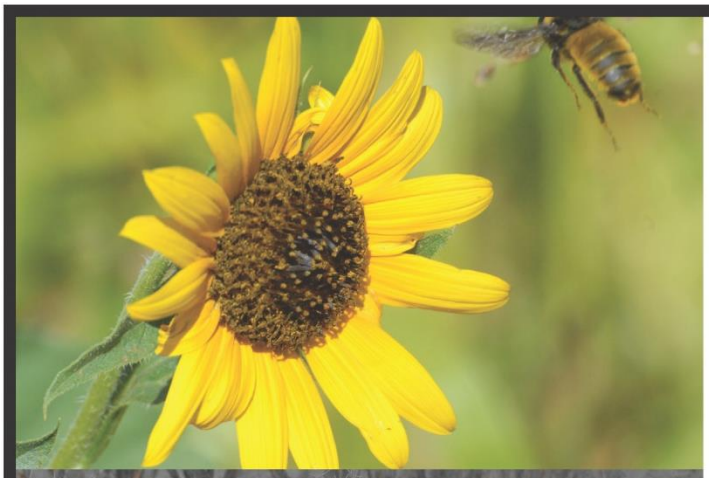


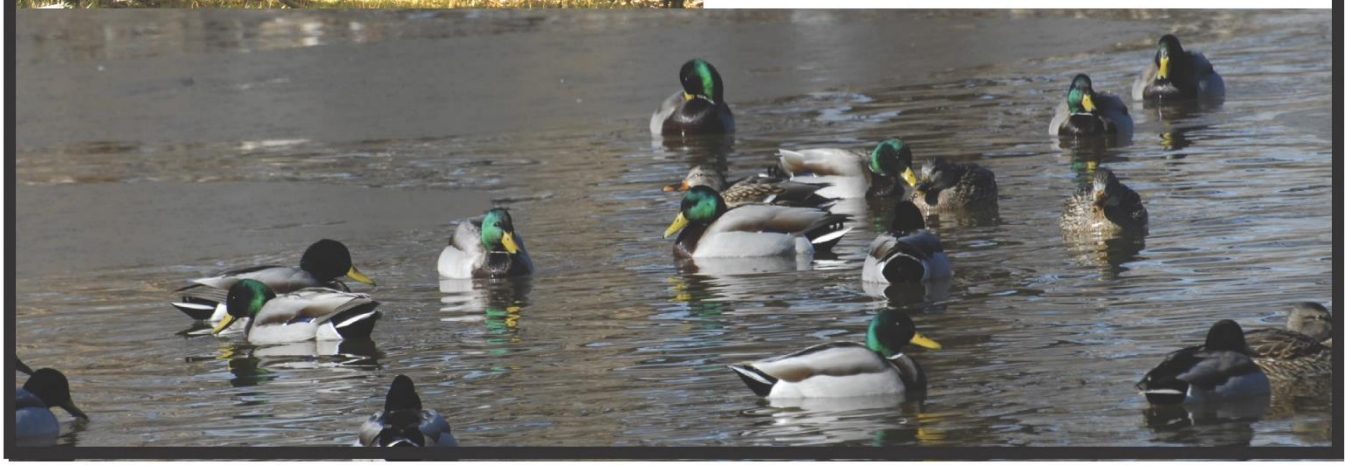
CANDELARIA NATURE PRESERVE RESOURCE MANAGEMENT PLAN

June 2019

ONE ALBUQUERQUE

city of albuquerque

The City of Albuquerque
Parks and Recreation Department
Open Space Division



CITY of ALBUQUERQUE
TWENTY SECOND COUNCIL

COUNCIL BILL NO. R-16-147 ENACTMENT NO. _____

SPONSORED BY: Isaac Benton

RESOLUTION

CONCERNING THE FUTURE MANAGEMENT OF CANDELARIA FARM PRESERVE AS A NATURE STUDY AREA AND WILDLIFE PRESERVE.

WHEREAS, Candelaria Farm Preserve (CFP) was purchased using funding to the State of New Mexico from the Land and Water Conservation Fund (LWCF) as part of the Bosque Open Space Land Acquisition Project in 1978; and

WHEREAS, the LWCF Purpose is to provide access to outdoor recreation resources by the public, which include opportunities for interpretive education; and

WHEREAS, LWCF rules apply to the entire property purchased with LWCF funds, even if such funds are not the only funds involved; and

WHEREAS, in September 1976 the City of Albuquerque (the City) and the State of New Mexico (the State) submitted a proposal to the LWCF for funding the purchase of "170 acres of bosque land adjacent to the Rio Grande River [sic] in Albuquerque's North Valley" for "Albuquerque Open Space Land Acquisition"; and

WHEREAS, the City/State proposal stated that the acquisition was important because: "The area planned to remain primarily natural with preservation of existing plant and animal life," and that "Purchase of this tract of land will insure [sic] a permanent open space adjacent to the river for nature study, recreation uses, open space, and urban shaping"; and

WHEREAS, in 1978, the CFP property was re-zoned from R-2 to SU-1: "Special Use for a Nature Study Center and Preserve," which reflected the intent of the City/State's proposal: that it be used for nature study, open space, and recreation while preserving existing plant and animal life; and

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WHEREAS, in March 1978, the USDA Soil Conservation Service (now the Natural Resource Conservation Service) prepared a "Land Use and Treatment" plan for the City to manage the CFP for wildlife, referring to this as a "conservation" plan with the "primary objective" being: "to provide optimum wildlife habitat. This will be accomplished by seeding the existing cropland to species that will provide a good source of food"; and

WHEREAS, in 1979 the City developed a Master Plan for the "Rio Grande Nature Center and Preserve" (the "Predock plan") that proposed two primary uses for the land: 1) a nature study area, which became the Rio Grande Nature Center and would provide public access to the CFP; and 2) the balance of the property – the Preserve – that would "remain primarily natural with preservation of existing plant and animal life" with "a minimum of 100 acres of historical farmland" preserved as irrigated farmland "for raising of crops for forage and cover for wildfowl and other wildlife" with areas not cultivated "to remain in as undisturbed a state as possible"; and

WHEREAS, the Predock plan was never sent to the LWCF oversight agency for approval, such that there is no approved plan for the CFP; and

WHEREAS, the 1983 "Rio Grande Nature Center State Park and Preserve Management Plan", prepared by the State Parks and Recreation Division, maintained the distinction between a "nature study area", the Rio Grande Nature Center (RGNC), and the Preserve and included the RGNC (38.8 acres), 127.2 acres of remaining CFP lands, and 100 acres of Bosque lands leased from the MRGCD with the 266-acre site "managed for the overall goal of a nature center and wildlife preserve"; and

WHEREAS, notwithstanding the stated intent of managing the entire 266 acres as a wildlife preserve and nature center, the 1983 Management Plan devotes 98 acres to commercial agriculture and mentions for the first time that the goal of CFP is to "preserve" vanishing agricultural traditions; and

WHEREAS, in 2004, a new management plan was drafted for CFP: the "Open Space Resource Management Plan for the Candelaria Farm Preserve" (RMP), which is the current management document for the lands and which acknowledges that, "the farm is uniquely situated to create and protect habitat for birds and wildlife" and that CFP, "will be managed as a preserve in the

strictest sense, whereby humans are only guests ... in order to provide the greatest possible protection to wildlife"; and

WHEREAS, neither the 1983 management plan nor the 2004 management plan were sent to the federal LWCF oversight agency for approval; and

WHEREAS, the RMP also states that it is focused on the "management issues regarding the integration of wildlife conservation with agricultural land use" and identifying "three obstacles to the efficient and productive operation of the farm" and concludes that running a commercial agricultural operation means that, "most of the property is operated as a farm, so target species and habitat types will need to be compatible with farming to some extent"; and

WHEREAS, the LWCF guidelines specifically prohibit agriculture as a primary activity on land purchased with LWCF funds, as follows from the Federal Financial Assistance Manual, Volume 69:

Chapter 3.B.5 – Acquisition involving compatible resource management practices. Acquisition of land upon which the project sponsor proposes natural resource management practices such as timber management and grazing, *not including agriculture*, may be carried out concurrently within the area if they are clearly described in the project proposal, are compatible with and secondary to the proposed outdoor recreation uses, and are approved by the NPS.

Chapter 3.C.6.e – Outdoor recreation and support facilities, such as demonstration farms and wildlife management and hunting areas, may be planned by the project sponsor in conjunction with agricultural activities, provided that the type and extent of the agricultural activity is limited to that necessary to support the outdoor recreation activity; and

WHEREAS, the LWCF Act states that, "No property acquired or developed with assistance under this section shall, without the approval of the Secretary, be converted to other than public outdoor recreation uses"; and

WHEREAS, in its proposal the City stated that it, "will maintain and operate this project in accord with acceptable standards as a public recreation facility for a 25-year period and beyond."

BE IT RESOLVED BY THE COUNCIL, THE GOVERNING BODY OF THE CITY OF ALBUQUERQUE:

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Section 1. The City of Albuquerque hereby reaffirms that the Candelaria Farm Preserve is to be managed as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors, as required by the LWCF Act; as intended by the 1976 proposal from the City and State for preserving the existing natural landscape and its plants and animals with a possible nature study area; as reaffirmed in the 1978 re-zoning as a Special Use Zone for a Nature Study Center and Preserve; as affirmed by the USDA "Land Treatment" plan for wildlife habitat conservation; and as affirmed by the 1979 Master Plan for the Rio Grande Nature Center and Preserve.

Section 2. The City of Albuquerque directs the Open Space Division (OSD) and Parks and Recreation Department (PRD) to immediately begin the process of creating a new Resource Management Plan (RMP) for Candelaria Farm Preserve. The RMP shall utilize as its basis and shall not reinvent, but rather clarify and update the conclusions and goals of previous plans, in particular the 1979 Predock plan. A draft RMP shall be submitted to the PRD Director, the Open Space Advisory Board, and the City Council for review that will include conformance to LWCF rules, consistency with City policy, fulfillment of the City's fiduciary duties, and inclusion of relevant surveys and cost estimates.

Section 3. To develop a new RMP, OSD and PRD shall immediately convene a Technical Advisory Group composed of:

a. Staff from Open Space Division and Parks and Recreation.
b. A representative from the Open Space Advisory Board.
c. Technical experts from Bosque del Apache NWR and Valle de Oro NWR and elsewhere in the Fish and Wildlife Service as appropriate.
d. Technical experts from the USDA Natural Resource Conservation Service.
e. The State Parks LWCF liaison and staff from the Rio Grande Nature Center State Park.
f. Staff from the Middle Rio Grande Conservancy District.
g. Other technical experts on wildlife habitat and farming for wildlife forage and cover crops.

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h. Two representatives of the North Valley Coalition.

i. Other experts as deemed necessary for the task.

