021). This would be considered an E or C water regime in the National Wetlands Inventory (NWI) classification system. The wetlands will be planted with obligate wetland graminoid rushes, sedges and grasses, several obligate wetland forb species, and several phreatophyte shrub and tree species. The ephemeral wetlands are meant to mimic former oxbow channels where soil was not saturated but instead flooded periodically from summer monsoons. This would be considered an A water regime in the NWI classification. The ephemeral wetlands will be planted with obligate/facultative wetland graminoid rushes, sedges and grasses, several facultative wetland forb species, and several phreatophyte shrub and tree species. The plan is for soils to be excavated and bermed, and both wetland units (damp and ephemeral) would be flood-irrigated at a frequency best suited to support the intended plant assemblages (OSD, 2021).

Initially the plan was to construct seven acres of wetlands, but the NM Department of Transportation suggested enlarging it so they could use the area as a wetland mitigation bank. CABQ paid for a 90% design for 23 acres at their own cost. This was a big expense and wetland construction would be a big expense. The 2023 Sackett Decision by the Supreme Court of the US caused uncertainty about the regulation of wetlands. NM DOT has backed off from the mitigation bank for now, consequently pulling out any construction funds that would have been provided for the Candelaria Nature Preserve Wetlands.

Candelaria Nature Preserve and Rio Grande Nature Center State Park provide habitat for numerous species of avian, amphibian and mammalian wildlife. The State Park has active environmental education programs. Visitors can access Candelaria Nature Preserve through weekly tours or through viewing from two wildlife blinds on the northwest and southeast edges of the property.

Tingley Wetlands

Construction of Tingley Ponds dates back to 1933 when Mayor Clyde Tingley saw an opportunity to establish a swimming area along the Rio Grande for citizens of Albuquerque. Initially the ponds were connected to the Rio Grande. After levees were built, the ponds were no longer in contact with the river, and instead ground water wells were drilled to supply water to the ponds. In the 1950s the ponds were closed to swimming due to water quality issues that were potentially harmful to human health, and were converted to fishing ponds (USACE, 2004).

In the 1990s the City of Albuquerque requested that the US Army Corps of Engineers investigate, design and implement a riparian and wetland restoration plan for the bosque to the southwest of Tingley Ponds. The plan was developed in the late 1990s and completed by 2005. The purpose of the project was to restore the riparian vegetation community adjacent to the Rio Grande that had been negatively affected by flood control projects by: creating wetlands, removing jetty jacks, removing invasive species, reestablishing native plants, enhancing hydrology in the bosque and increasing environmental education opportunities. Project objectives included: 1) restoring three distinct wetland communities (Deep Marsh, Shallow Marsh, and Wet meadow), 2) providing additional habitat for wetland dependent wildlife (amphibians, fish, and waterfowl) and 3) increasing recreational and educational opportunities. The project was approximately 48 acres with nine acres of created wetlands. The remaining 39 acres of restoration consisted of invasive/exotic removal and native riparian vegetation seeding. (USACE, 2004).

The resulting design included a Deep Marsh, a Shallow Marsh, and a Wet Meadow that receive flow in sequence from Tingley Ponds (Figure 2-13).

Figure 2-13. Map of Tingley Ponds and Wetlands. Labels are to the right of the features. Boundaries of the wet meadow are approximate. Google Earth Imagery, October 2020.

The water supply for the Deep Marsh, Shallow Marsh and Wet Meadow are supplied via a pumping scheme which starts with withdrawal from a ground water well located in the bosque (west of the Tingley Ponds) to a pump house which then pumps water to the Children's Ponds and South Pond. This water enters and mixes into the larger Central Pond from both ends and is pumped via underground pipe to the Deep Marsh (Figure 2-14). The Deep Marsh has a control flow weir at the outlet to a channel which feeds by gravity to the Shallow Marsh and then into the Wet Meadow (USACE, 2006).

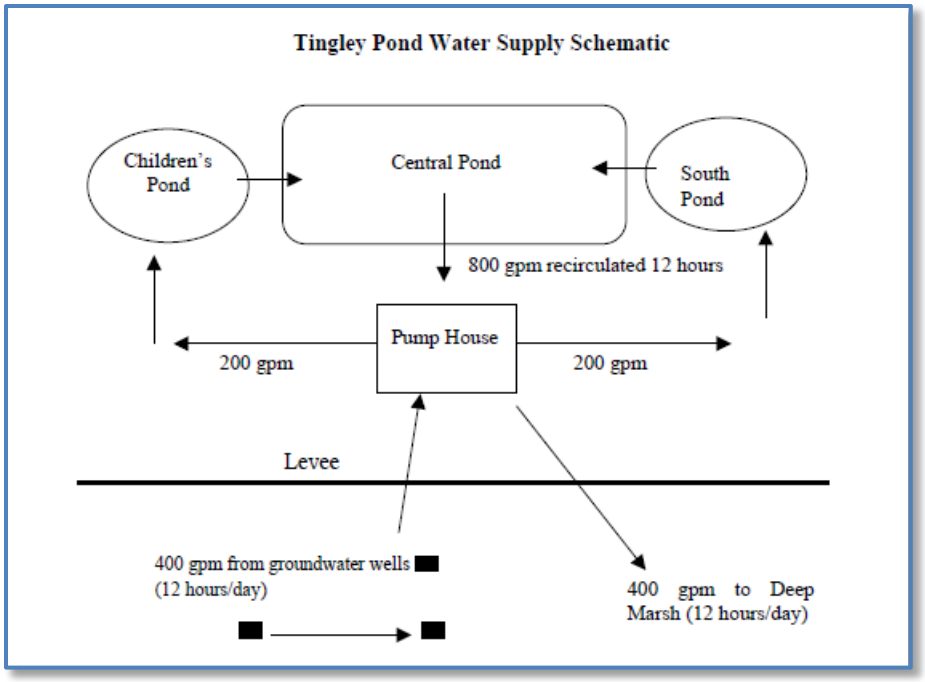


Figure 2-14. Tingley Wetlands Flow schematic showing how water moves through the system, from US ACE, 2006.

Soil and ground water investigations conducted at Tingley indicated that soils are indicative of a floodplain (Vinton and Brazito soils), had low salinity, and ground water was at a depth of approximately five feet (LeJeune, 2011). Because the area is a FEMA designated floodplain, projects cannot increase flood levels during a base flood discharge.

The water quality at the Tingley Ponds is rich in nutrients which leads to eutrophication and then nuisance algal blooms that reduce dissolved oxygen. In the past there have been fish kills and outbreaks of avian botulism (OSD, 2022). However, now there are monitoring and treatment systems in place to maintain adequate water quality to support fish in the ponds. Dissolved oxygen (DO) and temperature measurements are transmitted by in situ probes in the ponds. An aeration system can be turned on manually in Children's, South, and Central ponds when the DO is low. Surface water drawn from the Central Pond is continuously treated with ozone before it is routed to the South and Children's ponds. The ozone gas is meant to oxidize odor and turbidity-causing organic materials. Water levels in the Deep and Shallow marshes are also transmitted continuously using in situ sensors (USACE, 2006). Figure 2-15 shows conditions at the Deep Marsh unit.

Figure 2-15. Tingley Wetlands Deep Marsh unit. Photo by Jacob White.

In addition to water quality monitoring, there are in situ sensors in the Deep and Shallow marshes that trigger remote alarms when water levels fall too low. The Tingley operations manual acknowledges that additional operational action details are needed to ensure that the Wet Meadow stays wet (USACE, 2006).

Vegetation at Tingley Wetlands consists of large Cottonwoods with interspersed Siberian elms. The Deep and Shallow marshes are bordered by an approximately 25-foot zone of Coyote willow and Cattails with Russian olive and Salt cedar mixed throughout. A mature Cottonwood gallery adjacent to the marshes is littered with fallen branches and woody debris that provide important wildlife habitat. The dominant vegetation to the east of the marshes is Fourwing saltbush with some Russian thistle (OSD, 2022).

Wildlife at Tingley Wetlands is abundant and varied, including domestic waterfowl and resident avian species such as Coopers hawk, Great horned owl, Northern flicker, and numerous other bird species, as well as Coyote, Porcupine, Beaver, and Raccoon. Bat boxes that have been placed around the wetlands to encourage native bat habitat

appear to be occupied. Beaver activity (dams and chewed willow) is apparent in the channel between the Deep and Shallow marshes. OSD staff have repeatedly removed beaver dams in order to maintain adequate flow to the Shallow Marsh and Wet Meadow. Beaver dams may also be contributing to overflow of the Shallow Marsh that creates additional Wet Meadow to the west (OSD, 2022).

3. Wetland Inventory

The National Wetlands Inventory was updated for wetlands along the Middle Rio Grande in 2021.

Under the Clean Water Act, wetlands are defined for regulatory purposes, as “areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” (USEPA, 2016).

Wetlands exhibit one or more of the following characteristics (1) at least periodically, the land predominantly supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate predominantly consists of undrained hydric soil or contains hydric soil indicators and/or redoxymorphic features that indicate saturation periodically; and (3) at some period during the growing season of each year, the substrate is non-soil and either saturated with water or covered by shallow water. Because of the climatic variability of New Mexico which sometimes includes long periods of drought that dry up even the most persistent water sources, wetlands are not expected to be saturated each year.

This WAP considers wetlands as well as riparian areas and buffer zones. Riparian ecosystems are characterized by the presence of both phreatophytic and mesophytic vegetation and by habitats that are associated with bodies of water. These ecosystems are also dependent on the existence of surface and subsurface drainage, either perennial, intermittent, or ephemeral. Water requirements in the wetlands are strict; and are not as drastic in riparian ecosystems.

3-1. Wetland Mapping and Classification

NMED updated the National Wetlands Inventory for the Middle Rio Grande as part of ongoing efforts that will eventually provide updates for the entire state excluding tribal lands. Previous wetland mapping in New Mexico was sparse and dated. NMED contracted with GeoSpatial Services of Saint Mary’s University of Minnesota to complete the Geographic Information System (GIS)-based mapping. A report titled “Mapping and Classification of Wetlands in the Middle Rio Grande” includes updated mapping and classification for Bernalillo County (Allen et al., 2021).

Wetlands for the project area were mapped and classified using on-screen digitizing methods established in GIS. Aerial imagery, combined with soils, topographic, hydrologic, and land cover data sets, was used as a base map (Allen et al., 2021). The mapping performed by Saint Mary’s University is consistent with the Wetlands and

Deepwater Habitats Classification used for the NWI, which classifies wetlands by system (Cowardin et al., 1979).

Three systems are present in the Bernalillo County mapping area:

- The Riverine System includes deepwater habitats and mostly non-vegetated wetlands that are contained in natural or artificial channels. Either periodically or continuously, these channels contain flowing water that forms a connecting link between two bodies of standing water. Examples of the riverine systems include rivers, streams, creeks, arroyos, washes, or ditches.

- The Lacustrine System includes both wetlands and deepwater habitats. This system is defined by all the following characteristics: deep water that is situated in a topographic depression or in a dammed river channel; wetland areas lacking trees, shrubs, or persistent emergents; wetland areas consisting of emergent mosses or lichens with greater than 30 percent aerial coverage; wetland areas that exceed 20 acres; or wetland areas that total less than 8 hectares and, at low water, are deeper than 6.6 meters. Examples of these wetlands include lakes, reservoirs, or intermittent lakes, such as playa lakes.

- The Palustrine System includes all non-tidal wetlands that are dominated by trees, shrubs, emergents, mosses or lichens, and by all wetlands that occur in tidal areas where salinity due to ocean-derived salt is below 0.5 ppt. An estimated 95 percent of all wetlands in the U.S. are freshwater, palustrine wetlands. As a result, these wetlands will predominate in most wetland mapping efforts. No subsystems exist in the (P) Palustrine System. Examples of Palustrine wetlands found in the New Mexico project area include marshes, swamps, shoreline fringe, bogs, fens, or ponds.

After the Systems are classified, the NWI describes wetland characteristics in a hierarchal order including:

- Subsystem (with the exception of the Palustrine System)
- Class
- Subclass (only required for Forested, Scrub-Shrub, and Emergent Classes)
- Water Regime
- Special Modifiers (only required where applicable).

Detailed mapping for each of these NWI classifications is available on the NWI Mapper website: https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/

3-2. Hydrogeomorphic Classification

In addition to the NWI system, other systems of wetland classifications are commonly used to distinguish various types and characteristics between wetland resources. The SWQB Wetlands Program uses Brinson's Hydrogeomorphic (HGM) wetland classification (Brinson, 1993) for the Wetlands Action Plan process, because this classification system is easier to understand and allows for the categorization of a limited, reasonable number of subclasses. The HGM classification system, based on geomorphic settings, water sources, and hydrodynamics, results in six wetland classifications based on these three essential functions (NMED, 2012). The OSD wetlands fall into the Riverine, Slope, Depressional and Palustrine (Pond) Fringe classes.

Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources consist of either overbank flow from the channel or from subsurface hydraulic connections between the stream channel and the wetlands. Additional water sources may consist of interflow and return flow from adjacent uplands; the occasional overland flow from adjacent uplands; from tributary inflow; and from precipitation.

Depressional wetlands occur in topographic depressions with a closed elevation contour that allows surface water to accumulate. Precipitation, groundwater discharge, and interflow from adjacent uplands are the dominant sources of water for these wetlands. Since water normally flows from the surrounding uplands toward the center of the depression, the depressional wetlands may consist of any combination of inlets and outlets or may lack them completely.

Depressional wetlands may also lose water through intermittent or perennial drainage from an outlet or through evapotranspiration. If they are not receiving groundwater discharge, these wetlands may slowly contribute to the accumulation of groundwater and will often vary with the seasons. Prairie potholes are a common example of depressional wetlands. Playas are also considered to be depressional wetlands.

Slope wetlands are normally found where there is a discharge of groundwater to the surface of the land. Elevation gradients may range from steep hillsides to gentle slopes. Principal water sources are usually from the return flow of groundwater, interflow from surrounding uplands, and precipitation. If groundwater discharge is a dominant water source, slope wetlands can occur in nearly flat landscapes.

Slope wetlands lose water primarily by saturation of the subsurface, through surface flows, and by evaporation. Springs are examples of slope wetlands in New Mexico.

Palustrine (Pond) fringe wetlands are adjacent to ponds where the water elevation of the pond maintains the water table in the wetland.

3-3. Wetland Functional Assessment

A wetland functional assessment was completed as part of the Middle Rio Grande wetlands mapping and classification project. Wetland functions that were assessed within the project study areas include the following (Allen et al., 2021):

- Aquatic Invertebrate Habitat (AIH) –provides habitat for aquatic invertebrates
- Bank and Shoreline Stabilization (BSS) – wetland plants help bind soil to limit or prevent erosion
- Carbon Sequestration (CS) – serves as carbon sinks that trap atmospheric carbon
- Fish Habitat (FH) – habitat for a variety of fish, including a special category containing factors that maintain cold water temperatures for certain species, including trout
- Groundwater Recharge (GR) – sustaining sub-surface water storage and supporting baseflows
- Nutrient Transformation (NT) – breaking down nutrients from natural sources, fertilizers, or other pollutants, essentially treating the runoff
- Other Wildlife Habitat (OWH) – habitat for other wildlife (resident and migratory)
- Sediment and Other Particulate Retention (SR) – acting as filters to physically trap sediment particles before they are carried further downstream
- Streamflow Maintenance (SM) –providing a source of water to prevent streams from drying up during periods of drought conditions or low discharge
- Surface Water Detention (SWD) –storage of runoff from rain events or spring melt waters which reduce the force of peak flood levels downstream
- Unique, Uncommon, or Highly Diverse Wetland Plant Communities
- Waterfowl and Water Bird Habitat (WBIRD) –habitat for waterfowl and other water birds.

3-4. Wetland Classifications for the Five OSD Wetlands

The following is a discussion of NWI mapping for each of the five wetlands. Figures 3-1 through 3-5 display maps of the wetlands derived from the NWI Mapper (NWI Mapper, 2024).

Alameda Wetland is a permanently flooded excavated palustrine wetland pond with an unconsolidated bottom (PUBHx) (Figure 3-1). The shore around the pond and its island is excavated temporarily flooded palustrine scrub-shrub (PSS1A). The HGM classification is Depressional. The functional assessment indicates that this wetland

complex is highly functioning for Aquatic Invertebrate Habitat, Carbon Sequestration, Ground Water Recharge, Nutrient Transformation, Other Wildlife Habitat, and Waterfowl and Water Bird Habitat; and moderately functioning for Fish Habitat, Sediment and Other Particulate Retention, and Surface Water Detention.

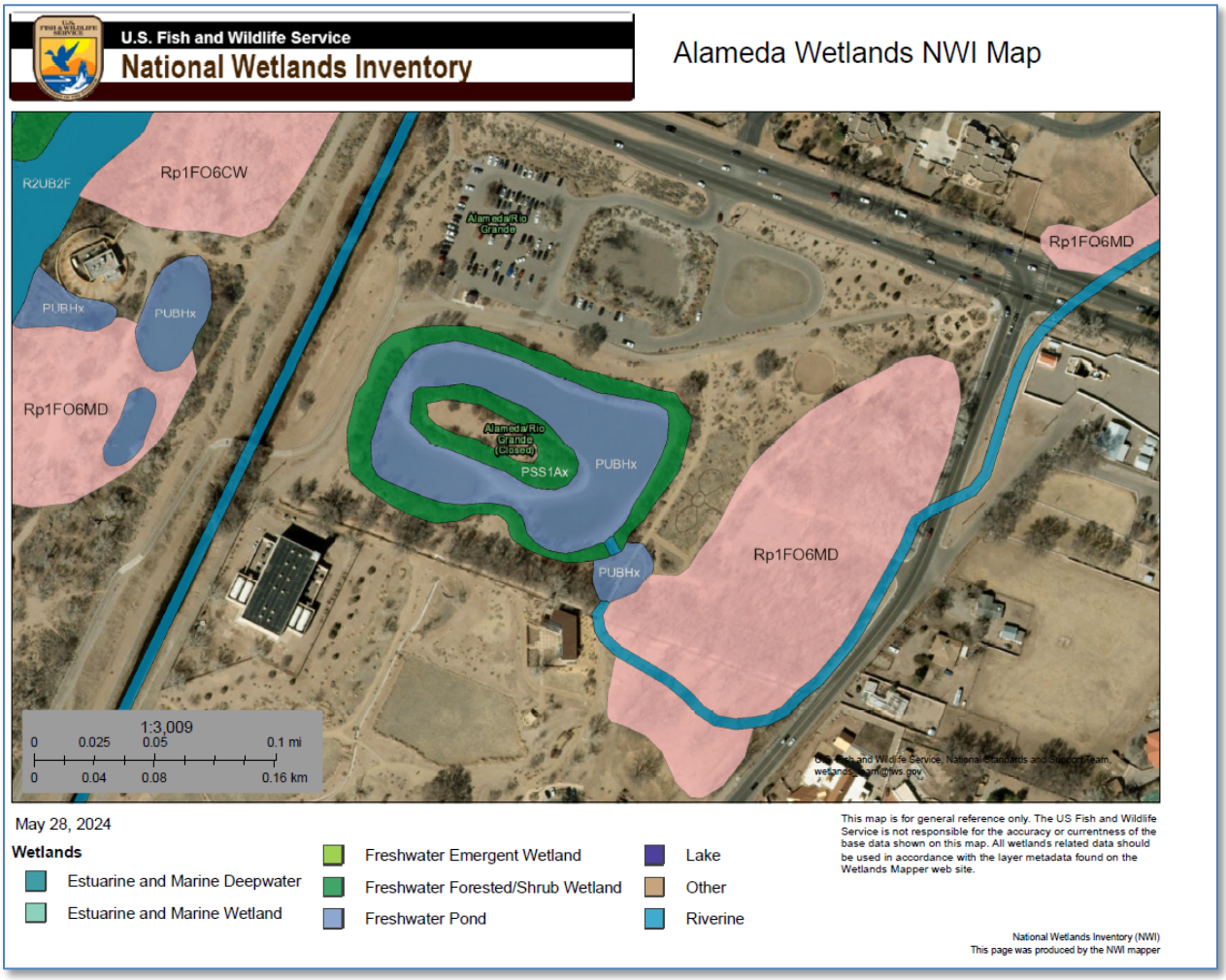


Figure 3-1. Map of Alameda Wetland from the NWI Mapper. The wetland appears as a donut-shaped polygon in light blue and dark green in the center of the map.

OSVC Wetland is an excavated temporarily flooded palustrine wetland pond with unconsolidated shoreline (PUSAx) (Figure 3-2). The HGM classification is Depressional. The functional assessment indicates that this wetland is highly functioning for Ground Water Recharge and moderately functioning Sediment and Other Particulate Retention and Surface Water Detention.

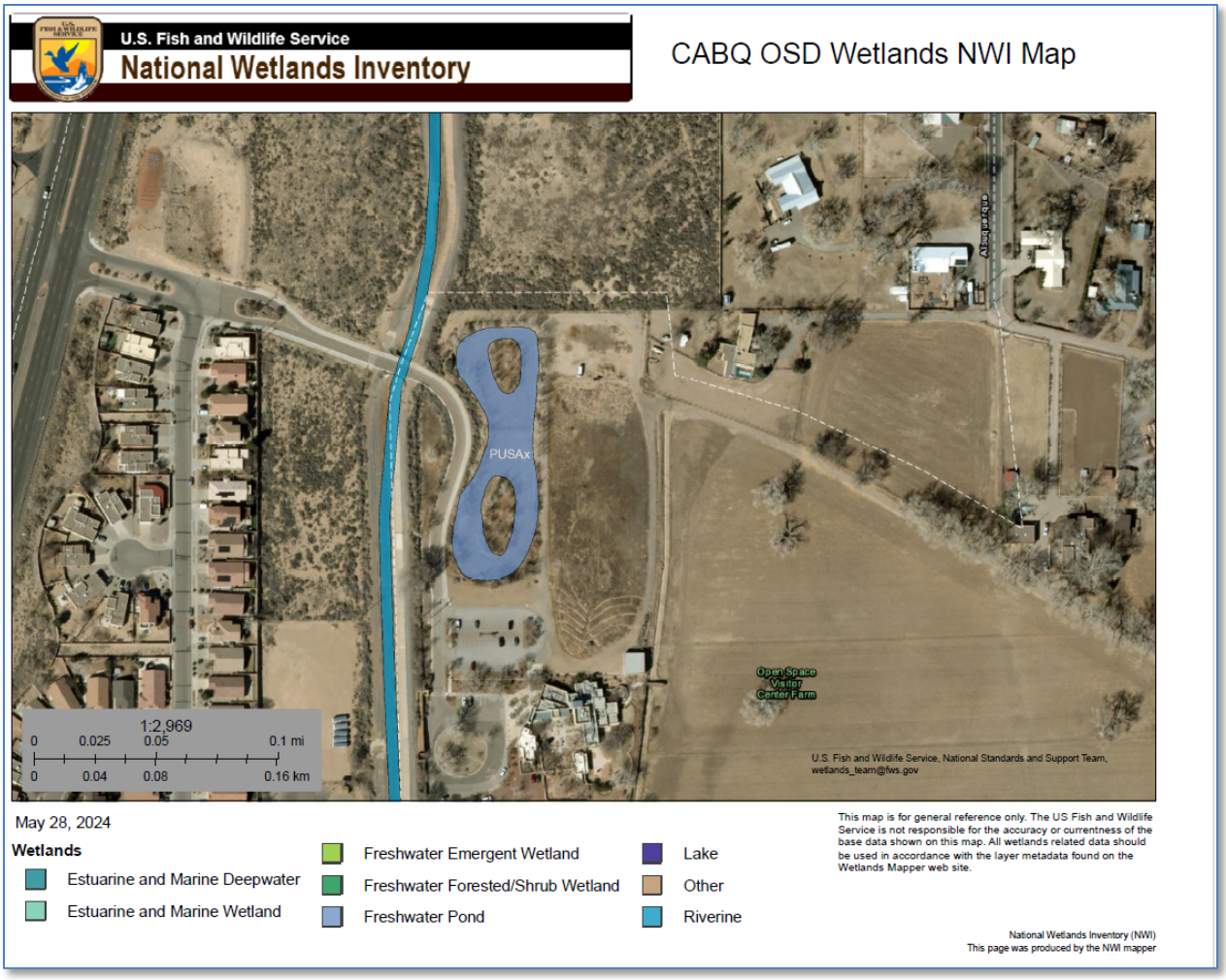


Figure 3-2. Map of OSVC Wetland from the NWI Mapper. OSVC Wetland appears as a light blue figure eight polygon in the center of the map.

San Antonio Oxbow Wetlands are a mosaic of natural and excavated permanently flooded shallow open water palustrine wetland ponds (PUBH), semipermanently flooded palustrine persistent emergent (PEM1F), and temporarily flooded persistent scrub-shrub (PSS1A) ringed by lotic riparian area forested with mixed deciduous trees (Rp1FO6MD) (Figure 3-3). The classification should also include a b modifier indicating the presence of beaver. The HGM classification is Riverine. The functional assessment indicates that this wetland complex is highly functioning for Aquatic Invertebrate Habitat, Bank and Shoreline Stabilization, Carbon Sequestration, Ground Water Recharge, Nutrient Transformation, Other Wildlife Habitat, Sediment and Other Particulate Retention, Streamflow Maintenance, Surface Water Detention, and Waterfowl and Water Bird Habitat.

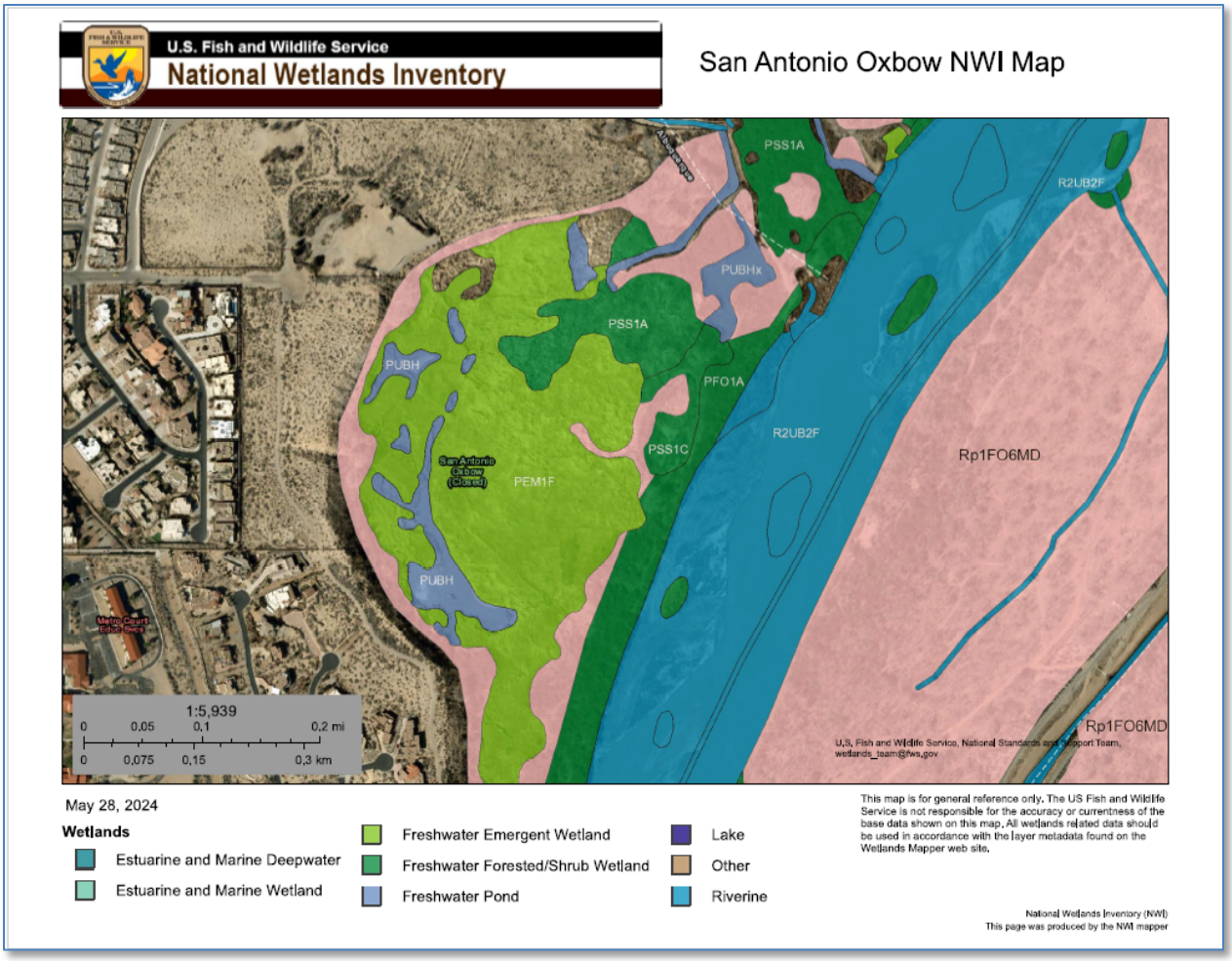


Figure 3-3. Map of San Antonio Oxbow from the NWI Mapper. San Antonio Oxbow is shown as light green and dark green polygons surrounded by pink, in the center of the map.