Section 4. In accord with the requirements of the LWCF Act and commitments made by the City in requesting and accepting LWCF funding for acquisition of Candelaria Farm Preserve, the Technical Advisory Group shall work with all interested parties to determine the funding necessary to return the CFP lands to wildlife croplands and natural areas and work collaboratively to secure the on-going funding to maintain CFP as a wildlife preserve and nature study area.

Section 5. To prevent degradation of the property and maintain wildlife habitat, the City may lease CFP for agricultural activity during the RMP process; however, organic farming practices shall be encouraged, use of pesticides shall be prohibited and use of herbicides shall be minimized.

Section 6. NO INTERFERENCE. Nothing in this resolution is intended to limit or interfere with projects intended for the repair, maintenance or upkeep of the CFP.

Section 7. SEVERABILITY. If any section, paragraph, sentence, clause, word, or phrase of this resolution is for any reason held to be invalid or unenforceable by any court of competent jurisdiction, such decision shall not affect the validity of the remaining provisions of this resolution. The Council hereby declares that it would have passed this resolution and each section, paragraph, sentence, clause, word or phrase irrespective of any provisions being declared unconstitutional or otherwise invalid.

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CITY of ALBUQUERQUE
TWENTY SECOND COUNCIL

COUNCIL BILL NO. R-17-159 ENACTMENT NO. _____

SPONSORED BY: Isaac Benton

RESOLUTION

AMENDING RESOLUTION R-16-147, CONCERNING THE FUTURE MANAGEMENT OF CANDELARIA FARM PRESERVE AS A NATURE STUDY AREA AND WILDLIFE PRESERVE, TO CLARIFY RESPONSIBILITIES FOR THE PROCESS OF CREATING A RESOURCE MANAGEMENT PLAN

WHEREAS, Resolution No. R-16-147 (Enactment No. R-2017-001) was approved by the City Council on January 4, 2017; and

WHEREAS, Resolution No. R-16-147 directed the Open Space Division (OSD) and the Parks and Recreation Department (PRD) to immediately begin the process of creating a new Resource Management Plan (RMP) for the Candelaria Farm Preserve and convene a Technical Advisory Group to accomplish this task; and

WHEREAS, more clarification is needed as to who will lead and have oversight of the RMP Technical Advisory Group.

BE IT RESOLVED BY THE COUNCIL, THE GOVERNING BODY OF THE CITY OF ALBUQUERQUE:

SECTION 1. That Section 2 of Resolution R-16-147 is amended as follows:

"The City of Albuquerque directs the Open Space Division (OSD) and the Parks and Recreation Department (PRD) to immediately begin the process of creating a new Resource Management Plan (RMP) for Candelaria Farm Preserve. [The Open Space Advisory Board shall have oversight of this process and will work collaboratively with OSD and PRD to complete the RMP]. The RMP shall utilize as its basis and shall not reinvent, but rather clarify and update the conclusions and goals of previous plans, in particular the 1979 Predock plan. A draft RMP shall be submitted to the PRD Director, the Open Space Advisory Board, and the City Council for review that will

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include conformance to LWCF rules, consistency with City policy, fulfillment of the City's fiduciary duties, and inclusion of relevant surveys and cost estimates."

SECTION 2. That Section 3 of Resolution R-16-147 is amended as follows:

"To develop a new RMP, [~~OSD and PRD~~] [the Open Space Advisory Board] shall [name a lead and alternate lead for the] [~~immediately convene a~~] Technical Advisory Group[, who shall immediately convene the group] composed of:

a. Staff from Open Space Division and Parks and Recreation.
b. A representative from the Open Space Advisory Board.
c. Technical experts from Bosque del Apache NWR and Valle de Oro NWR and elsewhere in the Fish and Wildlife Service as appropriate.
d. Technical experts from the USDA Natural Resource Conservation Service.
e. The State Parks LWCF liaison and staff from the Rio Grande Nature Center State Park.
f. Staff from the Middle Rio Grande Conservancy District.
g. Other technical experts on wildlife habitat and farming for wildlife forage and cover crops.
h. Two representatives of the North Valley Coalition.
i. Other experts as deemed necessary for the task.

[A final list of the Technical Advisory Group members shall be submitted to the Open Space Advisory Board, OSD, PRD and the City Council. The Technical Advisory Group shall submit a status report on the development of the Resource Management Plan to the City Council upon request.]"

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ACKNOWLEDGEMENTS

The City of Albuquerque, Open Space Division would like to acknowledge SWCA Environmental Consultants (SWCA) and Dekker/Perich/Sabatini (DPS).

The Open Space Division would also like to recognize and thank the Technical Advisory Group who led this planning process:

PARTICIPATION	ORGANIZATION	REPRESENTATIVE	EXPERTISE/ROLE
Technical Advisory Group Core Members			
Open Space Advisory Board	Open Space Advisory Board	Michael Jensen (lead) Alan Reed (alternate)	Member at Large Vice President
Agencies	CABQ Parks & Recreation Department	Christina Sandoval	Parks and Recreation Principal Planner Planning
	Parks and Recreation Department/ Open Space Division	Colleen Langan-McRoberts James Lewis	OSD Superintendent OSD Assistant Superintendent
	State Parks	Judy Kowlaski	Bureau Chief and LWCF Liaison
	State Parks	Heather McCurdy	RGNC State Park Superintendent
	USFWS / Valle de Oro NWR	Jennifer Owen-White	Refuge Planning
Neighborhood Associations	Neighborhood Association	Caroline Siegel	Alvarado Gardens NA
	Neighborhood Association	Christianne Hinks	Rio Grande NA
	Neighborhood Association	Peggy Norton	North Valley Coalition
	Neighborhood Association	Jeannie Allen	Rio Grande Compound
Additional	Self	Dave Parson	Wildlife Biologist
	Rio Grande Bird Research, Inc	Steve Cox	Bird Survey; RGNC Volunteer
	Self	Brian Hanson	Fish & Mammals Biologist (USFWS Retired); RGNC Volunteer
Additional Support Staff		Brandon Gibson	Deputy Director, Parks & Recreation
		Philip Clelland	Public Information Officer, P&R
		Kent Swanson	Open Space Visitor Center Manager
		William Pentler	Open Space Visitor Service Manager
		Matthew Peterson	Open Space Bosque Forester
		Tricia Keffer	Open Space Associate Planner
		Joran Viers	CABQ Forester

Additional Collaborators

Jim Roberts, J&T Farms
Richard Barish
Beth Dillingham
Kim Eichhorst
Kim Fike
Steve Glass
Dave Hutton
Bernard Lujan
David Mehlman
Santiago Misquez
Yasmeen Najmi
Linda Shank
Matt Schmader
Paul Tashjian

City of Albuquerque

Timothy M. Keller, Mayor
Sarita Nair, Chief Administrative Officer
Lawrence Rael, Chief Operating Officer
David J. Simon, Director, Parks and Recreation Department

Albuquerque City Council

Klarissa J. Peña, President, Council District 3
Ken Sanchez, Council District 1
Isaac Benton, Council District 2
Brad Winter, Council District 4
Cynthia D. Borrego, Council District 5
Pat Davis, Council District 6
Diane G. Gibson, Council District 7
Trudy E. Jones, Council District 8
Don Harris, Council District 9

Open Space Advisory Board

Chris Green, Chair
Don Couchman
Rene Horvath
Michael Jensen
Twyla McComb
Alan Reed
Tasia Young

EXECUTIVE SUMMARY

The Candelaria Nature Preserve (CNP) Resource Management Plan (RMP) was developed through a collaborative community driven process led by the Technical Advisory Group with oversight from the Open Space Advisory Board from 2016 – 2019. The CNP is to be managed as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors. This resource management plan provides the framework for implementing that mandate and to ensure compliance with the Land and Water Conservation Fund regulations and guidelines.

Beginning in the late 1960s, Albuquerque residents became concerned about preserving open spaces in the City. Not only were residents concerned about the rapid expansion of the City, but in 1969 the Bureau of Reclamation proposed cutting the Bosque to create more water for irrigation. Also, in 1969, the City created its Goals Committee, with the intent “to preserve the unique natural features of the metropolitan area by achieving a pattern of development and open space respecting the river, land, mesa, mountains, volcanoes, and arroyos." Groups were formed to watch over each element of the City's Open Space: the Bosque del Rio Grande Nature Preserve Society, Save the Volcanoes, Save the Sandias, and Save the Arroyos. In 1975 these groups were brought together under the banner of the Open Space Task Force.

The Bosque group conducted a study on Rio Grande ecosystems and recommended establishing a pond and marsh restoration project on the Candelaria Farm site (as it was then referred to). A plan for a nature study center on the western bluffs overlooking the site (above the San Antonio Oxbow) fell through. Building on these efforts, visionary leaders at the City of Albuquerque acquired 167 acres in 1977 located on both sides of far western Candelaria Road. To acquire the property, which is now being called the Candelaria Nature Preserve (CNP), the city used a combination of State and Federal grants (including Land and Water Conservation Funds), General Obligation Bond monies, funds from the sale of surplus City land, and city capital funding.

In 1978, the site was re-zoned to SU-1 (Special Use as a Nature Study Center and Wildlife Preserve). In 1980, the City granted a 25-year lease on 38.8 acres to the State of New Mexico for what became the Rio Grande Nature Center State Park (RGNCSP), which fulfilled the vision of having a nature study center on the site. Also, in 1980, the City claimed that a 7-acre parcel east of the Duranes Lateral and adjacent to Rio Grande Boulevard had not been intended as part of the purchased site and gave Parks and Recreation use of it as a tree nursery and sod farm.

A 31.8-acre section south of Candelaria Road was divided by 7 acres of land owned by the Fraternal Order of Police (FOP). In 1982, the City exchanged approximately 8 acres of the site along Campbell Road for the FOP parcel, creating a contiguous south tract; Rio Grande Compound now occupies the new FOP parcel along Campbell Road. In 1996, a thin strip totaling about 1 acre along the end of Veranda Street was given to the City to widen and improve the street; it was exchanged for 1 acre comprising a trail in the Bosque northwest of the Montano Bridge.

There have been several management plans for the site. In 1979, Antoine Predock completed the Rio Grande Nature Center and Preserve Master Plan (commonly called the Predock Plan). This

plan envisioned a nature center and at least 100 acres of wildlife forage and habitat. The 1983 Rio Grande Nature Center Management Plan had a stated purpose of guiding management for a nature center and wildlife preserve, but shifted the focus to growing agricultural crops, with 15 acres devoted to wildland crops; this plan included the Rio Grande Nature Center State Park as a management unit.

In a related development, in 1983 the Legislature authorized creation of the Rio Grande Valley State Park along 20 miles of the river running through the City. The Park is jointly managed by the City and the Middle Rio Grande Conservancy District (MRGCD). The 1983 Rio Grande Nature Center management plan included 100 acres of the newly formed park just west of the Nature Center among the management units of the site through an agreement with the MRGCD; this agreement has since expired.