Candelaria Nature Preserve Wetlands include the Rio Grande Nature Preserve wetlands which are coded as artificially flooded palustrine persistent wetland ponds with unconsolidated bottoms (PUBKx), artificially flooded palustrine persistent scrub shrub (PSS1Kx) and artificially flooded palustrine persistent emergent (PEM1Kx) (Figure 3-4). The functional assessment indicates that these wetlands are highly functioning for Ground Water Recharge and Waterfowl and Water Bird Habitat, and moderately functioning for Bank and Shoreline Stabilization, Other Wildlife Habitat, Sediment and Other Particulate Retention, and Surface Water Detention.

When constructed, the Candelaria Nature Preserve Wetlands are likely to be temporarily or seasonally flooded palustrine persistent emergent wetlands (PEM1Kx).

The HGM classification will be Depressional and wetland functions will be similar to the existing wetlands at Rio Grande Nature Center State Park.

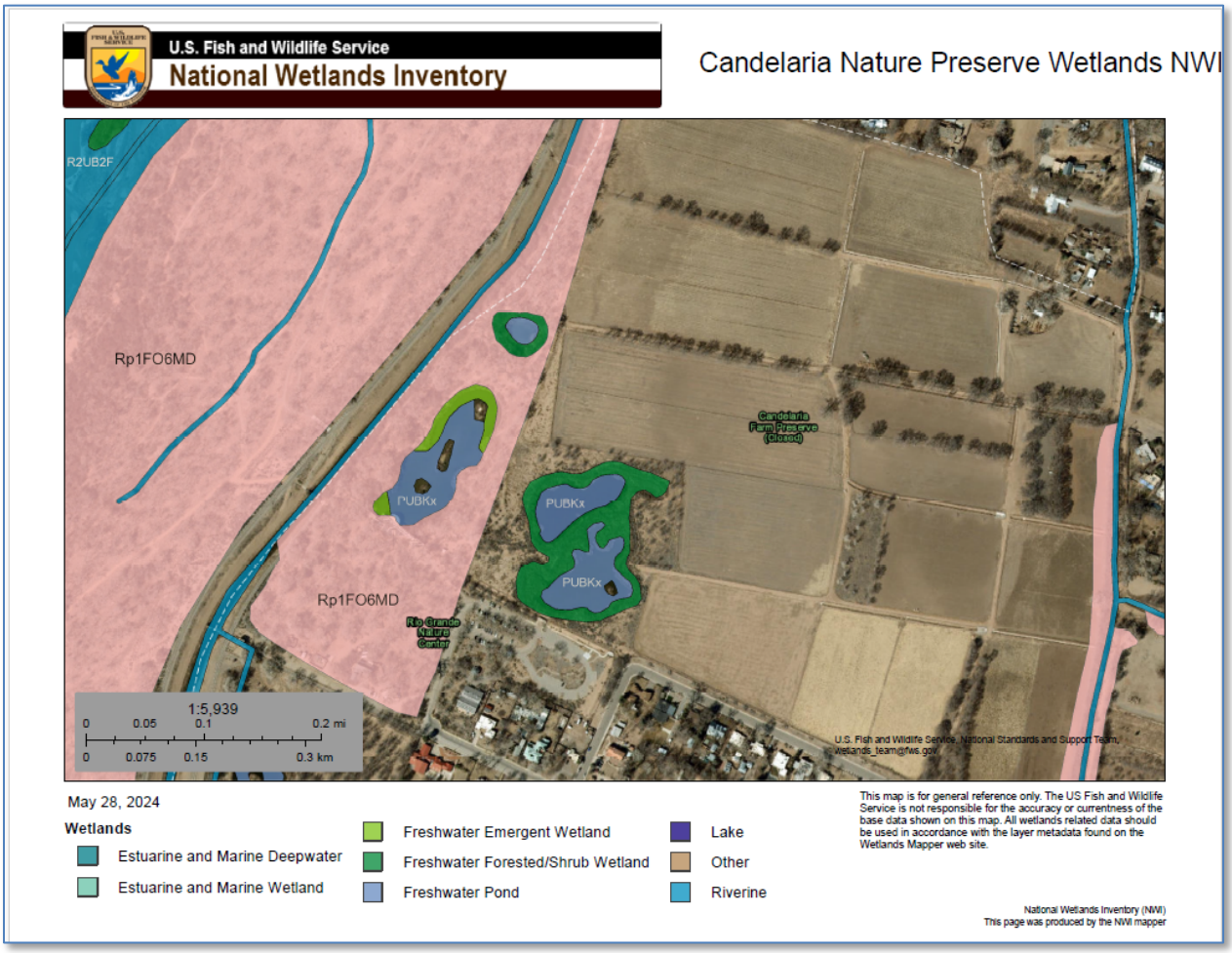


Figure 3-4. Map of Rio Grande Nature Center Wetlands and future site of Candelaria Nature Preserve Wetlands from NWI Mapper.

Tingley Wetlands (Shallow and Deep marshes) are excavated permanently flooded palustrine wetland ponds with unconsolidated bottoms (PUBHx) (Figure 3-5). The Wet Meadow is not mapped because it is difficult to distinguish from the surrounding bosque. If mapped, it would likely be coded as semipermanently flooded palustrine persistent emergent (PEMIF). The HGM classification is Depressional. The functional assessment indicates that this wetland complex is highly functioning for Aquatic Invertebrate Habitat, Carbon Sequestration Ground Water Recharge, Nutrient Transformation, Other Wildlife Habitat and Waterfowl and Water Bird Habitat; and moderately functioning for Fish Habitat, Sediment and Other Particulate Retention and Surface Water Detention.

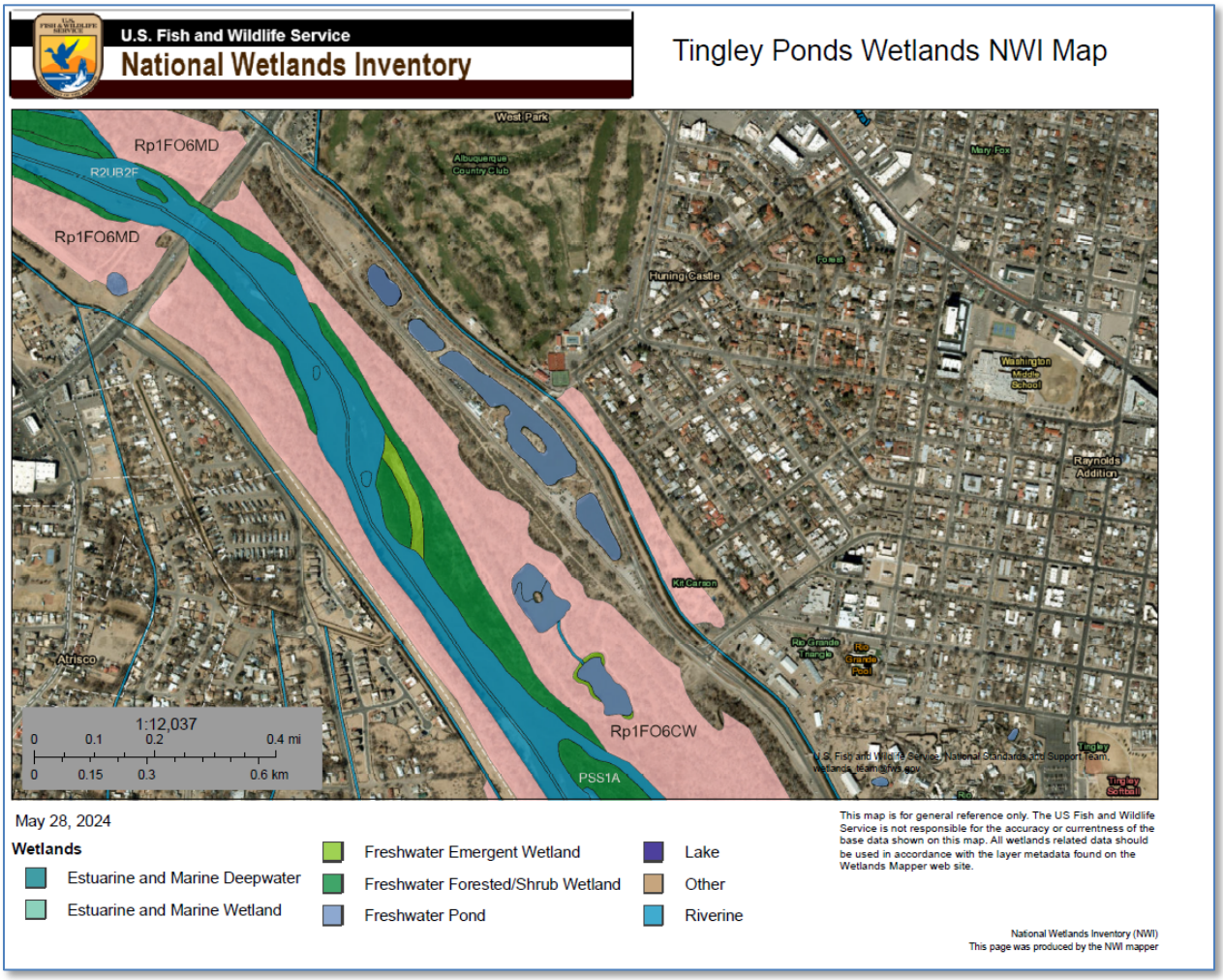


Figure 3-5. Map of Tingley Wetlands from the NWI Mapper. The wetlands appear as medium blue polygons in the center of the map.

3-5. Data Availability and Information Gaps

Table 3-1. Data and Gaps

Location	Manage-ment Plan	Water Rights	Water Use	Bird Surveys	Vegetation	Depth to Ground Water	Other Data
Alameda	None. Information on pond design is limited to a slide presentation.	Water rights agreement with MRGCD for surface water from the Lane Lateral	No data	Bird Alliance of Central New Mexico conducts bird surveys	No document provided about original planting or ongoing plant surveys	No data	Bosque School research: turtles
OSVC	None	No dedicated water rights	No data	No data	Open Space Visitors' Center Perennial Marsh Plan (Martinez, 2010) lists original plantings only. No ongoing plant surveys.	No data	None
San Antonio Oxbow	San Antonio Oxbow Biological Management Plan (OSD, 1997)	Corrales Drain	No data	Southwest Willow Flycatcher surveys	No ongoing plant surveys	No data	Bosque School research: beaver, bobcats, raccoons, porcupines, rodents, bats, rabbits, skunks, coyotes, javelina

Location	Manage-ment Plan	Water Rights	Water Use	Bird Surveys	Vegetation	Depth to Ground Water	Other Data
Candelaria	Candelaria Nature Preserve Resource Management Plan (OSD, 2021)	Ground water rights for existing wetlands. No water rights for the proposed wetlands	N/A for unconstructed wetlands	Friends of Rio Grande Nature Center conduct bird surveys	No vegetation surveys of RGNC State Park wetlands. Plant lists for the unconstructed wetlands are in the CNP management plan.	Depth inferred from intersection with ground water in the North Pond. Unknown in proposed wetland area.	Bosque School research: turtles in RG Nature Center ponds, bats Water quality monitoring by RGNC State Park
Tingley	Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) Manual, Albuquerque Biological Park, Tingley Pond and Wetland Restoration Project (USACE, 2006)	Ground water rights.	Estimated based on pumping rate and time.	Bird Alliance of Central New Mexico conducts bird surveys	2011 wetland delineation	Ground water depth in marsh area measured (LeJeune, 2011)	Bosque Ecosystem Monitoring Program (BEMP) east of the shallow marsh Water quality data for DO, temperature in the ponds, water levels in the marshes 2011 wetland delineation Bosque School research: beaver, turtles

4. Wetland Threats, Impairments and Opportunities

The five OSD wetlands are managed by humans rather than natural processes, so threats and impairments to the wetlands arise primarily from human impacts. Below is a general description of the issues facing the sustainability of healthy wetlands, followed by specific threats and impairments for each of the five wetlands, and well as opportunities to create improvements. Protection, management, restoration measures, stakeholder engagement and outreach for each of the wetlands will follow later in the WAP.

4-1. Drought and Water Availability

Water scarcity is resulting in the need for stronger, clearer water rights declarations for the wetlands. Historic informal or expired agreements need to be assessed, clarified and formalized. However, even where there are clear legal water rights permits attached to appropriate diversion points, there may not be enough water available each year to keep ponds full of good quality water. After formalizing current water rights declarations, additional senior water rights may need to be obtained for the wetlands. Senior water rights have a higher priority to use water than junior rights, so obtaining senior water rights would make water more likely to be available in drier years.

Systematic measurements of the amounts of water used in the wetlands are not conducted except in accordance with the operations plan for pumping, and ongoing water level sensors in the Deep and Shallow marshes at Tingley (US ACE, 2006). Without data on the amount of water used, it is difficult to address any kind of water conservation actions.

4-2. Non-native Plants

Non-native plants that occur on the wetland properties include Russian olive (*Elaeagnus angustifolia*), Salt cedar (*Tamarisk*), Siberian elm (*Ulmus pumila*), White mulberry (*Morus alba*), Tree of Heaven (*Ailanthus altissima*), Ravenna grass (*Saccharum ravennae*), Whitetop (Lepidium draba) Sweet clover (*Melilotus alba*) and Johnson grass (*Sorghum halapense*). These species are considered invasive, nuisance species or weeds because they crowd out native species. Figure 4-2 shows an example at OSVC.

The 2016 City of Albuquerque Bosque Management Plant: Central Avenue to Campbell Road includes guidance on removal of several invasive species found in the Bosque and variously on the five OSD wetland properties (GeoSystems Analysis, Inc., 2016). These best management practices merit repeating in this WAP because of the need for ongoing non-native vegetation management at each of the wetlands (Table 4-1).

Table 4-1. Non-Native Species Treatment Recommendations (from GeoSystems Analysis, Inc., 2016)

Target Exotic Plant Species	Recommended Treatment Specifications
Ravenna Grass	Option 1 (preferred): Hand excavate all live plants. Option 2: using a backpack sprayer, apply a 2% solution of imazapyr mixed with 5% solution of glyphosate plus nonionic surfactant per label instructions (typically 0.5) and a blue dye. Herbicide should be applied on all live leaf tissue, if possible. All herbicides should be approved for aquatic use. Bag and remove all live seed regardless of whether shovel removal or herbicide application occurs.
Kochia	Regularly monitor the site for seedling germination during peak germination seasons (March through May and August through September). Option 1 (preferred): Using hand tools (e.g. hoop hoes, shovels, and/or hoes) or via manual pulling, remove seedlings before they reach 6 inches tall, if possible. Live root tissue should also be removed as the seedling is pulled. Option 2: If large scale seedling emergence occurs before or after the April 15 - August 15 MBTA non-treatment window or if plants have not reached full maturity before August 15, mow live plants before plants mature and set seed. While mowing, cut plants as low to the ground as possible. Option 3: apply a foliar herbicide application of various herbicides (glyphosate, imazapyr, or triclopyr) using lowest mixing concentration recommended for foliar, backpack sprayer application per the manufacturer's label.
Tumbleweed	Regularly monitor the site for seedling germination during peak germination seasons (March through September). Option 1 (preferred): Using hand tools (e.g. hoop hoes, shovels, and/or hoes) or via manual pulling, remove seedlings before they reach 6 inches tall, if possible. Live root tissue should also be removed as the seedling is pulled. Option 2: If large scale seedling emergence occurs before or after the April 15 - August 15 MBTA nontreatment window or if plants have not reached full maturity before August 15, mow live plants before plants mature and set seed. While mowing cut plants as low to the ground as possible. Option 3: apply a foliar herbicide application of various herbicides (glyphosate, imazapyr, or triclopyr) using lowest mixing concentration recommended for foliar, backpack sprayer application per the manufacturer's label.

Tree of Heaven	A two- phased herbicide treatment approach is recommended for tree of heaven. First, an initial hack-and squirt treatment with triclopyr (50% solution) should be applied to all live stems. Hatchet frills should be cut at a downward angle at a depth that only penetrates the bark into live cambium tissue immediately below the bark layer. On very small diameter stems where the hatchet will slice all the way through the stem, a knife can be used to peel away bark. The hack-and-squirt incisions should be spaced evenly about 1 inch apart around the entire circumference of the stem. The initial hack-and-squirt treatment will trigger dieback to ground level and resprouting from below ground. The second herbicide application phase then occurs during subsequent growing seasons. Apply a foliar treatment of imazapyr at 2% concentration plus surfactant to all resprouted stems. The foliar application should be reapplied during subsequent years until no live shoots occur (typically 2-3 growing seasons after the initial treatment). A basal bark application with an ester triclopyr formulation (e.g. Garlon 4) can be substituted for the hack-and squirt treatment, if desired. Blue dye should be mixed with herbicide to ensure full coverage during application.

Siberian Elm	Trees larger than 10 inches basal diameter should be treated using a girdle technique. Girdling can be completed with a hatchet, handsaw, or chainsaw but chainsaw is typically the preferred method. Regardless of the tool used, at a convenient height, cut a perpendicular groove around the entire circumference of the tree that is approximately 2 inches deep. At that same depth, cut another groove approximately 6-10 inches above or below the first groove, depending on the size of the tree. Then remove only the bark and outer cambium tissue between the two grooves by cutting, frilling, or peeling the outside 0.5 to 1.5 inch of the tissue off the tree. Immediately apply a triclopyr formulation (at 25% concentration) to the freshly exposed tissue. A cut stump treatment is recommended for trees with a basal diameter of 1 to 10 inches. Cut stump treatment involves cutting stems as low to the ground as possible and chipping the material, typically onsite. After the cut is made, immediately (within 5 minutes) apply triclopyr at 25% concentration to the cut stump. In non-wetland areas, stems less than one inch at base can be treated using a basal bark application of an ester-type triclopyr formulation (e.g. Garlon 4) mixed at 25% triclopyr concentration with an oil. Only Garlon 3A (or similar aquatic approved, water soluble triclopyr product) should be used in locations requiring an aquatic use approved herbicide, thus, cut stump treatment is recommended in wetland areas, regardless of stem size. If chipping onsite, wood chip depth should not exceed 2 inches. Surfactant and/or adjuvant are also recommended per manufacturer recommendations for the particular application technique utilized. All herbicides should be mixed with blue dye. Note that this treatment specification can also be used on most exotic phreatophytes found in the bosque (e.g. Russian olive, Salt cedar, mulberry, etc.) but different techniques are recommended for Tree of Heaven, as described for that species. Girdling is not recommended for Salt cedar or Russian olive.
White top	Using a backpack sprayer, apply imazapyr based herbicide at 2% concentration during the rosette to flowerbud stage. Mix herbicide with non-ionic surfactant per manufacturer label instructions and blue dye.

Figure 4-2. Large Siberian elm near OSVC Wetland that spreads seeds in the wetland and has damaged the irrigation ditch. Photo by Peter Callen.

4-3. Beaver Activity

Beavers were present historically along the Middle Rio Grande as indicated by historic accounts of travelers through the region (Scurlock, 1998). Beaver trapping was a historic economic activity that decimated beaver populations in New Mexico by the mid-1800s. Currently in San Antonio Oxbow there is a thriving beaver population and there is evidence of beaver at Tingley Wetlands, Alameda and Candelaria. Beaver are valued for their ecological contributions at these sites, such as providing habitat for diverse terrestrial, avian and aquatic species. However, in these managed wetland systems beavers create challenges with regard to moving water between wetland units. Therefore there is a need to implement beaver//human coexistence strategies such as flow management devices (Figure 4-3) and in some cases strategic wiring or painting tree trunks with a mixture of latex paint and masonry sand to prevent vulnerable trees from being felled.

Figure 4-3. A pond leveler at San Antonio Oxbow that is helping to prevent beavers from damming an inflow channel. Photo shows the cage around the pond leveler pipe inlet.

4-4. Water Quality

Water quality issues in the five OSD wetlands are generally related to stagnation of ponded water. Water availability and delivery is an issue for all of the sites and there is not sufficient water to keep fresh water moving through the systems. Stagnation is a potential problem at Alameda Wetlands, Tingley Wetlands, and OSVC Wetland. In addition, sedimentation is an issue at San Antonio Oxbow due to erosion off the adjacent bluff.

Tingley has an ongoing monitoring program for DO and temperature in the ponds, and has treatment systems using ozone and aeration. However, water quality in the Deep and Shallow marshes is not monitored Figure 4-4 shows murky water in the Shallow Marsh at Tingley.

Monitoring of the Tingley Ponds is conducted because the ponds are stocked monthly with Rainbow trout for recreational fishing and human consumption.

The Children's, Central, and Catch and Release Ponds are tested monthly for pH, temperature, NH_3 -N, NO_2 -N, and NO_3 -N. There are specific limits set for each of the nitrogen tests, all units for measurements and limits are (milligrams/Liter) or PPM (Parts Per Million). The upper limit for NH3 -N is 0.01 mg/L. The upper limit for NO2 -N is 0.500 mg/L. The upper limit for NO3 -N is 40.0 mg/L. As Tingley is not temperature controlled and is at the mercy of the elements, there is no temperature standard applied. The approach is much the same for the pH as the goal is to behave as though it is a natural system. The preferred pH range is 7.4 and 7.8; but with Albuquerque having hard water even coming from the wells, typically the pH of the freshwater is between 8.0-8.6. Water quality in the Tingley Ponds tends to remain within the desirable ranges and does not vary much. Organisms living in the water seem to be acclimated to the water quality (M. Montoya, pers. comm. 2024).

Figure 4-4. Water in the Tingley marshes and other open water CABQ – OSD ponds appears murky and stagnant.

The ponds at Rio Grande Nature Center State Park are also monitored. The Friend of Rio Grande Nature Center Water Quality Team collects and tests the water from 7 different sites around the park and open space (North and South Cell of the wetlands, North Pond, Visitor Center Pond, River, Drain and Discovery Pond).

They monitor the following parameters at each site: Alkalinity, Hardness, CO2, Dissolved Oxygen, pH, Turbidity, Air Temp., H2O Temp.,and Ammonia-Nitrogen (only from lined ponds).

The other three wetlands (Alameda, OSVC and San Antonio Oxbow) do not have any water quality monitoring programs.

4-5. Wildfire

Wildfire is an ever-present threat to the Albuquerque bosque. In 2023, Albuquerque Fire and Rescue responded to 235 fire incidents in the bosque from both natural and human ignitions sources (CABQ, 2024). Risks are exacerbated by overload of fuels from the proliferation of non-native vegetation. Fire has the potential to decimate wildlife habitat around the wetlands. Vegetation would likely need to be re-planted in the event of fire at the OSD wetlands. The 2005 Bosque Landscape Alteration Strategy created a vision for reducing wildfire frequency and intensity in the bosque by reestablishing an ecosystem similar to what occurred historically (Najmi et al., 2005). The vision focused on reorganizing the landscape to retain historical bosque processes and wildlife communities, recreating a patchy mosaic of native trees and open spaces, removing populations of non-native species, and thereby reducing wildfires and water depletion. The strategy was formalized in two workshops for natural resources managers (2004 and 2005) at the University of New Mexico School of Law Utton Transboundary Resources Center and for nearly two decades has prevailed as a strategy for managing the bosque for wildfire reduction and ecosystem health. Fire prevention methods have typically involved removing dead trees and brush using heavy equipment, removing jetty jacks for access in the event of wildfire, clearing debris from the forest, and spreading chipped biomass as mulch (NMEMNRD, 2010).

Fire management is integrated into wetland management differently at the five wetlands, but fire prevention is key to the management plan for all sites. The following information was provided through personal communication with Superintendent McRoberts (September 2024). Alameda Wetland’s fire risk can best be mitigated by accomplishing restoration. This site is not as susceptible to wildfire as other OSD wetlands. The OSVC wetland is separated from major sources of wildfire risk. San Antonio Oxbow wetlands are not as accessible for implementing a wildfire response. Wildfire prevention and a wildfire response plan that allows for evaluation of risks in real time and discretion based on species at risk are the current policy. Candelaria wetlands are somewhat contained and separated from wildfire risk. Tingley wetlands likewise are somewhat contained and separated from wildfire risk but active restoration is an important aspect of wildfire prevention.

4-6. Staffing for Wetland Maintenance and Management

According to Superintendent McRoberts (November 2024), current staff time allocated to wetland maintenance and management are estimated as the following percentages of their total staff time:

- Open Space Technician, 20%
- Open Space Biologist, 20%
- Open Space Coordinator, 5%
- Open Space Educator, 2%
- Open Space Park Attendant, 10%
- Open Space Superintendent, 5%.

There is insufficient dedicated staffing assigned to some maintenance and monitoring activities for the wetlands, as reported by staff and partners alike. Specific needs are described in Table 4-2.

4-7. Funding for Wetland Infrastructure

Financial resources dedicated to wetland maintenance and management have been described consistently by staff and partners as insufficient but are difficult to quantify since the wetlands are not managed as a distinct set of the total OSD lands. General funds for the bosque and dedicated funds for Candelaria Nature Preserve are used for wetland maintenance and management activities, but no dedicated funds currently exist for these five important wetlands.

Each of the five wetlands has unmet funding needs around infrastructure, such as irrigation piping and gates, new liners, and construction of new wetlands, as well as trail infrastructure for recreational use. Specific needs are described in Table 4-2.

4-8. Environmental Education

OSD has well-developed environmental education programs that target multiple populations and occur on many of their properties (wetland, bosque, and upland settings). OSD's website (OSD, 2024) offers descriptions of the programming categories:

- Open Space Adult Programs
    - Intro to the Outdoors: Classes for Adults
    - Intermediate Outdoor Adventures: Classes for Adults
    - Beginning Birding Kit: The Public Library catalog, geared for adults
- Open Space Family Programs
    - Discovery Days, youth ages 3-5 and their grown-up
    - Family/Nature Club Hikes, all ages

    - Explorer Backpacks: The Public Library catalog, geared for families
- Open Space Youth Programs
    - Saturday Explorer Camp, ages 6-10
    - School Break Explorer Camp, ages 6-10
    - Summer Explorer Camp, ages 6-10
    - Outdoor Field School, ages 11-14
    - Youth Conservation Program for Teens and Young Adults
    - Eagle Scout Projects
- Open Space School Programs
    - Albuquerque Ecosystems Program for Elementary Schools
    - Conservation Education Program for Middle and High Schools
- Community Events
    - 2024 City Nature Challenge: Community Science in Your Neighborhood and Beyond: Guided Hikes on OSD properties
- Additional Educational Resources
    - OSD's Community Engagement Plan
    - iNaturalist
    - Bosque Education Guide, 621 pages
    - Albuquerque's Environmental Story: Toward a Sustainable Community teacher's resource guide

Because OSD is already involved in extensive active educational programming, this WAP focuses actions on more passive educational infrastructure that can be self-guided or teacher-led. Each of the five wetlands has some existing environmental education infrastructure, but there is potential to add educational components. Figure 4-5 shows an example of an educational sign that is in poor condition and needs replacing, whereas Figure 4-6 shows an example of an educational sign that is in good condition. OSD will create content through its existing environmental education program. Suggested educational topics include information about individual floral and faunal species, information about species assemblages, ecosystem services provided by wetlands, cultural values of wetlands (e.g. medicinal plants or historic uses of the bosque), and methods for wetland protection and restoration.

Figure 4-5. Dilapidated Educational Sign at OSVC Wetlands

Figure 4-6. Educational Sign at Alameda Wetland that is in good condition and has engaging messaging.

4-9. Issues Specific to Each of the Five Wetlands

During the stakeholder meetings and wetland field trips for this WAP there were discussions about threats and impairments, and there were also ideas presented about ways to add ecological or social value to the wetlands. These concepts are embodied in the following table about threats, impairments, and opportunities.