In 2004, after two decades of experience coordinating agricultural activity on the site and to meet requirements of the 1999 Major Public Open Space Facility Plan, the Open Space Division produced the Candelaria Farm Preserve Resource Management Plan to clarify future developments at the site at the interface of agricultural activities and wildlife. This plan dealt primarily with the fields located north of Candelaria Rd. and east of the RGNCSP.

The New Mexico State Park's staffed and managed the RGNCSP lease area, while the Open Space Division managed the remaining Open Space by leasing or otherwise contracting private farmers to grow crops and maintain the farm area. This enabled the City to maintain the property at little to no cost. Little was done with the South Tract (south of Candelaria) with the exception of the area around the "Discovery Pond," which is managed by State Parks as part of the RGNCSP.

The original 167-acre parcel of land was purchased in part using funds apportioned to the State of New Mexico from the Federal Land and Water Conservation Fund (LWCF) as part of the Bosque Open Space Land Acquisition Project in 1978. The purpose of the LWCF is to "assist in preserving, developing, and assuring to all citizens of the United States of present and future generations such quality and quantity of outdoor recreation resources as may be available and are necessary and desirable for individual active participating" (PL88-578: 16 U.S.C. 4601-4 et seq.). As interpreted by the National Park Service, U.S. Department of the Interior, the rules governing use of LWCF funds apply not only to the specific property purchased with those funds, but to the entire management unit. In this case, the entire CNP is "encumbered," or subject to the LWCF rules. The State is responsible for ensuring the LWCF projects are in compliance by undertaking an inspection every five years, in perpetuity. Over the years, as a result of changes in management of the LWCF program, the understanding that the entire property was subject to LWCF rules was lost and inspections were focused on the RGNCSP, which has always been compliant with LWCF guidelines. In 2016, the State recognized the error and conducted an inspection of the entire CNP property. The inspection revealed that the City of Albuquerque Open Space Division was out of compliance with LWCF rules as stated in Resolution R-16-147 and R-17-159. Consequently, the City of Albuquerque initiated this resource management plan upon learning about the State's conclusion.

Since 1978, several changes to the zoning of the CNP, development of the RGNCSP, and numerous management plans have been prepared for the property. However, none of these plans

were submitted to the State or the National Park Service to ensure they were compliant with LWCF rules and guidelines. This is because administrative management of the LWCF program changed over the years. As stated previously, LWCF inspections of the property focused only on activities at the RGNCSP, therefore, it was assumed by all that compliance was being met due to the activities at the RGNCSP.

In early Spring 2016, the farmer contracted by the City of Albuquerque to manage the CNP fields terminated his contract, and the City contracted another farmer to continue operations in order to prevent fields from going fallow and spreading invasive plants. Concerns over farming practices, specifically concerning the use of pesticides and herbicides, and future management led some CNP neighbors and other North Valley residents to contact the Albuquerque Open Space Advisory Board and the LWCF State Liaison Officer (SLO) asking for clarification of the status of the CNP site within the terms of both Major Public Open Space facilities and the LWCF. The SLO notified the City in October 2016 that the property was not in compliance with LWCF rules, specifically:

- signs acknowledging that the site has been purchased with LWCF funds were not posted on access points to the property; and
- public access to the site for outdoor recreation was prohibited on significant portions of the property.

In researching what outdoor recreation activities had been sanctioned for the property, the SLO found that there was no federally approved master plan. Further research into the current use of the property for commercial agriculture revealed that commercial agriculture is not an approved outdoor recreation activity on LWCF encumbered property. After several conversations with the City Parks and Recreation staff, the SLO, in a letter dated February 14, 2017, gave the City a 3-year transition period to come into compliance.

In 2016 and 2017, the City Council passed two resolutions (R-16-147 and R-17-159) to develop a Resource Management Plan that brings the City of Albuquerque's Open Space Division into compliance with the Land and Water Conservation Fund guidelines, which this document represents. The final plan will be submitted to the SLO and NPS to ensure compliance with LWCF guidelines.

This resource management plan is designed to implement habitat restoration to the benefit of wildlife, while also taking into account the financial burden of managing, maintaining, and operating the CNP, including the wildlife crops, proposed restoration, recreational activities, and educational outreach at the CNP.

This plan is estimated to cover a 20-year time span and to be implemented in quarterly phases. The OSD will provide an annual report to the Open Space Advisory Board, and available to the public, on the status of the RMP implementation that will include the year's activities, challenges, and funding. In addition, OSD will review this RMP every 4 years with the OSAB to discuss potential updates and changes to the plan in accordance with the goals of outdoor recreation, habitat restoration and wildlife forage.

TABLE OF CONTENTS

A. INTRODUCTION

1. The Purpose of this Resource Management Plan

The Candelaria Nature Preserve is to be managed as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors, as required by the LWCF Act. The vision of the CNP as a wildlife preserve to be enjoyed by the public was outlined in the 1976 proposal for LWCF funds from the City and State for preserving the existing natural landscape and its plants and animals with a possible nature study area; as reaffirmed in the 1978 rezoning as a Special Use Zone for a Nature Study Center and Preserve; as affirmed by the USDA "Land Treatment" plan for wildlife habitat conservation; and as affirmed by the 1979 Master Plan for the Rio Grande Nature Center and Preserve.

The City of Albuquerque directed the Open Space Advisory Board to convene a Technical Group to create a new Resource Management Plan (RMP) for Candelaria Nature Preserve to clarify and update the conclusions and goals of previous plans and come into compliance with Land and Water Conservation Fund rules and regulation. The RMP is consistent with City policy, fulfillment of the City's fiduciary duties, and include relevant surveys and cost estimates.

This RMP tackles the following management issues:

1. Transitioning the site to serve as a wildlife preserve that includes wet and dry areas, hedgerows, forage for wildlife, and agriculture as a management technique.
2. Adaptive management and monitoring.
3. Public access and outdoor recreation
4. Phased implementation plan to ensure success.

According to the City's 1999 Major Public Open Space (MPOS) Rank II Facility Plan, the goals of the Open Space Division (OSD), are to acquire and protect the natural character of land designated as Major Public Open Space. These lands are managed to conserve natural and archaeological resources, provide opportunities for outdoor education and low impact recreation, and define the edges of the urban environment." The Major Open Space Facility Plan identifies the types of Major Public Open Space, including Open Space Preserves, which the CNP falls under.

Additionally, the revised Albuquerque/Bernalillo County Comprehensive Plan (Rank 1 Comprehensive Plan) that was adopted by City Council in 2017 identifies goals that align with the mission of the CNP and LWCF requirements. Those goals include the following:

Goal 10.1 Facilities and Access: Provide parks, Open Space, and recreation facilities that meet the needs of all residents and use natural resources responsibly.

Goal 10.3 Open Space: Protect the integrity and quality of the region's natural features and environmental assets and provide opportunities for outdoor recreation and education.

2. The Vision and Mission of the Candelaria Nature Preserve

The Vision of the Technical Advisory Group is to engage in a planning process that results in improved ecosystem health and increased biodiversity of CNP, ensures compliance with Land and

Water Conservation Fund guidelines by providing opportunities for wildlife oriented recreation, and fulfills the requirements of City Council resolutions R-16-147 and R-17-159.

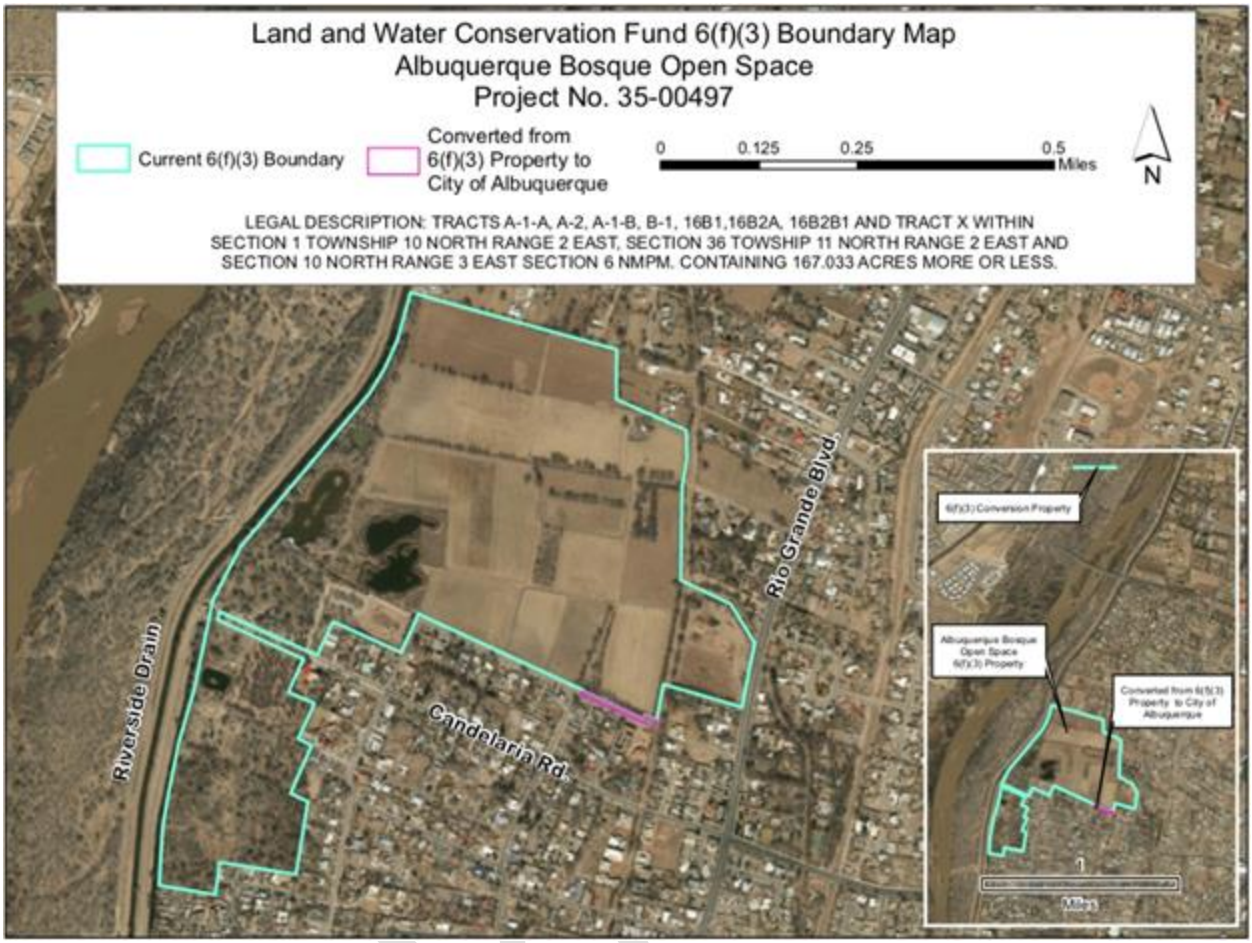
The Mission of the CNP, is to be managed as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors. The CNP is uniquely situated to create and protect habitat for birds and other wildlife. Located along the Rio Grande Flyway, the preserve attracts numerous migratory bird species as well as other wildlife. In addition, the preserve is connected to the aquatic and bosque habitats provided by the RGNCSP and Rio Grande Valley State Park (RGVSP). Together, these areas create a corridor of different habitats for birds, small mammals, reptiles, amphibians and insects. Additionally, the property is located in the heart of the North Valley and a popular destination for residents and visitors due to the rich programs offered at the RGNCSP. The opportunities for community engagement and education abound. The TAG has thoughtfully explored how to provide meaningful education and citizen science activities as well as cultivate stewards for this land while being protective of the wildlife habitat the CNP supports.