Table 4-1. Threats, Impairments and Opportunities for the Five OSD Wetlands

Location	Threat/ Impairment/ Opportunity	Explanation
Alameda		
1.	Water Availability	Water rights were leased in 1998 from MRGCD. The lack of confirmed water lease and the fact that it is a junior lease is a problem.
2.	Drying	The wetlands dry significantly during the non-irrigation season and cannot be filled often enough to offset evapotranspiration losses. This leads to public complaints due to the presence of dead fish and other animals.
3.	Stagnation	Water does not flow through the wetland so the water sits and stagnates. The wetland also has water circulation issues stemming from the creation of the small pond on the east side. Water is conveyed through the turnout from the lateral into the small pond and then upslope into the primary wetland. This creates stagnant water and an inefficient means of water conveyance.
4.	Non-native vegetation	There is no ongoing non-native plant removal at Alameda, but there was in the past when Youth Conservation Corps crew cut Russian elms. Decadent willows on the pond perimeter might be a fire hazard that could be mitigated with strategic cutting.
5.	City Staffing	There are no full-time City Staff solely dedicated to management of this wetland.
6.	Management Plan	The wetland has no maintenance and management plan.

7.	Pond Liner Degradation	The synthetic pond liner is degraded and may be leaking. If so, the wetland is losing water to infiltration.
8.	Environmental Education	There are opportunities to improve user engagement and understanding about the ecological value of wetlands. There are signs at the wildlife blinds about wetland importance, ecology, flora and fauna, but the signs do not extend to the Alameda side of the wetland.
OSVC		
1.	Water Availability	The wetland has undeclared water rights.
2.	Drying	The wetland dries significantly during the non-irrigation season.
3.	Management Plan	The wetland has no maintenance and management plan, only the initial design plan.
4.	Water Infrastructure	Currently the intake from the MRGCD ditch is undersized with an 8 ft. length of 12" diameter culvert.
5.	Habitat Management	In the absence of physical management, cattails fill the wetland, crowding out other species.
6.	City Staffing	This wetland has no city staff assigned to daily management and no formal agreement for a contractor to manage the wetland.
7.	Water Metering	Water metering is imprecise. The only way to measure the amount of water irrigating the wetland is record the time that water is flowing through the gate.
8.	Non-native vegetation	There is no ongoing non-native vegetation removal effort. Russian olive, Siberian elm, and Johnson grass encroachment is an ongoing issue. There is a large Siberian elm on MRGCD property over the fence line that spreads seeds all over the wetland and has damaged the irrigation culvert.
9.	Recreation	There is opportunity to improve recreational access by continuing the foot path around the wetland.
10.	Education	There is opportunity for environmental education through additional signage about aspects of the wetland.
11.	Data	Data are lacking for this wetland regarding the soil liner, water quality, vegetation and birds.

San Antonio Oxbow		
1.	Beaver Activity	Beavers are both opportunities and threats. Beavers provide ponded shallow water that creates habitat for some other species but they also block the flow of water and facilitate a cattail plant monoculture that limits habitat diversity.
2.	Diversity of Habitat	This wetland is on a trajectory to become a choked-out cattail forest which is only good for a few species, not diverse. Some of the cattails are dead or dying. There could be more habitat types. The key to diversity is to mimic natural disturbance. More disturbance by wetting and drying would allow for diversity of habitats and wildlife food supplies.
3.	Pollutants	Erosion occurs off the mesa, causing sedimentation; potential water pollutants come from San Antonio AMAFCA Arroyo and the Corrales Drain.
4.	Research	Continued biological research from Bosque School will help gain additional knowledge about species and habitats and support actions to increase biodiversity.
5.	Advisory Committee	Despite being identified in the original management plan, an advisory committee has yet to be created.
6.	Recreation	A design plan is being developed for the adjacent Poole property with visitor and interpretive engagement elements. This property was recently acquired by OSD.
7.	Non-native vegetation	Russian olive, Tamarisk, Phragmites and Ravenna Grass are invasive species at San Antonio Oxbow.
8.	Flow Management	The marsh dried up in 2022 and it will likely dry again.
Candelaria		
1.	Funding for Infrastructure	The Candelaria Nature Preserve Management Plan calls for wetlands but there is no funding to construct the wetlands.

2.	Water Availability	Water rights for Candelaria Nature Preserve are owned by MRGDC and delivered by the acequia system. Additional water rights will need to be obtained to construct the planned wetlands, but even additional water rights do not guarantee that water will be available.
3.	Site Specific Issues	The proposed wetlands are located in an area where the soil is sandy rather than a more clay soil needed to retain water.
Tingley		
1.	Beaver Activity	Beavers are active between the deep and shallow marshes. They dam the channel, inhibiting flow to the Shallow marsh and thence to the Wet Meadow.
2.	Non-native vegetation	Non-native plants in the area include Siberian elm, Russian olive, Salt cedar, and Ravenna grass.
3.	Flow management	Managing flows could improve water quality in the shallow and deep marshes and habitat in the wet meadow.
4.	Research/Data	a. The last delineation of the Wet Meadow was in 2011. b. There is water quality monitoring occurring in the Tingley Ponds but not in the marshes. c. There are no surveys of fauna such as fish, bats or birds.
5.	Recreational trampling	The west side of the marshes receives a lot of foot and bike traffic that is damaging to vegetation and habitat. There is limited natural regeneration of sandbar habitats or new habitats.
6.	Expand adjacent wetland habitats	Adjacent habitats are static, but water availability exists for increasing dynamic processes and wetland conditions to support additional habitat.
7.	Education	There is an opportunity for educational signage for environmental education, as well as art in public places.

5. Actions to Protect and Restore Wetlands

5-1. Land Stewardship Plans

OSD has several management plans for the wetlands, either historic or more recent. These plans guided the construction and planting of the wetlands, informed that initial operation and maintenance, and in some cases are continuing to direct daily management. In some cases the initial management plans recommended actions that were not implemented or were discontinued and need to be re-initiated.

Alameda Wetland

Alameda Wetland does not have an historic or current management plan. General responsibilities for property use and management are defined in a Memorandum of Understanding between the CABQ and Bernalillo County for Open Space Facility Management and Collaboration (CABQ, 2012).

OSVC Wetland

The OSVC Wetland does not have a management plan. The original design document, Open Space Visitors' Center Perennial Marsh Plan (Martinez, 2010), provides information on the intent and implementation of the wetland project but does not offer guidance on daily operation.

San Antonio Oxbow Wetlands

The San Antonio Oxbow Biological Management Plan documents baseline and existing conditions and describes management goals and policies for maintaining wildlife habitat in the wetlands (OSD, 1997). The plan recommends management strategies related to water supply, native and non-native vegetation, recurrent siltation at the outlet of San Antonio Arroyo, recreation, and environmental research and education. The plan also recommends forming an Oxbow Advisory Committee, a recommendation that has apparently never been implemented.

Tingley Wetlands

The Final Detailed Project Report and Environmental Assessment for Albuquerque Biological Park Wetland Restoration Project (US ACE, 2004) describes the baseline conditions, need and conceptual design of the Tingley wetlands expansion that offered an opportunity to restore the riparian community next to the Rio Grande. Opportunities for restoration included creating sustainable aquatic habitat and native fishery for Tingley Ponds, and the opportunity to use city water to create wetland communities in the riparian area adjacent to the Tingley Ponds. Other riparian restoration opportunities

included jetty jack removal, exotic/invasive species removal, native plant establishment, enhancing hydrology in the bosque, and increasing the educational experience for visitors to the Biological Park area.

The Tingley Ponds Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) Manual (USACE, 2006) provides information about project design and as-built construction, provides schematics for the flow among ponds and wetland units, and recommendations for the operation of the Albuquerque Biological Park Tingley Pond and Wetland Restoration Project, including recommendations for adaptive management. The plan notes that refinement of flow management is needed to optimize wetland meadow saturation.

Candelaria Nature Preserve Wetlands

The Candelaria Nature Preserve Resource Management Plan (2021) (CNPRMP) is a stakeholder-developed document that provides a framework for management as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors. The plan also helps to ensure compliance with the federal Land and Water Conservation Fund (LWCF) regulations and guidelines and the Major Public Open Space Facility Plan.

There were several precursors to the CNPRMP. The 1979 Master Plan for the Rio Grande Nature Center aimed to guide development of the Candelaria Farm site for education, recreation, and beneficial open space qualities (Predock, 1979). The 1983 Rio Grande Nature Center Management Plan described the planned expansion of wetland ponds and planting of native vegetation in wetlands area and visitor center, while planning for corn, clover and sorghum to be planted as waterfowl and wildlife crops in the Candelaria fields (Johnson, 1983).

The Rio Grande Nature Center State Park Management Plan (NMEMNRD, 2010) provided guidance on operations and management, and proposed improvements over a five-year period, including a description of the Park's existing conditions, issues of concern, and recommendations.

Albuquerque Bosque

There have been many project and program management plans developed pertinent to the vast Albuquerque bosque. Key plans relevant to the scope of this WAP are described below.

The Rio Grande Valley State Park Management Plan (OSD, 1987) is a policy document designed to address the public need for recreational use of the bosque. It established

goals related to habitat and resource preservation, recreation, interagency cooperation, education, and visitor protection.

The Bosque Action Plan (CABQ, 1993) is the City's management document for the bosque adopted through Resolution 111-1993. Portions of San Antonio Oxbow and Tingley Wetlands fall under this plan. In 2023, CABQ developed the Bosque Assessment and Update Prioritization (BAUP) based on the BAP (OSD, 2023). The purpose of the BAUP is to assess current conditions and identify desired future conditions of the Bosque; identify priority projects over the next five years; and focus on protecting and enhancing the current ecosystem while supporting sustainable public use and education.

5-2. Wetland Actions Relevant to All Five Wetlands

This section is a general description of wetland actions that are relevant to all five wetlands.

Ecological Disturbance

The concept of dynamic ecological disturbance from the movement of water and sediment was raised several times during stakeholder field trips and meetings. Ecological disturbance occurs in natural riverine and wetland systems from overbank flooding, from scour and deposition of sediments, and from seasonal wetting and drying. With the Middle Rio Grande's history of water management and flood control and irrigation infrastructure, water control projects have eliminated the element of disturbance and cyclic regeneration that fosters diversity of riparian and wetland communities.

The OSD wetlands also lack these natural disturbance cycles because they are manmade, thus the systems tend to be more static. Mechanisms to mimic ecological disturbance are proposed in this WAP, including pulsing flow to simulate a wetting/drying cycle, and physical removal of Cattails. Chemical treatment of Cattails is not advisable because of the potential toxicity of chemicals to other plants and wildlife.

Cattails can be removed mechanically using a Marsh Master® marsh buggy (Figure 5-1). According to the Marsh Master® website, "*The MM-2LX can be outfitted with a front-mounted 3-point hitch and a vegetation blade. This blade is designed to effectively clear cattails and other invasive wetland plants that encroach into ponds, lakes, and drainage areas inaccessible by non-amphibious equipment"* (Marsh Master®, 2024).

Other methods of Cattail control include physical pulling by hand (which is labor intensive but may be feasible for the smaller OSVC wetland), or dewatering the wetland so the cattails die, then mowing or burning dead Cattails. These methods are all

described in OSD 1997 for San Antonio Oxbow but have not been performed on a regular basis.

Figure 5-1. Marsh Master® MM@LX with Vegetation Blade. Photo from Marsh Master®, 2024.

Beaver Coexistence

Beaver Coexistence refers to measures that mitigate infrastructure impacts that can be caused by beavers, such as flooding, tree felling, or clogging waterways, and that allow beavers to remain at locations they have chosen. Beaver coexistence measures such as flow devices, fences and wired trees have been implemented at some of the five OSD wetlands (i.e. pond leveler at San Antonio Oxbow) but not fully explored or constructed at others. Pond levelers are specifically mentioned in the San Antonio Oxbow Biological Management Plan (OSD, 1997) but could be further utilized to manage water levels.

The New Mexico Department of Game and Fish (NMDGF) has guidelines for bridge and culvert construction that describe beaver coexistence structures (NMDGF, 2024). The Beaver Coalition also has guidelines that describe several coexistence structures (Beaver Coalition, 2022) (Figures 5-2 and 5-3). Additionally, programs that could provide financial assistance with beaver coexistence include the Defenders of Wildlife

Beaver Coexistence Incentive Fund (Defenders of Wildlife, 2024) and the Human Beaver Coexistence Fund (Human Beaver Coexistence Fund, 2024).

In a study of 413 beaver conflict sites that were evaluated between 1998 and 2005, flow device success rates were determined to be 97% for culvert devices and 87% for pond levelers. In the same study, beaver trapping was the sole intervention at 69 sites where coexistence measures were infeasible due to topography/logistics, zero tolerance for any water level change, or zero tolerance for beaver. In contrast to the beaver coexistence structures, beaver trapping had an 84% failure rate due to the sites being recolonized with beaver within two years (Simon, 2006). If beaver removal is considered in order to temporarily manage water levels or habitat conditions at one of the wetlands, OSD could work with NMDFG and beaver-related non-profit organizations to ensure that the trapped beaver are transported to an approved site for beneficial beaver reintroduction.

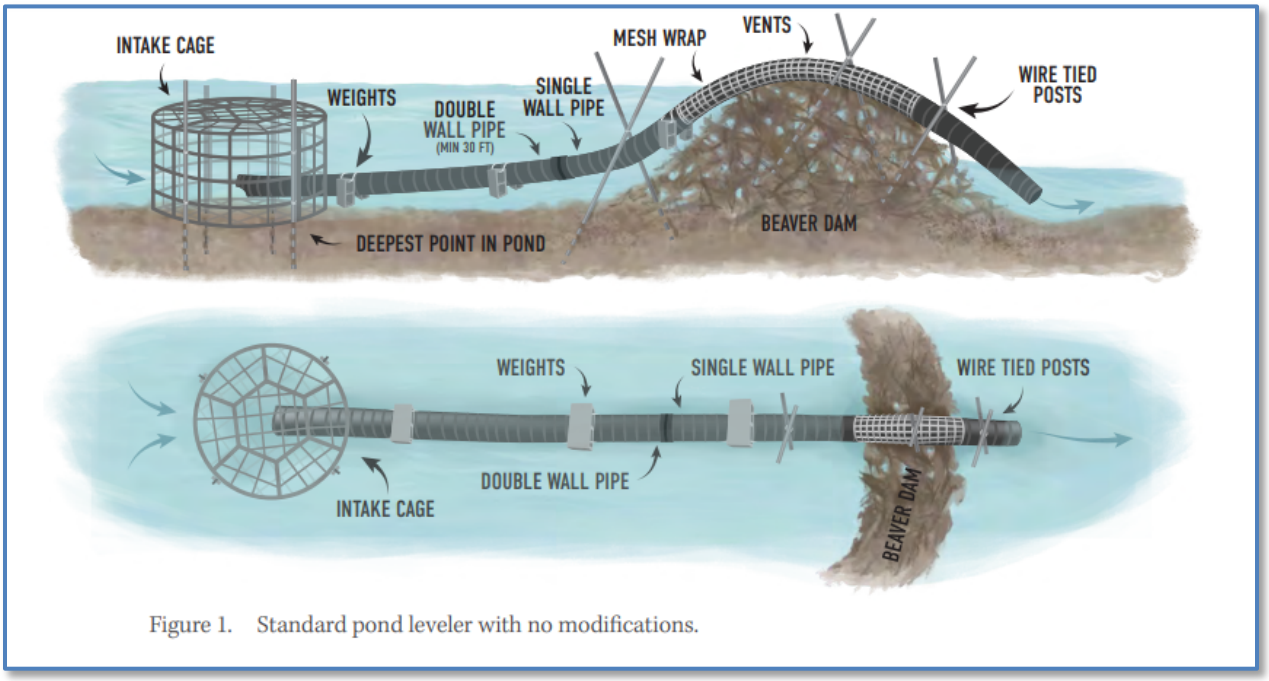


Figure 5-2. Schematic Diagram of a Pond Leveler, a type of flow device (Beaver Coalition, 2022).

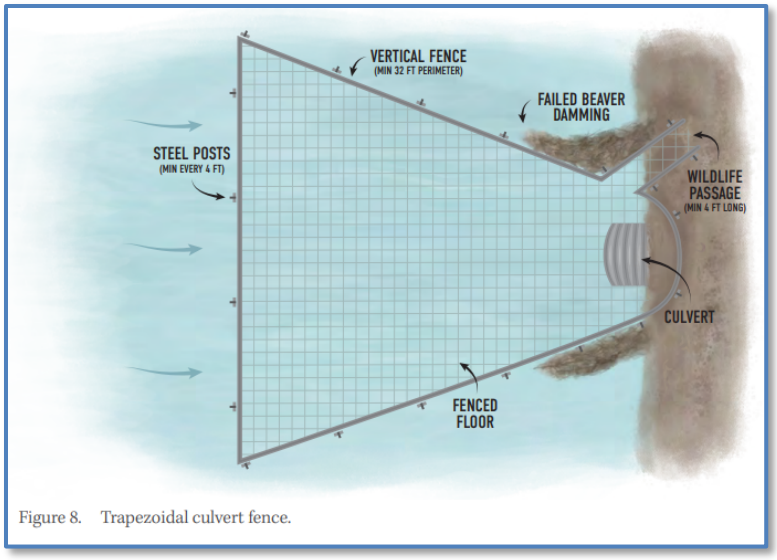


Figure 5-3. Schematic Diagram of a Trapezoidal Culvert Fence (Beaver Coalition, 2022).

Flow Measurements

There is uncertainty about pond capacity and the volume of water in each of the wetlands at any given time. Staff gauge plates could be placed in each of the wetlands for periodic measurements that would provide more information about water uses and needs. A staff gauge is long ruler oriented vertically and installed permanently on a post for repeat observations. Staff gauges are typically made of steel with easy-to-read porcelain enamel or fiberglass numbers. Depth-capacity curves (also called pond curves) would then need to be developed to establish the relationship between the pond depth measured by staff gauge and the volume of water in the pond at that depth. USACE (2024) offers instructions on how to install a staff gauge. University of California (2020) provides instructions and an online calculator to create a depth-capacity curve (Figure 5-5). The curve is developed by measuring water depth and surface area of the pond at that depth for at least three different fill levels. This method could work well for Alameda, OSVC and Tingley wetlands which have controls on filling through culverts or pipes and have easily measured rectangular dimensions. However, it would be more difficult for San Antonio Oxbow that has an irregular shape, multiple ponds due to beaver dams, and poorer control over filling.

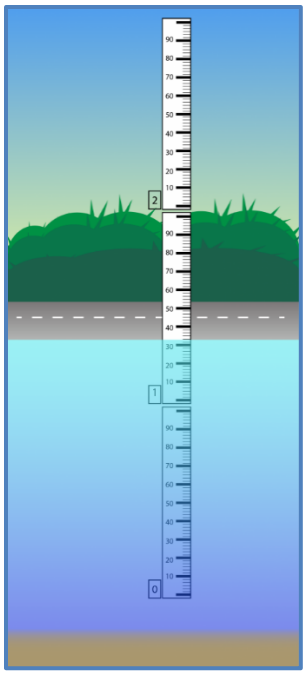


Figure 5-4. Schematic diagram of a staff gauge for measuring pond depth, from ESS Earth Sciences, 2021.

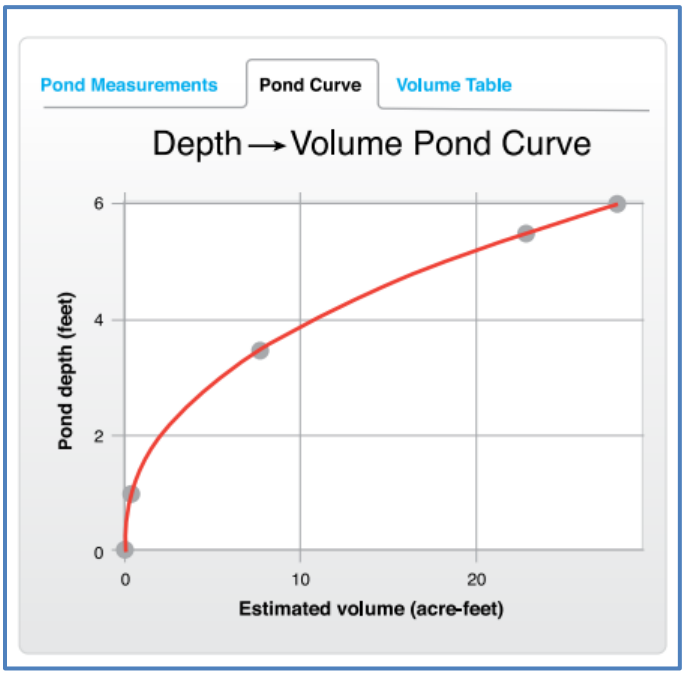


Figure 5-5. Conceptual Depth Capacity Curve for a Pond showing relationship between pond depth and volume, from University of California, 2020.

Water Quality Monitoring Program

OSD could develop a water quality monitoring program for the wetland ponds at Tingley (Deep and Shallow marshes), Alameda, and OSVC. The initial goal of the program would be to gather baseline water quality data. The secondary goal would be to establish target ranges for water quality and action steps to take if data show that parameters do not meet the targets. Data could be collected quarterly (seasonally) using in situ meters that transmit the data electronically and do not require manual collection. OSD would need to establish a database to store the data.

Since New Mexico does not have quantitative water quality standards for wetland ponds, it will be necessary to look to other state or local monitoring programs for parameters applicable to ponds. New Mexico State University (2019) and Pennsylvania State University (2022) offer some useful information about understanding water quality parameters for pond management that can be used as the basis for a developing water quality monitoring program:

1. Dissolved oxygen (DO) concentration will strongly influence the ability of a pond to support fish and other aquatic organisms that require oxygen. Low DO can result in fish kills and problems with water clarity and odors.
2. Temperature of the pond affects what fish can survive in the water and it affects how much DO is in the water.
3. Nutrients in the forms of nitrate (NO3) and Phosphorus (PO3) affect aquatic plants and algal blooms. In excess, nutrients can cause eutrophication, which can increase algae and aquatic plants to the extent that they deplete oxygen when they die and decompose.
4. Ammonia in the forms of un-ionized ammonia (NH_3) and ionized ammonia, also known as ammonium ion (NH_4^+). High levels of ammonia can cause fish kills.
5. At very high or low levels of pH can cause fish kills. Generally, a range of 6-9 pH is considered healthy in pond water.
6. Alkalinity, which is the water's buffering capacity against changes in pH.
7. E Coli., which is an indicator of sewage or animal waste contamination in water. Although none of the ponds is designated for human drinking water nor recreation, they do serve as water for various wildlife.

5-3. Wetland Actions by Wetland Property

Table 5-1 offers a summary of specific actions that complement prior actions and are consistent with OSD objectives for management of the wetlands. Actions were prioritized with OSD staff and ranked as high, medium and low ranking. Low (L) ranking indicates this action is being addressed by another program or action plan but is related to wetland management planning. High (H) ranking means the action is related to the

function of the habitat itself or is an action that can be taken now to improve management or ecological function. The difference between a medium (M) or high ranking is a matter of urgency or the degree of control that OSD has to take the action.

Table 5-1. Protection/Restoration Actions for the Five OSD Wetlands

Location	Addresses Threat/ Impairment/ Opportunity	Protection/Restoration Action Description	Priority H=High M=Medium L=Low
Alameda			
1.	Water Availability	Investigation and clarify water rights leasing agreements.	H
2.	Drying	Revisit ground water rights and drilling a well. Update and add irrigation gates. Increase coordination with Bernalillo County staff.	H
3.	Stagnation	Implement periodic flushing flows to freshen the water in the pond. Flush to agricultural lands or the depression south of the wetlands and the ditch into the grasslands. Alternatively, install aeration or circulation pumps for water treatment. Add flow features at the bottom of or inflow/outflow structures to aid in water movement and water quality.	M
4.	Non-native vegetation	Partner with volunteer groups or youth conservation crews to assure annual removal of non-native vegetation using best management practices.. Develop and approve an integrated vegetation management plan. NMDOT has an integrated vegetation management plan that may be a good model.	H

5.	City Staffing	Incorporate management of wetlands into management routines. Review existing job descriptions to determine if management of Alameda is already part of a staff job. Alternatively, designate a staff person to manage the wetlands or seek services under contract or with a volunteer group. (Bosque Technician and Open Space Biologist positions may be options).	M
6.	Management Plan	Develop a management and seasonal maintenance plan and assign to City Staff (which may address the previous five items).	H
7.	Pond Liner Degradation	Commission a pond liner inspection, evaluation and recommendations. Based on the results, either replace the pond liner or convert the wetlands to a more ephemeral water regime that embraces a wet/dry cycle.	H
8.	Environmental Education	Add interpretative signage and/or art to make the wildlife blinds more engaging. Collaborate between Bernalillo County and OSD to create shared signage and an educational workbook.	L
OSVC			
1.	Water Availability	Support Audubon Southwest's effort to lease water rights for the wetland through a pilot environmental flows project.	H
2.	Drying	Ensure wetland management is closely managed with irrigation to avoid missing opportunities to fill the wetland.	H

3.	Management Plan	The maintenance regime is not consistent with the design. Develop an updated management plan that describes operations, short-term and long-term maintenance, and desired five-year or ten-year outcomes.	H
4.	Water Infrastructure	Seek funding and design to upgrade the intake structure from the MRGCD ditch. It could be upgraded to a gate (3' wide and 12" deep). This would allow the wetland to filled at a much faster rate, allowing the ISO to close the turnout and move on to the next property. Add flow features at the inflow/outflow structures to aid in water movement and water quality.	H
5.	Habitat Management	Remove Cattails mechanically by manual removal, renting a Marsh Master, mowing or burning, taking care not to remove the protective clay layer with mechanical removal.	H
6.	City Staffing	Incorporate management of wetlands into management routines. Review existing job descriptions to determine if management of Alameda is already part of a staff job. Alternatively, designate a staff person to manage the wetlands or seek services under contract or with a volunteer group. (Bosque Technician and Open Space Biologist positions may be options). The needed daily to weekly water monitoring may warrant a specific position or assignment at OSD.	M

7.	Water Metering	a. Measure water input using current time and duration method to determine water needs. b. Install a staff gauge and develop a pond rating curve. Read staff gauge on a regular basis.	H
8.	Non-native vegetation	Continue to partner with volunteer groups or youth conservation crews to assure annual removal of non-native vegetation using best management practices. Coordinate with MRGCD and PNM for removal of the large Siberian elm along the fence line. Develop and approve an integrated vegetation management plan.	H
9.	Recreation	Improve the recreational trail to the wildlife blind (use mulch from non-native plant removal to demarcate path). Improve the location of the wildlife blind for safety.	M
10,	Education	Add educational signs about aspects of the wetlands. Add art in public places.	M
11.	Data	a. Soil Liner. Identify soil types beneath pond and determine how thick the silt/clay layer is. Protect soil layer from excavation in future. b. Water Quality. c. Birds. d. Vegetation.	H
San Antonio Oxbow			
1.	Beaver Activity	Monitor beaver activity by observing and recording dam locations. Implement Beaver Coexistence measures where needed.	H

2.	Diversity of Habitat	Mimic natural disturbance by using a Marsh Master, especially on the north 1/3 of the wetland, or otherwise mow or burn dead cattails. Pulse flows to force a wet/dry water regime cycle.	H
3.	Pollutants	Evaluate and install erosion control structures and/or Green Stormwater Infrastructure to address erosion and sedimentation from the mesa. Pulse flows to flush fresh water into the wetlands from the Corrales Drain.	H
4.	Research	Collaborate with ongoing Bosque School and BEMP activities at San Antonio Oxbow, Native Plant Society, UNM Museum of Southwestern Biology and UNM Water Resources Department, and Audubon Southwest, and retrieve existing data. Determine need for additional research and draw on the local community of specialists. Ensure that these entities obtain an office permit for research and share their finding with OSD.	M
5.	Advisory Committee	Create advisory committee coordinated by City Staff.	M
6.	Recreation	Increase recreation and education in designated spaces.	M
7.	Non-native vegetation	Partner with volunteer groups or youth conservation crews or contract with a qualified firm to assure annual removal of non-native vegetation using best management practices.	H

8.	Flow Management	Manage for inevitable wet/dry cycles. Conduct appropriate management activities during dry times (i.e. cattail removal). Develop long-term climate resilient strategy through advisory committee. Add flow features at the inflow/outflow structures to aid in water movement and water quality.	H
Candelaria			
1.	Funding for Infrastructure	Explore funding sources for constructing the wetlands, such as Land and Water Conservation Act funding through NM Energy, Minerals and Natural Resources Department (EMNRD). Explore wetland mitigation banking with US Bureau of Reclamation.	M
2.	Water Availability	Consider design options for only ephemeral soil wetlands instead of the damp soil unit, and connecting the proposed wetlands to Rio Grande Nature Center Wetlands. Investigate ground water source options.	M
3.	Site Specific Issues – Soils	Consider other locations at CNP for building the wetlands, e.g. areas with soils more conducive to holding water and wetland vegetation. Consider connecting the wetlands to the existing ponds. Because there are other wetlands present at RGNC, OSD considers new wetlands a lower priority.	M