3. Maps and Location

The CNP, including the RGNCSP, comprises approximately 167 acres east of the Rio Grande within the municipal limits of the city of Albuquerque (Figure 1.1 [the LWCF conversion map below]). This site is a well situated in the network of local Parks and Open Space areas and is easily accessed from area trails.

The RGNCSP is located on 38.8 acres leased from the original site and is managed by New Mexico State Parks. The remaining Open Space acreage is managed by the City of Albuquerque OSD. The Open Space has several distinct areas: the “Farm Fields” east of the RGNCSP and west of the Duranes Lateral, the “Tree Nursery” east of the Duranes Lateral along Rio Grande Boulevard, and the “South Tract” south of Candelaria (excluding the Discovery Pond area, which is managed by State Parks).

The South Tract section includes remnants of the Fraternal Order of Police structures including a swimming pool that has been filled in with dirt creating a slight elevation, a broken and degraded asphalt road, and a crumbling fire pit lined with basalt; this area is not currently arable and is not irrigated. The Rio Grande Valley State Park (RGVSP; “the Bosque”) is adjacent to the CNP on the west side of the Albuquerque Riverside Drain. (Figure 1.2 [the Google Earth map with hand-drawn boundaries below]).


Land and Water Conservation Fund 6(f)(3) Boundary Map
Albuquerque Bosque Open Space
Project No. 35-00497
Current 6(f)(3) Boundary
Converted from 6(f)(3) Property to City of Albuquerque
0
0.125
0.25
0.5
Miles
N
LEGAL DESCRIPTION: TRACTS A-1-A, A-2, A-1-B, B-1, 16B1,16B2A, 16B2B1 AND TRACT X WITHIN SECTION 1 TOWNSHIP 10 NORTH RANGE 2 EAST, SECTION 36 TOWSHIP 11 NORTH RANGE 2 EAST AND SECTION 10 NORTH RANGE 3 EAST SECTION 6 NMPM. CONTAINING 167.033 ACRES MORE OR LESS.
Riverside Drain
Candelaria Rd.
Rio Grande Blvd.
6(f)(3) Conversion Property
Albuquerque Bosque Open Space 6(f)(3) Property
Converted from 6(f)(3) Property to City of Albuquerque
1
Miles

4. Legal Description

The CNP property is described as a Parcel of Land, Section 1, T10N, R2E and Section 36, T11N, R2E, N.M.P.M., said parcel comprising portions of Tracts A-1, A-2, and B-1 of the Candelaria Farms Area Middle Rio Grande Conservancy District (MRGCD) Maps 31 and 34 (filed in Bernalillo County Clerk's Office on 12-29-67 in Vol. D3 Folio 181).

5. Policy Framework

This plan has been written within the context of an existing policy framework that includes the City of Albuquerque Major Public Open Space Facility Plan, the Albuquerque/Bernalillo County Comprehensive Plan (updated by the City in 2017), the zoning established by the City of Albuquerque, the 1979 Predock Plan, 1980 Lease Agreement for the RGNCSP site, the 1983 Rio Grande Nature Center Memorandum of Agreement, the Rio Grande Nature Center Management Plan, the Land and Water Conservation Fund Regulatory Framework, State Assistance Program Federal Financial Assistance Manual, and other planning documents such as the 1993 Bosque Biological Management Plan. These documents as well as other policy framework and planning documents are listed in Appendix A. Due to the amount of reference documents in Appendix A, the documents are available on CD.

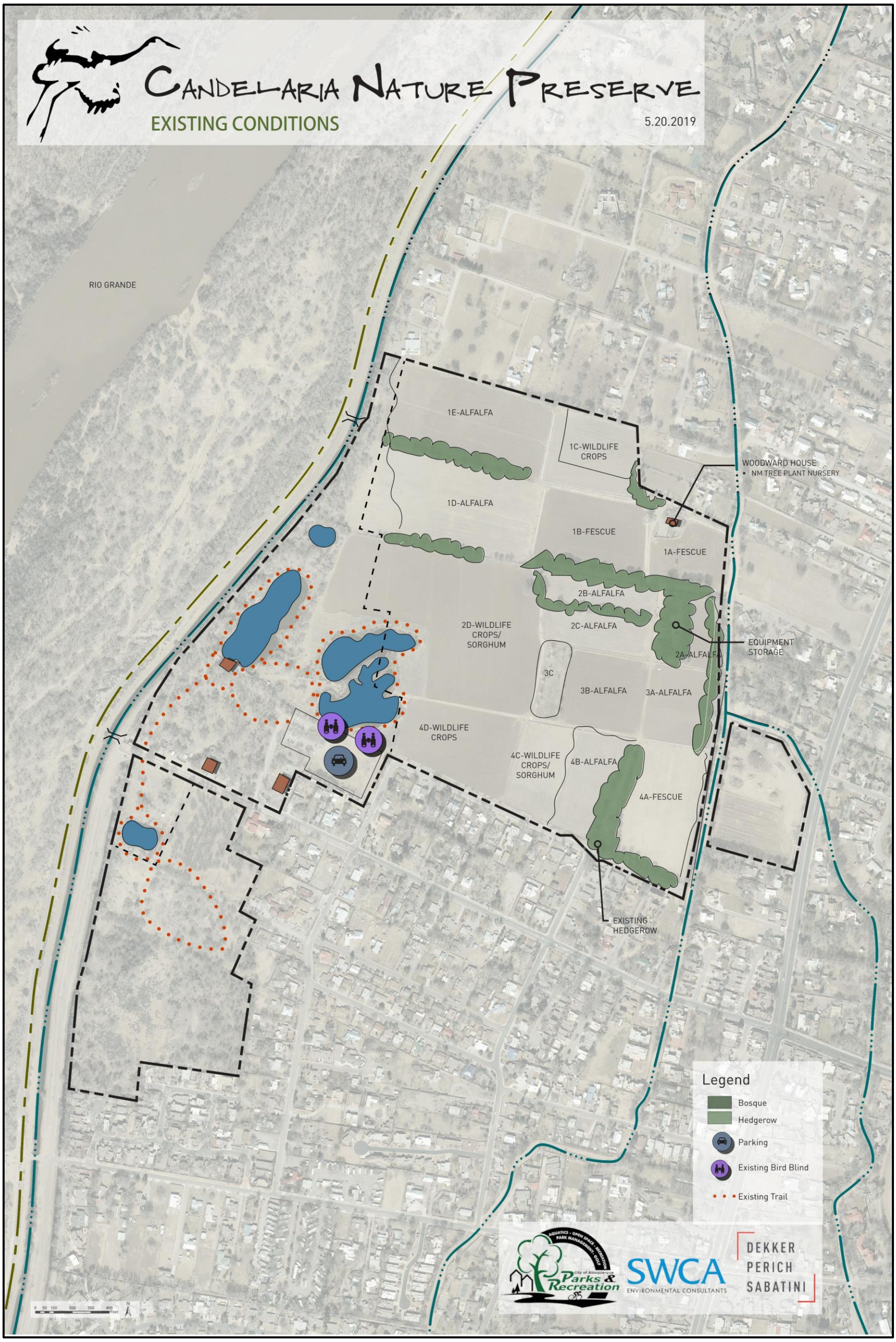


Figure 1.1. Aerial view of the Candelaria Nature Preserve and Rio Grande Nature Center State Park.

5.1 The Land and Water Conservation Fund Regulatory Framework

The property's purchase, costing $1,707,000, was funded with a combination of State and Federal grants ($600,000), sale of surplus City land ($308,500), General Obligations Bonds ($737,324), and Surplus City Capital dollars ($61,176). The grant monies were from the Secretary of the Interior's Contingency Fund of the Land and Water Conservation Fund (LWCF; U.S. Code Annotated Title 16, Conservation, Sections 460D, 4601-4 to 4601-11). The LWCF funds, used to purchase the property as a nature preserve for public outdoor recreation, impose certain restrictions on the property *in perpetuity*. The LWCF regulations require that properties acquired or developed with LWCF assistance shall be operated and maintained so as to appear attractive and inviting to the public; protective of public safety and health; kept open for public use at reasonable hours and times of the year, according to the type of facility; kept in reasonable condition to prevent undue deterioration and to encourage public use; and shall have posted an LWCF acknowledgement sign at the project site. Any removal of the property or portion of the property from outdoor recreation use constitutes a "conversion," which must be approved by the National Park Service (NPS) through a rigorous application and review process. An approved conversion requires that the outdoor recreation facility or property be replaced with a facility or property of equivalent value. Congress must approve any transaction for a facility or property replacement. Responsibility for compliance with the LWCF regulations rests with the State and the State Liaison Officer.

On September 21, 2016, the LWCF State Liaison Officer (SLO) performed an inspection of the Candelaria Nature Preserve property and found several issues of non-compliance. One, the entire property was not reasonably accessible to the public. The farm fields were fenced and equipped with signs clearly prohibiting public access. Two, no signs were posted acknowledging LWCF funding for the property's acquisition. In researching the history of the property, the SLO also found that there had been no NPS-approved management plan for the entire property outlining acceptable outdoor recreation activities so as to ensure compliance with LWCF guidelines. The City of Albuquerque was notified of these issues in an October 6, 2016, letter to the Mayor requesting that efforts be made to bring the property into compliance. Since no NPS-approved management plan for the entire property existed, the City determined that the best course of action was to develop a new management plan with public participation. This Resource Management Plan (RMP) is the result of that effort.

This planning document, prepared with public notice and involvement, outlines the goals and objectives of the outdoor recreation use of the CNP property so as to ensure consistency with LWCF regulations and guidelines.

As of 2019, large areas of the Candelaria Nature Preserve property are still devoted to agriculture, effectively excluding safe access by the public. The LWCF manual specifically excludes agriculture as a natural resource management practice compatible with outdoor recreation. The LWCF also specifically prohibits acquisition of land primarily for the preservation of agricultural purposes. These mandates were not recognized in previous management plans completed for the property, which was intended to be a nature study area and wildlife preserve. Appropriate and allowable outdoor recreation activities consistent with the

wildlife preserve objective must be outlined and management practices developed as to provide reasonable public access to the property for all residents and visitors. This applies to the entire property, including the Candelaria Farms, the South Candelaria tract, and the Rio Grande Nature Center State Park.