Tingley			
1.	Beaver Activity	Implement Beaver Coexistence measures to lower the pond incrementally and allow the beavers to remain without the continual need to destroy their dams. Coordinate with Albuquerque BioPark staff on planning and implementation.	H
2.	Non-native vegetation	Partner with volunteer groups or youth conservation crews to assure annual removal of non-native vegetation near the wetlands using best management practices. Yerba Mansa Project may be a good partner for this effort.	H
3.	Flow management	Time the high flow with flushing extra water. Coordinate a pulse flow through the Deep and Shallow marshes. This special release would require an operational plan with Albuquerque BioPark and coordination with any other stakeholders. Investigate whether with Albuquerque BioPark whether this is feasible. Add flow features at the bottom of or inflow/outflow structures to aid in water movement and water quality.	H
4.	Research/Data	a. Delineate wetlands in the Wet Meadow and compare it to 2011 data to determine whether wetlands have expanded, contracted or maintained size. b. Collaborate with Albuquerque BioPark specialists. Use a bioblitz approach, citizen science, college and high school science programs to survey fish, bats and birds.	M

5.	Recreational trampling	Close some or all trails on the west side to reduce foot and bike traffic with signs or by eliminating/blocking some of the trails. Using signs labelled “closed for habitat” or “habitat restoration in progress” and highlighting the wildlife that are being protected may help yield compliance to closure. Designating a main path with signage and mulch may reduce the number of user-created recreational trails. Retain the higher trail and close the lower trail and allow it to flood.	H
6.	Wetland expansion	Identify short- and long-term opportunities to expand adjacent wetland habitat and compatibility with recreational reroutes. Look at opportunities to enlarge the wetland habitat. There may be an opportunity to coordinate with the CABQ Department of Municipal Development for stormwater outfall connection assessment.	M

7.	Education	a. The Ciudad SWCD Urban Waters Program is receiving a $200,000 grant in 2024 for an 18-month artist-in-residence for projects adjacent to waterways. This could be used for art installation at the CABQ wetlands that could be a means to engage the public. For example, wildlife sculptures could be installed for children to find and interact with. (Determine if would fall into extraordinary facilities.) b. Install new signs to discourage fishing in the ponds. c. Educational kiosks could be placed at major trailheads, as well as river access signs.	M

5-4. Potential Funding Sources

Table 5-2. Potential Funding Sources for Wetland Protection and Restoration Actions

Source	Agency	Grant
Federal	Environmental Protection Agency	Clean Water Act Section 319 Watershed Restoration Grants
		5 Star Restoration Challenge Grant Program
		Environmental Education Grants
	Natural Resource Conservation Service	Environmental Quality Incentive Program (private lands cost-matching)
		Wetland Reserve Program
		Wildlife Habitat Incentive Program
	U.S. Fish and Wildlife Service	North American Wetland Conservation Act
	U.S. Bureau of Reclamation	WaterSmart Grants
State	New Mexico Environment Department	River Stewardship Program
	New Mexico Economic Development Department – Outdoor Recreation Division	Trails+ Grant
	NM Game and Fish Department	Potential matching monies for other grants
	New Mexico State Forestry	New Mexico Forestry Division Watershed Restoration Project
	New Mexico Energy, Minerals and Natural Resource Department	Youth Conservation Corps
		Natural Heritage Conservation Act
	New Mexico Water Trust Board Grants	Grants can be used for watershed restoration
Private		
	Defenders of Wildlife Beaver Coexistence Incentive Fund	Funds Beaver Coexistence
	Human Beaver Coexistence Fund	Funds Beaver Coexistence
	Wildlife Conservation Society	Watershed restoration
	Wetland Mitigation Funds	
	Private Donors	

	Volunteer Labor or Low-Cost Labor	Youth Conservation Corps
		Ancestral Lands Conservation Corps
		Yerba Mansa Project
		High School Community Service Clubs
		Boy Scout or Girl Scout Troops
		Friends of Candelaria Nature Preserve
		Alameda/Bachechi Master Naturalist Cohort

Funding for OSD is tied to the role played by the Open Space Alliance (OSA), a nonprofit organization whose purpose is to promote public awareness and conservation of Open Space lands, and to educate the public about the natural, historic, cultural, educational, and recreational aspects of Open Space areas. The OSA enhances the experience of all users of the Albuquerque Open Space lands by providing financial support to Open Space Division programs. Member support, memorial and other donations, and fundraising activities help support special programs and events, typically organized by the Open Space Division, aimed at preserving and promoting Open Space lands. The OSA administers grant funds for OSD projects, with funds going directly to supporting OSD initiatives and programs.

Wetland mitigation is the process of restoring, enhancing, or creating new wetlands to compensate for the loss of wetlands caused by development. Under Section 404 of the Clean Water Act, wetlands may be legally destroyed, but their loss must be compensated for by the restoration, creation, or enhancement of other wetlands, resulting in “no net loss” of wetlands. Such activities are regulated by the US Army Corps of Engineers. RGR spoke with Justin Riggs, Senior Regulatory Project Manager with USACE, about how wetland mitigation is related to the OSD wetlands, existing and planned.

Advanced permittee-responsible mitigation is a permitting process to construct compensatory wetlands in advance of unavoidable authorized impacts to aquatic resources and follows standards and requirements laid out in the 2008 USACE Mitigation Rule. The expectation is that this form of mitigation would involve larger sites selected using a watershed approach, be developed using scientific and technical expertise, and be completed in advance of permitted impacts. Mr. Riggs stated that the Albuquerque District has the capacity to evaluate new proposals for advanced mitigation for local projects, such as working with state agencies interested in the restoration, enhancement, or creation of wetlands at OSD properties. It is not necessary

for such wetlands to be planned on jurisdictional wetlands according to the recent definition subject to the Clean Water Act. In fact, the creation of new wetlands in hydrologically disconnected locations can result in a total net increase in wetlands. In a March 2024 memorandum with the subject “Civil Works Actions to Sustain and Advance the Nation’s Waters and Wetlands After the Sackett Decision”, Assistant Secretary of the Army (Civil Works) Michael L. Connor directed the Corps to “use applicable authorities and available resources to engage in specific action to protect, restore, and enhance our Nation’s waters and wetlands that are now more vulnerable” including evaluating compensatory mitigation proposals that have lost protection as jurisdictional aquatic resources (SACW, 2024).

Compared with advanced mitigation, wetland mitigation banking is more complex, and New Mexico has very little experience of this tool compared with any other state. A wetland mitigation bank is the restoration, creation, enhancement, or in certain cases, preservation of wetlands expressly for the purpose of providing compensatory mitigation by a third party other than the permittee. There are no examples of completed wetland mitigation banks in New Mexico, but Mr. Riggs clarified that there are no barriers to their evaluation at the USACE Albuquerque District, adding that a working group on this topic at NMED Wetlands Program could be useful and that the Colorado Mitigation Procedures (currently under development) can be applied to New Mexico proposals for wetland mitigation bank development. Wetland mitigation banks rely on collaborators (“sponsor”) who invest in wetlands and then sell the resulting “credits” to developers or others responsible for offsetting impacts. The process remains under the monitoring and evaluation of USACE, including the determination of credit requirements. Some advantages to permittee-responsible advanced mitigation include the ability to localize the benefits of mitigation and credit ratios can be used to incentivize local mitigation, as well as providing consistency in the permitting process. Disadvantages can include the lack of available land or sponsors, uncertainty about the credit approval process and the need for coordination with federal regulators in a financial scheme. Although this strategy may not be an immediate fit for the OSD five wetlands evaluated in this report, this approach to funding wetland restoration, enhancement, creation, and preservation may play an influential role in the available funding strategies for the Middle Rio Grande if federal disinvestment in watershed protection and restoration priorities occurs.

6. Partnerships and Public Involvement Strategy

This WAP relies on the voluntary actions of willing land managers and stakeholders to protect and restore wetlands. The NMED Wetlands Program does not rely on any mandatory regulatory measures for wetland protection. Consequently, the participation of landowners, land managers and other interested partners is a critical component to complete and implement an effective WAP.

The WAP was developed by consulting numerous stakeholders during in-person meetings and field trips to each of the five wetlands. OSD staff searched their archives for historical information and data, and each participant contributed data and ideas about historic and ongoing issues, actions and management of the wetlands.

The following organizations (in alphabetical order) are important stakeholders for the OSD wetlands.

Albuquerque Bernalillo County Water Utility Authority provides water and wastewater services to the greater Albuquerque metropolitan area. The Water Utility Authority maintains the Alameda stormwater outfall, which is located on the east side of the Rio Grande, west of the City of Albuquerque Alameda Bosque Trail parking area, the Bernalillo County Bachechi Open Space, and the Albuquerque Riverside Drain The outfall is within a portion of the Middle Rio Grande Bosque that is operated and maintained by OSD.

Albuquerque Biological Park (a division of City of Albuquerque) owns and manages Tingley Ponds. The mission of the Albuquerque Biological Park is to enhance the quality of life for Albuquerque citizens and its visitors; to improve educational, recreational and leisure opportunities by providing a comprehensive environmental museum consisting of the Aquarium, Botanic Garden, Zoo and Tingley Beach.

Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) is responsible for building and maintaining flood control channels throughout the Albuquerque area, including San Antonio Arroyo near San Antonio Oxbow Wetlands. AMAFCA's purpose is to prevent injury or loss of life, and to eliminate or minimize property damage from flooding.

Audubon Southwest is a regional office of the National Audubon Society, covering Arizona and New Mexico. Audubon Society protects birds and the places they need, today and tomorrow, using science, advocacy, education, and on-the-ground conservation. Audubon Southwest is working to obtain water rights for the OSVC Wetland.

Bird Alliance of New Mexico (formerly Central New Mexico Audubon Society) is a chapter of the National Audubon Society. Their mission is to protect and conserve birds and wildlife habitats regionally, support responsible stewardship of land, promote environmental education, and welcome all communities to join them in the love and appreciation of birds. Bird Alliance of New Mexico conducts bird surveys at Alameda Wetlands

Bernalillo County is a local government entity that provides services to its citizens and manages public property. Bernalillo County shares ownership and management responsibilities with OSD for the Alameda Wetlands.

Bosque Ecosystem Monitoring Program (BEMP) is an environmental monitoring program operated through Bosque School. BEMP's mission is community science, education and stewardship: equitable and inclusive hands-on student research essential to the management of the Rio Grande ecosystem. In response to the Bosque Biological Management Plan, BEMP was founded in 1996 to monitor the state of the bosque ecosystem. Monitoring and data collection began at three sites (Alameda, Rio Grande Nature Center & Los Lunas) in 1997. As of 2024, BEMP had 33 active sites, across 270 miles of the Middle Rio Grande, with over 1 million data points collected each year. Data are primarily collected by K-12 students and their teachers.

City of Albuquerque Open Space Division owns and has management responsibilities, either solely or in partnership with other agencies, for the five WAP properties. The mission of the OSD is "to acquire, protect, manage, and maintain the significant natural landscapes and cultural resources while providing low impact recreation for current and future generations."

Ciudad Soil and Water Conservation District, a political subdivision of the state of New Mexico, promotes the conservation, improvement and responsible use of the natural resources on the rural and urban lands within its boundaries. Ciudad Soil and Water Conservation District is contracted by OSD to manage Candelaria Nature Preserve.

Friends of the Candelaria Nature Preserve are a group of citizen volunteers that has formed to support rewilding by serving as a guiding body for citizens' support of projects that will build and maintain ecological health and educational activities of the preserve. The group works closely with OSD on preserve management issues, and they seek to include all voices of the City's neighborhoods and their friends in this work. Members of the group conduct volunteer labor at the preserve each Friday morning and offer input on planning and management. In 2023 Friends of the Candelaria Nature Preserve became a committee within the Open Space Alliance.

Habitat Farms Collective creates and stewards vibrant, community-driven habitats for wildlife and humans alike. Habitat Farms Collective is a contractor to OSD that manages wildlife habitat at OSVC.

Middle Rio Grande Conservancy District delivers water to some of the five OSD wetlands (Alameda through the Lane Lateral of the Albuquerque Main Canal, Visitors Center through the La Orilla Channel, San Antonio Oxbow through the Corrales Drain, and Candelaria Nature Preserve delivery is proposed through the Duranes Lateral). MRGCD's mission is to operate, maintain and manage irrigation, drainage and river flood control in the Middle Rio Grande Valley, promote efficient and responsible water management, protect the environment, wildlife and endangered species in cooperation with other local, state and federal agencies, and provide recreational opportunities within the Middle Rio Grande Valley.

Open Space Alliance is a non-profit organization whose purpose is to promote public awareness and conservation of Open Space lands, and to educate the public about the natural, historic, cultural, educational, and recreational aspects of Open Space areas.

Rio Grande Return is a 501(c) (3) non-profit organization that focuses on reviving the regenerative capacity of damaged ecosystems. Rio Grande Return restores riverscapes and ecosystems unique to the arid Southwest using low tech process-based methods to foster resilience, adaptive capacity and stewardship in these important land and water resources. Rio Grande Return is subcontracted by Ciudad Soil and Water Conservation District and in 2024 has a cooperative agreement directly with CABQ to help manage Candelaria Nature Preserve.

Rio Grande Nature Center State Park (NM Energy, Minerals and Natural Resource Department, State Parks Division) owns and manages the wetlands at Rio Grande State Park, adjacent to future Candelaria Nature Preserve Wetlands. The mission specific to the Rio Grande Nature Center State Park is to preserve and protect the Rio Grande Bosque, educate the public about the Rio Grande ecosystems, and to foster positive human interactions with those systems.

US Bureau of Reclamation (USBBOR) oversees water resource management, specifically as it applies to the oversight and operation of the diversion, delivery, and storage projects that it has built throughout the western United States for irrigation, water supply, and attendant hydroelectric power generation. US BOR has responsibility for management of a portion of San Antonio Oxbow Wetlands.

US Army Corps of Engineers designs, builds, operates and maintains critical national infrastructures, including dams and reservoirs. Along the Middle Rio Grande US Army Corps has built reservoirs and other flood control structures and has also been instrumental in

restoring riparian habitat for wildlife that has been negatively impacted by water infrastructure. US ACE has responsibility for management of a portion of San Antonio Oxbow Wetlands.

Valle de Oro National Wildlife Refuge (US Fish and Wildlife Service) owns and manages Valle de Oro National Wildlife Refuge in the South Valley of Bernalillo County. As a managed refuge with a variety of wetland and upland ecotypes within the former floodplain of the Rio Grande, it experiences many of the same threats, impairments and opportunities as the OSD wetlands.