This plan will identify appropriate outdoor recreation activities for the CNP, develop guidelines for reasonable public access consistent with the wildlife preserve objective, and outline a process and schedule for transitioning the current, non-compliant land uses to wildlife-preserve-related outdoor recreation.

5.2 City of Albuquerque Documents and Policies Related to Candelaria Nature Preserve

5.2.1 Resolution R-16-147

Resolution R-16-147 states that the CNP is to be managed as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors, as required by the LWCF Act and as intended by the 1976 proposal from the City and State for preserving the existing natural landscape and its plants and animals for "nature study, recreation uses, open space, and urban shaping." The Resolution directed the Open Space Division (OSD) and Parks and Recreation Department (PRD) to develop a new Resource Management Plan for CNP that will meet LWCF requirements and commitments the City made in accepting LWCF funding to acquire the CNP site. In particular, the resolution stated that "[t]he RMP shall utilize as its basis and shall not reinvent, but rather clarify and update the conclusions and goals of previous plans, in particular the 1979 Predock plan." The RMP is to be submitted to the PRD Director, the Open Space Advisory Board, and the City Council for review that will include conformance to LWCF rules, consistency with City policy, fulfillment of the City's fiduciary duties, and inclusion of relevant surveys and cost estimates. [NEW PARAGRAPH] To aid in developing the RMP, OSD and PRD were directed to convene a Technical Advisory Group (composed of representatives from neighborhoods, federal agencies, state agencies, and other technical experts) to work with all interested parties to determine the funding necessary to carry out the RMP and work collaboratively to secure the on-going funding to maintain CNP as a wildlife preserve and nature study area. The Resolution stated that to prevent degradation of the property and maintain wildlife habitat, the City may lease CNP for agricultural activity during the RMP process; however, organic farming practices shall be encouraged, and use of pesticides shall be prohibited and use of herbicides shall be minimized. In addition, nothing in the resolution is intended to limit or interfere with projects intended for the repair, maintenance, or upkeep of the CNP.

5.2.2 Resolution R-17-159

Resolution R-17-159 amended parts of Resolution R-16-147. The amendment gave the Open Space Advisory Board oversight of the RMP process including convening the Technical Advisory Group and working collaboratively with OSD and PRD to complete the RMP. To develop a new RMP, the Open Space Advisory Board named a lead and alternate lead for the Technical Advisory Group. A final list of the Technical Advisory Group members where to be submitted to the Open Space Advisory Board, OSD, PRD and the City Council. The Technical

Advisory Group where charged with providing status report on the development of the Resource Management Plan to the City Council upon request.

5.2.3 1978 Zoning Change to Special Use

The City Environmental Planning Commission zoned the original Candelaria Farm Nature Center and Preserve lands SU-1 (Nature Center and Preserve) on May 16, 1978. The SU-1 zoning also imposes restrictions on the use of the land. For example, new permanent buildings are considered Extraordinary Facilities and must pass through a public hearing process before they are approved at the site.

5.2.4 1979 Rio Grande Nature Center and Preserve Master Plan (Predock Plan)

The 1979 Rio Grande Nature Center and Preserve Master Plan (Predock Plan) was developed to outline the elements necessary to establish a properly functioning nature facility. The facility would include a Nature Preserve - for the encouragement and protection of native wildlife communities - and a Nature Center and Interpretive Programs as an interface whereby the public can benefit from the knowledge gained in studying wildlife at the preserve. The site would be managed based on key criteria: biological feasibility; improvement of soils, plants and wildlife communities; increased plant productivity with minimal artificial treatment; economic feasibility; and maximum edge condition. The plan states that in order to prevent disturbance to the wildlife, access would be limited.

was developed to provide a guide for development of the Candelaria Farms site which will not only explore its exciting educational and recreational potential but will also preserve and reinforce its existing beneficial open space qualities. The plan states that in order to prevent disturbance to the wildlife, certain zones of the site are restricted and public entry is not permitted into these areas (Predock 1979). The CFP shall be considered one such restricted are, and entry will be limited to guided programs. The plan also states that the farm was to be farmed for wildlife crops.

5.2.5 1980 Lease Agreement

The state leased 38.8 acres of the original site for the development and operation of the RGNCSP on December 3, 1980. The boundaries of this lease area are illustrated in Figure 1.1.

5.2.6 1983 Rio Grande Nature Center Management Plan

The 1983 Management Plan, prepared by the New Mexico State Park and Recreation Division, developed comprehensive operation and management strategies for the two distinct land uses at the CNP. For agriculture, the contract farmer was to use 60 acres for alfalfa as a cash crop and plant the remaining acreage with crops that support wildlife. Each of these management units have specific planting, watering and fertilizing, and cutting schedules the sharecropper must adhere to in compliance with the Farming Agreement.

5.2.7 1983 MOU Between the City and State

The Memorandum of Understanding between the State and the City (Contract No. 71-541-15 dated 6-6-83) documents the working relationship between the City of Albuquerque Open Space Division and the New Mexico State Parks and Recreation Department (Appendix A). The MOU

states that the lands will be managed as outlined in the Rio Grande Nature Center Management Plan dated May 1983.

5.2.8 1999 Major Public Open Space (MPOS) Rank II Facility Plan

The City's 1999 Major Public Open Space (MPOS) Rank II Facility Plan identifies the types of Major Public Open Space, including Open Space Preserves. An Open Space Preserve is defined as an area that is set aside for its exceptional natural, cultural or scenic value. Resources are fragile, and protection is the primary management objective. An Open Space Preserve provides protection of views, native vegetation and wildlife habitat, geological features and/or archaeological, historical, or cultural features. Management emphasis is on restoring, preserving and enhancing the characteristics of the area. Development is limited to the minimum required for public safety and resource protecting and enhancement. Public access is only allowed under the supervision of staff and by permit. Open Space Preserves may be closed to public access to protect habitat and historic, cultural, and archaeological resources. In the case of Candelaria Nature Preserve, the values intended for development and protection were a nature study area and a preserve for wildlife forage and habitat, with the goal of providing public education about the Middle Rio Grande and Bosque ecosystems through the RGNCSP. However, limited access for outdoor recreation - most typically wildlife viewing - needs to be provided at CNP due to LWCF requirements. Therefore, the MPOS policies restricting general public access will be modified to comply with LWCF policy."

Policy A.1.B. This MPOS type shall be conserved and protected for its intrinsic value as a significant visual, natural or environmental resource. Trails shall be limited to those necessary for research, maintenance, policing and scientific study. Protection of these resources should include natural barriers, fencing, signage, control of use, and patrol by rangers.

Policy A.2.C Resource Management Plans should be developed for the Sandia Foothills, West Side Open Space, Candelaria Farms, the Montessa ORV Park, Placitas Open Space, Calabacillas Arroyo, East Mountain Open Space and Tijeras Arroyo.

The Resource Management Plan shall:

- Identify land use "carrying capacity";
- identify access point(s);
- identify facility locations, including utility and transportation corridors;
- identify areas to be monitored and develop a monitoring and management plan;
- establish policies (in this RMP these are reference as protocols) for resource management, access and parking, facility management, staffing, fees, interagency cooperation and enforcement;
- classify the parcels within the Resource Management Plan area by MPOS type, according to the criteria contained in Table 2-1;
- evaluate impacts or proposed development within the Major Public Open Space on adjacent areas; and
- evaluate reasonable alternative development schemes.

5.3 Albuquerque/Bernalillo County Comprehensive Plan (2017) Rank 1 Plan

Additionally, the revised Albuquerque/Bernalillo County Comprehensive Plan that was adopted by City Council in 2017 identifies goals, policies and Actions that apply to this RMP. They include the following:

Goal 10.1 Facilities and Access: Provide parks, Open Space, and recreation facilities that meet the needs of all residents and use natural resources responsibly.

Policy 10.1. 1: Distribution: Improve the community's access to recreational opportunities by balancing the City and County's parks and Open Space system within the built environment.
A) Protect and maintain a high-quality, accessible system of recreation facilities and site sufficient to serve all areas.
B) Establish an interconnected network of parks, Open Space, and trails with safe pedestrian connections to community facilities, neighborhoods, and Centers.

Actions

10.1.1.1 Monitor levels of services for parks and recreation facilities, including the impacts of recent and expected growth.
10.1.1.2 Evaluate costs, benefits and impacts of new facilities.

Policy 10.1.2: Universal Design: Plan, design program, and maintain parks, Open Space, and recreation facilities for use by people of all age groups and physical abilities.
A) Design and maintain landscaping and park features appropriate to the location, function, public expectation, and intensity of use.

Actions

10.1.2.1 Identify and prioritize projects to address existing ADA deficiencies through coordinator among the Bernalillo County Parks and Creation and Public Works Departments and City of Albuquerque Parks & Recreation and Municipal Development Departments.
10.1.2.2 Bring existing facilities into compliance based on the Bernalillo County 2014 Parks and Recreation Access Audit and Transition Plan or the City's parks and trails ADA audit and Transition Plan.
10.1.2.3 Provide information to the public about parks, Open Space facilities, and trails that are ADA accessible and current efforts to improve accessibility within the system.

Policy 10.1.4: Water Conservation: Employ low-water use and reclamation strategies to conserve water.
A) Incorporate native vegetation and low water use species wherever possible, particularly in areas without easy access to irrigation.
B) Integrate irrigation, water conservation, drainage, and flood control functions within parks and Open Spaces with ecological preservation and recreational purpose.

Actions

10.1.4.1 Review and update technical standards that balance water resources management with ecological preservation and recreational purposes.

10.1.4.2 Improve facilities and neighborhood parks using sustainable and green development practices.
10.1.4.3 Coordinate with MRGCD to develop best management practices and to accommodate facilities, such as trails, where appropriate and feasible, within parks and Open Space that do not compromise the function of the irrigation system for its designed purpose and are consistent with the Rio Grande Compact requirements.

Goal 10.3 Open Space: Protect the integrity and quality of the region's natural features and environmental assets and provide opportunities for outdoor recreation and education.

Policy 10.3.2: Preservation: Identify and manage sensitive lands within the Open Space network to protect their ecological functions.
A) Manage public access to best protect natural resources.
B) Ensure that development within Open Space is compatible with its preservation purpose.

Action
10.3.2.1 Conduct slope, soil conditions, and/or other appropriate surveys to determine Open Space property liens and identify sensitive lands.
10.3.2.2 Develop and implement site management strategies and preservation techniques for protected areas.

Policy 10.3.3: Use: Provide low-impact recreational and educational opportunities consistent with the carrying capacity of the Open Space resources.
Actions
10.3.3.2 Develop standards to minimize impacts and environmental damage on areas suited for public access.

Policy 10.3.4: Bosque and Rio Grande: Carefully design access to the Rio Grande, the bosque, and surrounding river lands to provide entry to those portions suitable for recreational, scientific, and educational purpose, while controlling access in other more sensitive areas to preserve the natural wildlife habitat and maintain essential watershed management and drainage functions.
A) Minimize disturbance or removal of existing natural vegetation from the bosque.

5.4 Other Applicable Planning Documents

Planning documents that may further complement the policy context of this plan are:

- 1979 Rio Grande Nature Center and Preserve Master Plan (i.e., Predock Plan)
- 1988 Albuquerque/ Bernalillo County Comprehensive Plan.
- 1993 North Valley Area Plan.
- 1993 Bosque Action Plan (Rank 2 Plan).
- 1993 Middle Rio Grande Ecosystem: Bosque Biological Management Plan
- 1999 Major Public Open Space Facility Plan.
- 2004 Open Space RMP for the Candelaria Farm Preserve, Draft

- 2005 Middle Rio Grande Ecosystem Bosque Biological Management Plan, The First Decade: A Review and Update.
- 2010 Special Management Areas Joint Management Plan
- 2010 Rio Grande Nature Center State Park Management Plan
- 2012 Department of Interior mandated Middle Rio Grande Conservation Initiative: A Citizen's Report: Strengthening Our Heritage in the Middle Rio Grande
- 2017 Albuquerque/Bernalillo County Comprehensive Plan
- City of Albuquerque's Integrated Development Ordinance (IDO).

B. PROJECT HISTORY

1. Environmental History of the North Valley

The North Valley and CNP are situated at the northern end of the southern Rio Grande Rift valley, located at the western base of the Sandia Mountains in the physiographic Basin and Range Province of North America (Hawley 1978). The southern Rio Grande Rift valley resulted from extensive tectonic activity, producing horst/graben physiography with fault block mountains, volcanic activity, and a subsidence rift valley during the early Miocene approximately 20 million years ago (Hawley 1978; Hunt 1983). The Rio Grande historically began flowing through the vicinity of the Albuquerque Reach of the Rio Grande during the Miocene, initiating the present river course (Hunt 1983). The southern Rio Grande Rift valley becomes broad in the vicinity of the Albuquerque Reach, where the Rio Grande transitions from a region of steeper elevation gradients and narrow valleys and canyons to the north, to a more gradual grade over a broad valley with historic floodplains to the south (Corps, Albuquerque District et al. 2006).

The MRG Basin is defined as that portion of the Rio Grande and its drainages from Bandelier National Monument on the east side of the Jemez Mountains, south to the upper end of Elephant Butte Reservoir (Scurlock 1998) within New Mexico. However, this same geographic area also is known as part of the "Upper Rio Grande Basin" (Corps et al. 2006) relative to the entire Rio Grande watershed from Colorado to the Gulf of Mexico. The North Valley area is part of the Albuquerque Reach of the Middle Rio Grande (MRG). The Albuquerque Reach ranges in elevation above sea level from 1,538 m (5,047 feet) at the upstream end at Angostura Diversion Dam to 1,490 m (4,890 feet) at the downstream end at the southern boundary of Isleta Pueblo. The MRG adjacent to the CNP is defined by Scurlock (1998) and the multi-agency Endangered Species Collaborative Program (Tetra Tech 2004).

Since the onset of the Holocene about 10,000 years ago, the climate of northern New Mexico has been semiarid with a history of cyclic drought and wet periods (Swetnam and Betancourt 1999). For the past 600 years, there is little evidence for any major changes in the climate of the MRG Basin, other than a cool period from about A.D. 1450 to 1850 and the recent global warming trend (Hall et al. 2006; Rahmstorf et al. 2007). At least 52 major droughts were recorded in the MRG Basin over the past 448 years, occurring about every nine years. In more recent times, increased occurrences of El Niño Southern Oscillation (ENSO) events have resulted in numerous short-term changes in precipitation and temperature, affecting flow volumes and rates in the Rio

Grande (Swetnam and Betancourt 1999; Lee et al. 2004). Snowmelt runoff from the San Juan, Sangre de Cristo, and Jemez mountains have historically been the primary source of water for the Rio Grande, with additional local input from summer storms. Hall et al. (2006) demonstrates that in recent times (since the 1960s), the timing of spring runoff and subsequent Rio Grande flow rates have begun to occur earlier in the season, in response to variations in temperature and precipitation. See the Climate section below, for more about recent global warming and climate change.

2. Native and Early Spanish Settlement along the Middle Rio Grande

The valley floor of the Rio Grande varies in width from three to five miles near Albuquerque. It has the richest agricultural land in the semi-arid environment of New Mexico. The valley's fertility was maintained by the continuous deposition of rich organic soils formed by erosion of rocks and debris from the Sandia Mountains and the west mesa as well as from flooding of the valley floor by the Rio Grande.

Native peoples experienced unstable agricultural conditions caused by seasonal floods and droughts. Although floods periodically wreaked havoc on valley settlements, the indigenous people who carefully tended these productive lands to grow food for human and animal consumption considered them a blessing. In order to maintain economic stability, survival, and sustenance, they were forced to move their villages between the upland and riverine areas, as dictated by the river. Management of their agricultural and hunting lands involved rich symbolism and rituals that served to regulate land use practices and to articulate the agrarian knowledge of non-literal peoples (Ellen, 1982 & Conklin, 1972). The survival of their pueblos along the river depended on the sustainable land use practices that enhanced the land's productivity.

When the Spanish settlers came to New Mexico, they entered with a different paradigm. Their evangelical activities often altered the symbolic, social, and ceremonial bases of agriculture of the Indians. The Spanish established small farms and a few large haciendas among the Indian lands. Using Indian labor, they planted new crop species such as onions, lettuce, radishes, grapes, plums, peaches, wheat, barley, and chiles, and a variety of beans from Mexico. On the grasslands and lower foothills, the settlers grazed domesticated herds of cattle, sheep, and goats.

Although the Spanish were driven from the valley during the Pueblo Revolt of 1681-1692, they soon returned and reinstated the process of intense colonization. The land use patterns they established persisted in the valley for over 200 years. These patterns included the development of acequia irrigation and the division of land into lineas (long narrow strips) for the purpose of accessing both productive valley lands adjacent to irrigation waters and mesa lands for continued grazing of large herds of cattle and sheep. Their primary occupation was subsistence farming, through which farmers raised enough food to support themselves and their extended families.

By the time the Villa of Albuquerque was established in 1706 where Old Town is located today, the emergence of cash cropping and increased demand for particular export items had simplified indigenous and traditional Spanish land use strategies. The result was a destabilization of the resource base and agriculture risk management strategies. The Villa served a vital role as the

center of early trading for food and supplies along the El Camino Real, or the "Royal Highway", which ran from Mexico City north to Santa Fe. An early Spanish visitor described the crops taken from the north valley for sale in the plaza at harvest time as being, "many, good, and everything sown [in the valley] bears fruit" (Sargeant and Davis, 1986).

By 1790, an official Spanish census listed six defined family settlements, or "plazas," north of Albuquerque, which grew into small villages. From south to north – roughly between present-day Rio Grande Blvd and 4th Street – these were the Plaza de Senor San Jose de los Duranes, the Plaza de los Candelarias, the Plaza de Nuestra Senora del Guadalupe de los Griegos, the Plaza del Senor de los Gallegos, the Plaza de San Antonio de los Poblanos, and the Plaza de San Jose de Los Ranchos (See Historical Plazas of the North Valley, Figure 2.1). Each community was centered around a chapel and connected by a series of dirt roadways (Sargeant and Davis, 1986).

An updated map is being prepared

Figure 2.1. Historical plazas of the North Valley.

3. River Flooding, River Engineering, and the Consequences

Before the engineering of the mid-20th century, the Rio Grande consisted of numerous braided channels that were dynamic and changed frequently across a broad floodplain in the Albuquerque Reach (Scurlock 1998), and see images in TetraTech 2004:28). Numerous channels, oxbows, and wetlands were common (Crawford et al. 1993; Scurlock 1998). During the 1700s the Rio Grande channel shifted considerably to the west in several reaches of the MRG, including at the settlement of Bernalillo and likely the northern portion of the Pueblo. The Rio Grande again shifted to the west in the early 1800s and was described as about 91 m (300 feet) wide, shallow, and sandy. However, in 1873, the Rio Grande at Albuquerque (Barelas) was described as being 183 m (600 feet) wide and about 1.2 m (4 feet) deep (Scurlock 1998).

Prior to the 1500s, human water use in the Rio Grande valley consisted of limited agricultural irrigation by native pueblo people and early Spanish settlers (Scurlock 1998). Starting in the late 1600s, the division of the large Spanish and Pueblo land grants into smaller private parcels throughout the valley confined the historical and cultural movement of peoples from the riverine lands to the uplands. As a result, valley farms were susceptible to the Rio Grande's annual flooding and unpredictable activity, and precipitation events occurring in higher elevations would cause flash flooding in the lower land. Water volume in the Rio Grande historically peaked during the spring months due to snowmelt runoff and subsided to low-flow levels by late summer. At least 82 major Rio Grande flood events occurred in the MRG Basin between 1591 and 1942 (Scurlock 1998). The largest estimated flood was from spring runoff in 1872 at 100,000 cubic feet per second (cfs) in the MRG. Historic records for Rio Grande measured flow rates date back to the installation of gaging stations in 1889. Prior to the construction of dams and widespread river regulation from the 1930s to 1970s, large flooding events that altered river channel spatial distribution and morphology were common. Spring floods of 20,000 to 30,000 cfs resulting from snowmelt runoff were recorded fairly commonly between the late 1800s when gaging stations were installed, and 1942 when river regulation began. Record levels of rainfall and snow contributed to high Rio Grande flow rates from 1940 through early 1942, resulting in extensive flooding, but peak flow rates remained around 20,000 cfs. The largest measured Rio Grande flood within the MRG resulted from summer convectional storms in August 1929 and reached 47,000 cfs. In contrast, channel drying has also been observed several times since 1752, particularly during the 1880s downstream from Albuquerque (Scurlock 1998).

A considerable increase in water use and diversions occurred in the late 1800s. Growing numbers of settlers diverted increasing amounts of water from the river for irrigation. In addition, heavy logging in northern sections of the Rio Grande led to heavier snowmelt and rainwater sediment runoff. Rio Grande sediment loads likely were highest during the spring months and also following summer convectional storms. Historic records describe the Albuquerque Reach as experiencing considerable riverbed aggradation during the late 1800s and early 1900s. Reduced river flow from water diversions and growing agricultural practices caused soil erosion throughout the watershed, providing heavy sediment loads. The channel bed of the MRG apparently consisted mostly of sand, whereas the riverbed above the confluence of the Rio Jemez consisted largely of cobble and gravel (Crawford et al. 1993). Historically, groundwater rose as a result of increased flood irrigation within the floodplain resulting in waterlogged fields and alkali

conditions (Berry and Lewis 1997). By early 1900, much of the land that had at one time been rich, fertile and cultivated was classified as a "wasteland". Government reports listed much of the land as alkali, marsh, and sand hills.