Yerba Mansa Project is a non-profit organization that aims to reestablish the connectivity of people, plants and the land in the Middle Rio Grande Valley through restoring nutritive and healing plans, teaching youth and adults about their importance and helping to protect critical habitats and associated cultural knowledge. Yerba Mansa project volunteers have assisted with non-native plant removal at OSD wetlands.

Continued outreach efforts involving these stakeholders will be a key component for the successful implementation of the WAP. Outreach efforts will be guided by the five-year Community Engagement Plan established by OSD in 2023 (OSD, 2023). The following text is directly from the plan:

This Strategic Plan is intended to be a guiding document for the next five years for the City's Open Space Division (OSD) community engagement and education programs, The Plan is responding to City Council's Resolution R-22-8 to address equitable access and enjoyment of Major Public Open Space. The Plan identifies current programs and practices; presents the Neighborhood Open Space initiative City of Albuquerque and methods for a scaffolding approach to community engagement; explains the fundamental intent, values, and vision for the strategic plan; and outlines priority areas under six overarching goals, co-created with partners and stakeholders, including the Office of Equity and Inclusion (OEI). The six major goals include: Goal 1 - Increase Access to Major Public Open Space Goal 2 - Grow the Relevancy and Impact of Education Programs Goal 3 - Increase a Sense of Belonging and Stewardship through Outreach and Communication Goal 4 - Grow Connections and Opportunities for Residents to Access Major Public Open Space Goal 5 - Collaborate with New and Long-Standing Community and City of Albuquerque Partners to Grow Collective Reach Goal 6- Make Informed Decisions through Improved Evaluation and Studies.

PPrinciples laid out in the Community Engagement Plan will be used to implement this WAP as follows.

1. OSD will coordinate with specific stakeholders for each wetland, as identified below. Public events and outreach materials will be developed and advertised through the OSD

marketing and communications coordinator. Events will include tours, such as manager tours with multi-agency coalitions (for example, with the Middle Rio Grande Endangered Species Collaborative), citizen science groups conducting studies (for example, with the Bird Alliance of New Mexico), and general interest opportunities (for example, through pollinator planting and maintenance in restoration areas). The examples cited here are all recent actual events.

Alameda Wetland – Bernalillo County, MRGCD, Audubon Southwest, ABCWUA

OSVC Wetland – MRGCD, Audubon Southwest, Habitat Farms Collective, LLC

San Antonio Oxbow Wetlands – US ACE, US BOR, MRGCD, AMAFCA, Bosque School/BEMP

Candelaria Nature Preserve – Rio Grande Nature Center State Park, Ciudad Soil and Water Conservation District, Rio Grande Return, Friends of Rio Grande Nature Center State Park, Friends of Candelaria Nature Preserve

Tingley Wetlands - Albuquerque BioPark, US ACE

2. OSD will establish a San Antonio Oxbow Advisory Committee.

The original San Antonio Oxbow Biological Management Plan (OSD, 1997) called for an advisory committee consisting of a representative of OSD and five people with scientific expertise related to managing the wetlands. The committee would meet annually or as needed per internal decisions to review the ecological state of the wetlands and make management decisions to OSD. Outreach to nearby disadvantaged communities needs to be incorporated into future development of the advisory committee.

3. OSD will work with volunteers and youth crew on maintenance and management.

OSD will establish and strengthen connections with youth conservation corps, student clubs, and volunteer crews for removal of non-native vegetation and ongoing data collection. Outreach to nearby disadvantaged communities is and will continue to be an important aspect of these connections.

4. OSD will further enhance education opportunities through interpretive signage and programs.

OSD will take a systematic approach to increasing signage around the wetlands and creating educational programming, including electronic and in-person outreach and development of educational materials. Programs such as River Xchange with Ciudad Soil and Water Conservation District (which provides field science for 5th graders) and

Cottonwood Gulch Expeditions with Rio Grande Return (which provides monthly hands-on field science for 9th graders) are existing examples of how these opportunities can and should continue to reach nearby disadvantaged communities.

References

Allen, K., Robertson, A., Rokus, D. D., Anderson, J. 2021. Mapping and Classification of Wetlands in the Middle Rio Grande Region of Western New Mexico. Saint Mary's University of Minnesota, Winona, Minnesota.

Bartolino, J.R., Cole, J. C., and Hester, D.J. 2002. Ground-Water Resources of the Middle Rio Grande Basin: U.S. Geological Survey Fact Sheet FS-088-02, 6 p.

Beaver Coalition. 2022. Beaver Coalition Flow Device BMPs. https://www.beaverinstitute.org/wp-content/uploads/2023/03/BeaverCoalition_FlowDeviceBMPs_2022.pdf. Accessed June 27, 2024.

BISON-M Website. 2024. Biota Information System of New Mexico, New Mexico Department of Game & Fish, https://bison-m.org/, Bernalillo County List. Accessed May 28, 2024.

Brinson, Mark M. 1993. A Hydrogeomorphic Classification for Wetlands. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS, USA. Technical Report WRP-DE-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Chronic, H. 1987. Roadside Geology of New Mexico. Mountain Press, Missoula, MT. 255 p.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. U.S. Fish and Wildlife Service: Washington, D.C.

Crawford, C.S., A. Cully, R. Leutheuser, M. Sifuentes, L. White, J. Wilber. 1993. Middle Rio Grande Ecosystem: Bosque Biological Management Plan. US Fish and Wildlife Service. Albuquerque, NM. 281 p.

deBuys, W. 2011. *A great aridness: Climate change and the future of the American Southwest*. Oxford University Press, USA.

Defenders of Wildlife. 2024. Beaver Coexistence Incentive Fund webpage. https://coexistwithbeavers.org/our-mission/. Accessed June 27, 2024.

Dunbar, N.W., Gutzler, D.S., Pearthree, K.S., Phillips, F.M., Bauer, P.W., Allen, C.D., DuBois, D., Harvey, M.D., King, J.P., McFadden, L.D., Thomson, B.M., and Tillery, A.C. 2022. Climate change in New Mexico over the next 50 years: Impacts on

water resources: New Mexico Bureau of Geology and Mineral Resources, Bulletin 164, 218 p. https://doi.org/10.58799/B-164.

Dunmire, W. W. 2013). New Mexico's Spanish livestock heritage: Four centuries of animals, land, and people. UNM Press.

ESS Earth Sciences. 2021. What Are Staff Gauges? Webpage. https://www.essearth.com/what-are-staff-gauges/. Accessed June 28, 2024.

FEMA. 2022. Draft Environmental Assessment City of Albuquerque Rio Grande Bosque Wildfire Mitigation Project HMGP-5184-0004-NM Bernalillo County, New Mexico. US Federal Emergency Management Agency, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.fema.gov/sites/default/files/documents/fema_oehp-bosque-wildfire-dea.pdf. Accessed June 7, 2024.

Friedman, J. M., Scott, M. L., & Lewis, W. M. 1995. Restoration of riparian forest using irrigation, artificial disturbance, and natural seedfall. Environmental Management, 19(4), 547–557.

GeoSystems Analysis. 2016. City of Albuquerque Bosque Management Plan: Central Avenue to Campbell Road, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.cabq.gov/parksandrecreation/documents/geosystems-central-to-campbell-draft-report-06-30-16.pdf. Accessed June 6, 2024.

Grassel, K. 2002.Taking Out the Jacks - Issues of Jetty Jack Removal in River in Bosque and River Restoration Planning. Water Resources Professional Project Report. Water Resources Program. University of New Mexico. Publication No. WRP-6. 46 p.

Human Beaver Coexistence Fund website. 2024. https://coexistwithbeavers.org/our-mission/cc. Accessed June 27, 2024.

LeJeune, C.L. 2011. Investigation of Groundwater - Surface Water Interaction at the Albuquerque Biological Park Wetland Restoration Project. Prepared by Wetwater Environmental Services for US ACE Albuquerque District, 78 p.

Martinez, M. 2010. Open Space Visitor's Center Perennial Marsh Plan. City of Albuquerque Open Space Division, 11 p.

National Wetlands Inventory Mapper. 2024. US Fish and Wildlife Service, https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/. Accessed May 28, 2024.

NMDGF. 2024. Bridge and Culvert Construction Guidelines. https://www.wildlife.state.nm.us/download/conservation/habitat-handbook/project-guidelines/Bridge-and-Culvert-Construction-Guidelines-2024.pdf. Accessed June 27, 2024.

NMED. 2012. New Mexico Wetlands Technical Guide 1 – Wetland Functions. New Mexico Environment Department Surface Water Quality Bureau Watershed Protection Section Wetlands Program., 36 p.

NMED. 2023. New Mexico Environment Department Surface Water Quality Bureau, New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC).

NMED. 2024. New Mexico Environment Department Surface Water Quality Bureau *2022-2024 State of New Mexico CWA§303(d)/§305(b) Integrated List and Report*; Water Quality Control Commission Approved.

NMEMNRD. 2010. Rio Grande Nature Center State Park Management Plan. New Mexico, 69 p.

New Mexico Museum of Natural History and Science. 2024. Bosque Education Guide, Chapter 5, https://www.nmnaturalhistory.org/bosque-education-guide/chapter-5-meandering-channels. Accessed May 29, 2024.

New Mexico Rare Plant List Website. 2024. New Mexico Department of Energy and Minerals and Natural Resources, https://www.emnrd.nm.gov/sfd/rare-plants/state-rare-plant-list/, Bernalillo County List. Accessed May 28, 2024.

OSD. 1997. San Antonio Oxbow Biological Management Plan. City of Albuquerque Open Space Division. 35 p.

OSD. 1998. Alameda Wetland and other improvements in the Rio Grande Valley State Park. City of Albuquerque Open Space Division. PowerPoint presentation by Ondrea Linderoth. 70 slides.

OSD. 2009. Application for State Wildlife Grant (SWG) Funding Grant Statement City of Albuquerque Open Space Division. 9 p.

OSD. 2012. Memorandum of Understanding Between City of Albuquerque and County of Bernalillo for Open Space Facility Management and Collaboration. City of Albuquerque Open Space Division, 12 p.

OSD. 2017. Exhibit A. Bachechi/Alameda Open Space City and County Ownership Boundaries. OSD. One page map.

OSD. 2021. Candelaria Nature Preserve Resource Management Plan. City of Albuquerque Open Space Division. 155 p.

OSD. 2022. OSD Wetlands Overview by Kyle Harwood. 8 p.

OSD. 2023. Bosque Assessment and Update Prioritization. Prepared by TetraTech, Albuquerque, NM. 146 p.

OSD, 2023. Community Engagement Plan. City of Albuquerque Open Space Division. 13 p.

OSD. 2024. Bosque Thinning and Restoration Project webpage, https://www.cabq.gov/parksandrecreation/open-space/bosque-thinning-project#:~:text=The%20project%20area%20is%20where,2019%20to%20235%20in%202023. Accessed June 26, 2024.

OSD. 2024. Open Space Education and Public Programs webpage. https://www.cabq.gov/parksandrecreation/open-space/open-space-education-public-programs. Accessed August 20, 2024.

PennState, 2022. Interpreting Water Tests for Ponds and Lakes. Pennsylvania State University Extension Website. Extension.psu.edu/interpreting-water-quality-tests-for-ponds-and-lakes. Accessed July 18, 2024.

State Parks Division, Energy, Minerals and Natural Resources Department. 69 p.

Noss, R., M. O'Connell, and D.D. Murphy. 1997. *The Science of Conservation Planning: Habitat Conservation Under the Endangered Species Act*. World Wildlife Fund. Island Press. 263 p.

Phillips, F. M., G.E. Hall, and M.E. Black. 2015. Reining in the Rio Grande: People, land, and water. Albuquerque, New Mexico: UNM Press.

Sallenave, R. 2019. Understanding Water Quality Parameters to Better Manage Your Pond. Guide W-104. College of Agricultural, Consumer and Environmental Sciences. New Mexico State University Website. pubs.nmsu.edu/_w/W104/index.html/. Accessed July 18, 2024.

Saville, D. 2021. *The ecology of herbal medicine: a guide to plants and living landscapes of the American Southwest*. University of New Mexico Press.

Shah, J. J. F., & Dahm, C. N. 2008. Flood regime and leaf fall determine soil inorganic nitrogen dynamics in semiarid riparian forests. Ecological Applications, 18(3), 771–788.

Simon, L. 2006. Solving Beaver Flooding Problems through the Use of Water Flow Control Devices. Proceedings of the Vertebrate Pest Conference, 22(22). https://www.beaverinstitute.org/wp-content/uploads/2023/03/Solving-Beaver-Flooding-Problems-through-the-Use-of-Water-Flow-Control-Devices.pdf, accessed June 27, 2024.

United Plant Savers Medicinal Plant Conservation Website. 2024. https://unitedplantsavers.org/species-at-risk-list/yerba-mansa-anemopsis-californica/, Yerba Mansa. Accessed May 28, 2024.

University of California. 2020. Determining Volume in a Small Pond with a Staff Gaugge and Depth Capacity Curve. Agricultural and Natural Resources UC ANR Publication 8681. https://anrcatalog.ucanr.edu/pdf/8681.pdf. Accessed June 28, 2024.

US ACE. 2004. Final Detailed Project Report and Environmental Assessment for Albuquerque Biological Park Wetland Restoration Project. U.S. Army Corps of Engineers Albuquerque District. 60 p.

US ACE. 2006. Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) Manual, Albuquerque Biological Park, Tingley Pond and Wetland Restoration Project. Prepared by HDR and FISHPRO for US ACE Albuquerque District, 59 pp.

US ACE. 2024. 2012 Staff Gauge Setup Instructions. https://www.spa.usace.army.mil/Portals/16/docs/emergencymgmt/2012-Staff_Gage_Setup-Instructions.pdf. Accessed July 5, 2024.

United States Environmental Protection Agency. 2024. Section 404 of the Clean Water Act: How Wetlands are Defined and Identified. http://www.epa.gov/cwa-404/section-404-clean-water-act-how-wetlands-are-defined-and-identified, Accessed June 30, 2024.

US Fish and Wildlife Service/City of Albuquerque Private Lands Agreement. 2010. City of Albuquerque Open Space Division archived records.

Western Regional Climate Center. 2021. New Mexico Climate Summaries: Albuquerque Valley, New Mexico (COOP Station 290231). https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm0231. Accessed June 6, 2024.

Yerba Mansa Project. 2024. https://yerbamansaproject.org/. Accessed May 28, 2024.