Devastating floods and degraded land put the state government under pressure to reclaim the valley lands. Extensive Rio Grande water manipulations began after the formation of the Middle Rio Grande Conservancy District (MRGCD) in 1925 to protect users along the river against flooding and provide centralized allocation of irrigation waters. By 1940, the MRGCD had built over 400 miles of levees, drains, and irrigation ditches, making thousands of acres of North Valley land safe for agricultural production and building. Even with those controls in place, more severe flooding occurred in 1941 and 1942, and this forced the Bureau of Reclamation and the Army Corps of Engineers to implement widespread channel modifications with the implementation of the MRG Project in 1950. The river was straightened and confined between two parallel levees, and large iron Kellner jetty jacks were fixed to the bank to protect the newly created levees. Drainage systems, water diversion channels, and increased groundwater pumping eventually served to effectively limit overbank flooding and lower the water tables of the floodplain (Scurlock 1998). Commercial cropping expanded rapidly as a result.

All of the engineering done to tame the river for human purposes ultimately disrupted the ancient connection between river water and groundwater in the adjacent floodplain, which is essential to the survival of native riparian vegetation. Jetty jacks collected sediment that in turn became a seedbed for the establishment of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) (Muldavin et al. 2004). The result was the transformation of a relatively open riparian zone into a nearly continuous, even-aged gallery forest (Crawford et al. 1993). Furthermore, the sediment and flood control structures constructed along the MRG caused accelerated channel degradation, creating a riverbed that is, and will continue to be more incised and channelized (Crawford et al. 1993). Sediment loads have declined considerably since the construction of the Rio Jemez Dam in the early 1950s and Cochiti Dam in 1973 with a reduction from average annual suspended sediment (SSED) concentrations of about 4,000 parts per million (ppm) by water volume to about 500 ppm (Corps et al. 2006). Groundwater levels in the Sandia Reach have declined significantly due to groundwater pumping, particularly by municipalities and channel incision.

Recent long-term trends in groundwater elevation indicated a decline in groundwater elevation (S.S. Papadopulos and Associates [SSPA] 2005). Wells located near Alameda Boulevard exhibited a linear decrease in groundwater elevation at rates of 0.23 to 0.35 m/year (0.75–1.15 feet/year) over a 16- to 48-year period (SSPA 2005). These declines are attributed to municipal and industrial water uses in the Albuquerque area. Groundwater fluctuations also have occurred seasonally. In the Alameda area, the fluctuations vary from well to well, but average about 0.3 m (1 foot) in magnitude. Greater fluctuations are evident at other wells between the riverside drains with peak groundwater elevations occurring between April and June. Since late 2008, when the Albuquerque Bernalillo County Water Utility Authority began supplementing groundwater pumping with surface water from the San Juan Chama Drinking Water Project, groundwater levels have generally risen somewhat, but projections are that increased groundwater pumping will begin again by the 2030s.

Differences between the evapotranspiration rates of native versus non-native vegetation also have significant implications for groundwater depth. Simulation models used by SSPA (2005) have revealed that evapotranspiration rates have decreased by 20% when non-native vegetation was replaced by native vegetation, resulting in higher groundwater elevation and reduced seepage loss. Additional information about groundwater in the Albuquerque area can be found in McAda and Barroll (2002), Tetra Tech (2004), and SSPA (2005, 2006).

4. Agriculture in the North Valley

The name "Candelaria Farm" remains elusive in historical records and oral interviews with senior North Valley Residents. However, it can be assumed that it is named after the the Plaza de Los Candelarias and the prominent Candelaria family, who had strong agricultural ties in the early development of the North Valley. Candelaria Road has historically been, and currently remains, a major corridor that connects into the Plaza de los Candelarias (750-present), just 1.5 miles east of the Farm (Figure 2.1). The CNP's location at the farthest west end of Candelaria Road may be one simple reason why it has maintained the name Candelaria Farms.

Little is known about the actual history of ownership and land use on the Candelaria Farm site before 1928. Until the Rio Grande was contained within its levees and the riverside drains had eliminated the wetlands and marshes in the floodplain, there was not likely much agriculture in the area now the site of Candelaria Nature Preserve and the Rio Grande Nature Center State Park. A 1917 Rio Grande Drainage Survey map prepared by the Office of the State Engineer shows 22 acres with water in the southeast corner of the site bounded by Veranda and the Duranes Lateral with the rest of the current CNP site listed as "Timber." A 1922 MRGCD map based on a Reclamation Service (now the Bureau of Reclamation) map does not indicate cultivation on the site. The area from Candelaria Road (which ended at Rio Grande Blvd) west to the river and northwards along Rio Grande was dominated by marshes, "Alkali," "Grasses," "Sandbar," and "Timber," with pockets of cultivation southeast of Candelaria and Rio Grande, and south and west of Griegos at Rio Grande.

In her 2018 book, "Albuquerque's North Valley: Los Griegos and Los Candelarias," Francelle Alexander has many oral history descriptions of the area as constantly flooding and containing lots of marshy land. She has a photo (p219) from the MRGCD archive titled, "Lake or estero in the 1930s, probably near Rio Grande Boulevard and Griegos" showing a broad shallow flooded and open plain with a single horse grazing at its edge. She quotes (p219) a resident who grew up on Rio Grande a little north of Arbor Rd who remembered that "[t]he swamp ran from where we lived to near Candelaria." In a discussion of the Olguín property (p177) on Rio Grande and Cherokee, she says that until the MRGCD started draining the lands in the 1920s, "much of it was swampy *vega* land with a lagoon that the kids paddled in." Aurelio Candelaria (1885-1984), who grew up in a house on Rio Grande Blvd just north of Griegos Road, described the area: "From my house on it was pure thicket to ditch [the Griegos ditch] until Mr Dietz came. There were swamps all the way to Old Town."

Based extensively on Robert Smith's 2014 unpublished manuscript, "History of Albuquerque's dairies," there is an interesting connection between the area near the CNP site and the Valle de Oro National Wildlife Refuge on 2nd Street south of Rio Bravo in the South Valley (Alexander,

pp152-154). James Matthew moved from Canada in 1881 shortly after the railroad came and began buying land on both sides of 12th Street, founding a dairy around 1893-4 on land leased from the Armijo family; he owned the land by 1903 and had built a house northwest of what is now Matthew Ave and 12th Street. He would eventually own land all the way to the end of Candelaria and Campbell roads. He built a milk plant at the corner of 3rd and Roma.

Starting in 1908, consolidation of North valley dairy operations began, with Matthew and his partners playing a leading role, beginning with modern facilities on the east side of Rio Grande south of Candelaria down to Matthews Road. A 1927 MRGCD survey indicates Matthew owned almost 200 acres in this area and another large parcel west of Rio Grande Blvd. Two Campbell family brothers were partners starting in the teens after James Matthews incorporated; Campbell Road is named after them. When Matthew died in 1931, the dairy merged with that of one of the partners, C.H. Christ to form Valley Gold Dairy, which was soon purchased by Russell Price from El Paso, who moved the dairy to the far end of 2nd Street in the South Valley. The 570 acres of "Price's Dairy" are now the site of Valle de Oro National Wildlife Refuge, whose name, in Spanish, means Valley Gold.

As part of the process that led to Price purchasing the dairy operations and moving them, other parts of the Matthew Dairy were sold between 1932-37, with an early sale becoming Alvarado Gardens Additions. Remaining dairy lands eventually became Matthew Meadows and Meadows on Rio Grande. However, the land at the end of Campbell and Candelaria stayed agricultural. It is likely that alfalfa and corn were grown to support the dairy and, apparently, a slaughter house operated near the river in the area. Some of the land was worked by Japanese-American farmers moved to Albuquerque during the war. The history of Matthew Dairy is indicative of the larger process taking place in the North valley: large land owners bought out small-holders and then turned around and offered them wage labor on their operations. Eventually, the large holdings were sold off to provide housing for the expanding City.

5. Candelaria Farms

Beginning in the early 1950s, tracts of north valley agricultural lands were annexed under the City of Albuquerque's jurisdiction for the purpose of increasing the tax base. Ultimately, many of the historic land grant holders lost their land due to outstanding taxes. The extremely severe drought that ran from the late 1940s into the early 1960s may have made paying taxes from agricultural proceeds difficult, resulting in easy land acquisitions by those who were able to purchase large parcels of land through immediate sales.

Around 1950, approximately 150-acres of land known as the Candelaria Farms Tract A-1 and Tract X were quitted from Mrs. Leola Smith to Mr. Hugh Woodward.[1] Mr. Woodward acquired significant amounts of land throughout Albuquerque for his long-term personal secretary, who, in turn, would quitclaim them to Mr. Woodward's estate. When Mr. Woodward died in 1968, half of the acquired land was turned over to the Sandia Foundation[2] and the other half was turned over when Mrs. Woodward passed away in 1974. Fortunately, the Sandia Foundation preserved the land until it was purchased by the City of Albuquerque in February 1977.

Around the time of his death, Hugh Woodward applied to the State Enginer for a well permit that could provide sufficient water for the area north of Candelaria Road. From his application, we know that there were three Japanese farmers, all elderly men, working and living on the land. Two of them lived in the area around the Woodward House and worked fields in the northeast corner of the site. The third farmer lived near the end of Candelaria Road. They all worked small parcels growing a wide variety of fruits and vegetables, likely for sale at local markets as well as for subsistence. There was no mention in his application of any alfalfa or other crop activity. One of the farmers initiated the well application for himself, but Woodward stepped in and re-applied to get water for the whole site. In 1968, Woodward had just received Office of the State Engineer approval for a well that could serve the three farmers. It appears that the well project, which was dug and tested, but did not yet have a pump, was abandoned with his death.

Whether from age or the failure of the well, or Mrs. Woodward's interest in getting rent from activity on all the acreage, by the time of the sale to the City in 1977, the Japanese gentlemen were gone and there were three leaseholders on the property. Local farmers who maintained alfalfa crops on the southern fields and a horse pasture to the north held two of the leases. The third lease was held by a Midwest broadcast station that used approximately 9-acres within the current leased acreage of the RGNCSP Visitor Center for the placement of their transmitter.

The City of Albuquerque acquired the Candelaria Farm site in 1977, culminating more than a decade of community activism advocating for the establishment of a nature study area and wildlife preserve on the site. In 1969, the Middle Rio Grande Park Plan recognized the potential of this historical agricultural land adjacent the Rio Grande and stated that the "purchase of this tract of land will insure a permanent open space adjacent to the river for nature study, recreations uses, open space, and urban shaping". In 1975, the City of Albuquerque and the Bosque del Rio Grande Nature Preserve Society conducted a joint study on the relationship between the river ecosystems and the Albuquerque metro area, which recommended establishing a pond and marsh restoration project on the Candelaria Farm site.

In 1976, the New Mexico State Legislature, persuaded by strong local support, agreed to partially fund a nature preserve and study center, and the City decided to contribute by purchasing Candelaria Farm as a site for the center. The Regional Office of the Bureau of Outdoor Recreation (now the National Park Service) contributed federal funds through the Land and Water Conservation Fund for purchasing the property, which was enacted by the Albuquerque City Council (Resolution 248) in early 1977. Following suggestions by the Kinney administration, funds for the purchase were consolidated as follows:

- State and Federal Grants $600,000
- Sale of Surplus City Land $308,500
- Proceeds of Parks and Recreations GO Bonds 737,324
- Surplus Capital Account $61,176
- The final purchase price $1,707,000

The environmental assessment completed by the City in preparation for acquiring the Candelaria Farm stated that this land was a "valuable resource for Albuquerque, presently and in the

foreseeable future," both aesthetically and ecologically. Following purchase, the Environmental Planning Commission (EPC) voted to rezone the entire land from R-2 to Special Use Zoning, SU-1 (Nature Study Center and Wildlife Preserve) on May 16, 1978 (No. Z-78-52). On December 30, 1980 the City Council approved a 25-year renewable lease with the State of New Mexico, Natural Resource Division for 38.8 acres upon which the RGNCSP would be constructed. Once the 8.934-acre lease agreement with a national radio station transmitter expired in April 1981, a 2.5-acre lined pond was constructed. Soon after, the RGNCSP Visitor Center, designed by Antoine Predock, was constructed with a $715,000 appropriation from the New Mexico Legislature.

The original 167-acre site was not contiguous. The Fraternal Order of Police (FOP) owned 7 acres of residential-zoned land on the south side of Decker Road, which separated the 144-acre parcel (Tracts A-1 and A-2) acquired by the City north of Decker Road from the 23-acre parcel (Tract X) acquired by the City south of the FOP site, towards Campbell Rd. In 1982, the City exchanged 8 acres of land on the northwest corner of Trellis and Campbell for the 7-acre FOP site. The land along Campbell became the Gated Rio Grande Compound development. The FOP parcel was later re-zoned to SU-1, matching the zoning of the rest of the site. In 1996, approximately one acre at the end of Veranda was converted (a process under the LWCF to remove land no longer being used for the original purpose and exchange it for similar land) in order to allow the City to improve Veranda's terminus. The exchange land was a short length of trail in the Bosque northwest of the Montano Bridge equaling approximately one acre. As a result of the exchanges, the **Candelaria Nature Preserve** is a contiguous site of approximately 166 acres.

6. Candelaria – From Farm to Nature Preserve

The CNP site was managed as farmland since 1980 to preserve a cultural remnant of the agricultural land that was once abundant in the North Valley, and to minimize expenses to the City. The City, which had extended the leases of the existing alfalfa farmers in 1980, began contracting private farmers in 1985 to operate the CNP. Through Farm Operating Agreements, contracted farmers managed production of alfalfa and other commercial crops in the fields north of Candelaria (commonly referred to as "Candelaria Farms") that included around 60 acres in exchange for growing crops on the remaining acreage for wildlife feed and maintaining the irrigation infrastructure. The commercial farming strategy allowed the City to preserve Candelaria Farms as farmland, while providing feed crops for migratory birds that visit the farm and adjacent ponds at the RGNCSP, without incurring the expenses that would normally be required to farm the land.

Over the course of two years of Technical Advisory Group meetings, involving staff from federal, state, and City agencies, other technical experts, and the public, a revisioning of the site began to take shape. There was strong support to no longer allow crop production for commercial farming, but rather to grow plants and crops solely for wildlife. This was the 1979 Predock Plan vision, with "100 plus acres" devoted to growing wildlife crops. This would represent a dramatic shift in the way the farm had been managed since the City purchased the property and would pose both unique possibilities as well as challenges to the Open Space

Division. The new vision would require funds to convert fields to wildlife crops as well as on-going operations and management to continue tilling, seeding, and cutting crops multiple times a year to accommodate waves of migratory birds.

New information moved the TAG to a different approach, one adopted by the US Fish and Wildlife Service (FWS) at Valle de Oro National Wildlife Refuge and by Valencia County Soil and Water Conservation District (with assistance from the USDA Natural resources Conservation Service) at Whitfield Wildlife Management Area. Both these wildlife areas will have natural mosaic landscapes that reflect the pre-engineering landscape of the Rio Grande valley, with wetlands, riparian vegetation, and a mix of upland grasses and shrubs. At Whitfield, this decision to shift from growing wildlife crops came when analysis showed that the cost of producing wildlife crops was not worth the amount of forage being produced. At Valle de Oro, the Federal Aviation Administration prohibited growing wildlife crops on the refuge because it is in the flight path of planes landing at the Sunport and the agency was worried about bird strikes. Although initially concerned that conversion of 570 acres of alfalfa and other crops on the former Price's Dairy would diminish the attractiveness of the refuge to migratory birds, especially sandhill cranes, research by FWS experts indicates that there may be little to no impact on migratory bird numbers, while increasing the overall habitat diversity at the Refuge.

The TAG has come to the conclusion that Candelaria Nature Preserve should be converted to a restored natural mosaic landscape and move away from crops all together over time. The TAG took the ideas developed in alternative plans for the site and "updated" them to create a vision for something special in the heart of Albuquerque –a natural landscape supporting diverse wildlife and providing outdoor recreation and environmental education for all the City's residents and visitors.

7. Public Process

The Candelaria Nature Preserve is a highly visible and well-loved open space that has a wide variety of stakeholders with differing opinions about the management and operations of the property. Many of those diverse opinions are held without knowledge of the requirements of either LWCF or Major Public Open Space rules or the shifting paradigm for wildlife management in the Middle Rio Grande. A planning team composed of Open Space Staff, Technical Advisory Group members, and the consultant team of SWCA Environmental Consultants (SWCA) and Dekker Perich Sabatini (DPS) developed a public outreach and input plan to listen and address the various interests and concerns through public forum environments. Public meeting notes, stakeholder interviews, and conversation records are located in Appendix C.

Goals of Public Outreach/Input:

- Educate the public about LWCF regulations
- Comply with LWCF regulations for public input in the development of LWCF encumbered property resource management plans
- Address operations and management issues posed by the new Resource Management Plan

- Establish durable lines of communication among managing agencies, oversight officials, stakeholders and local organizations
-

1. The Public Engagement Process for Candelaria Nature Preserve Resource Management Plan

Public engagement in a planning process provides a measure of inclusion and transparency to the public decision-making process and provides a barometer to gauge the success of a planning effort. The Candelaria Nature Preserve Resource Management Plan public outreach effort included the following outreach and engagement elements:

*Stakeholder Interviews:

- Stakeholder interviews-Groups and individual interviewees identified by the TAG, OSAB and the OSD staff.

*Public Meeting #1: Planning Process Introduction

- Present purpose statement and planning overview, goals and management objectives, existing ecological resources and mapping.

*Candelaria Preserve Discovery Hikes

- Scheduled hikes to speak to the complexity of the landscape and what may be required in the planning process to achieve goals.

Public Meeting #2: Presentations of Alternatives and Preferred Alternative

- Present alternative management and the preferred plan as developed through the process to date.

Public Meeting #3: Preferred Alternative presentation
• Present preferred alternative management plan and process by which it was developed.

*Complete components as of this draft report

To the extent that public meetings are required for approval of the Resource Management Plan, the following presentations, review comments and plan approvals may be considered part of the public outreach and input process:

- CABQ Open Space Advisory Board (OSAB)
- Candelaria Nature Preserve Technical Advisory Group (TAG)
- New Mexico State Parks Land and Water Conservation Fund Liaison
- CABQ Parks and Recreation Director
- CABQ City Council

Another component included the development of a Candelaria Nature Preserve webpage, which allowed interested persons to find out the latest information, download documents and make comments.

1. Roles

The core planning team of the CNP RMP is SWCA/DPS, RGNCSP, OSAB, OSD, and the TAG. The roles each of these organizations play in this the public outreach effort are below

SWCA/DPS: Conducted public engagement that contributed to the RMP. Tasks included: Providing a framework for public engagement, stakeholder interviews, conveying qualitative and quantitative information in verbal, written and graphic form at public meetings, guiding and documenting public input for inclusion in the final RMP.

Open Space Division: The city dedicated OSD management staff to planning and provided expertise to Consultants on OSD processes including introductions to stakeholders and research into resources. CABQ staff ran public meetings, were liaisons between the Open Space Advisory Board, TAG, and other city departments communicating regularly with other divisions of CABQ government including the leadership of the CABQ Parks and Recreation Department, and the Public Information Office. The CABQ PIO and Open Space staff coordinated updates to the CABQ website, initiated stakeholder meetings and responded to public comments.

Technical Advisory Group: Laid the groundwork for the RMP through the first year of meetings, coordinated a two-day Landscape Workshop led by US Fish and Wildlife staff that clarified the historical pre-engineering landscape at the CNP site, provided advisement and scientific expertise, visited other nature preserves, contacted residents for input, consistently advocated for developing a visionary RMP, and participated in all aspects of the RMP.

Rio Grande Nature Center State Park: The RGNCSP provided an operational base for public input and outreach by providing access to meeting rooms and promoting outreach efforts and offered their experience managing the Nature Center and its interface with the rest of the Candelaria nature Preserve site.

1. Description of Public Outreach Components

a. Stakeholder interviews:

Stakeholders were identified by TAG, and CABQ Open Space staff for consultant contact and meeting initiation and performed the following functions:

- Gathered preliminary public input regarding the planning effort.
- Uncovered common themes or issues that guided planning conversations.
- Identified other persons or organizations with knowledge and concerns
- Educated stakeholders about LWCF compliance issues, resource management planning, existing resources and goals
- Encouraged involvement in the upcoming planning process

Interviews were open ended discussions that sought answers for the following questions:

1. What is the importance of Candelaria Nature Preserve?
2. What management strategies are critical/important/not so important?

3. What do you think Candelaria Nature Preserve should look like in ten, twenty years, and beyond?
4. Who else should planners be speaking to and involving in the planning process?

Twelve stakeholder interviews were conducted between mid-November 2018 and mid-January 2019 in which more than 60 people were interviewed regarding their opinions about the Nature Preserve. Conversation records are located in Appendix C.

Some important findings came from interviews that became guiding principles in the development of the plan:

- Ecological Science ought to guide the planning decisions
- Access to the Nature Preserve ought to be primarily visual in nature
- Agri-chemical farming operations were considered incompatible with the purpose of the Nature Preserve

Public Meeting #1:

The first public meeting was held on January 30, 2019 at the RGNCSP. The meeting was attended by approximately 108 people which filled the education conference room to capacity. The audience included representatives of local neighborhood associations, non-profit, environmental, local government organizations and residents. The meeting was an open house with a short presentation. Afterward attendees could gather in smaller stations to discuss the specific topics such as farming, wildlife and public access.

The purpose of public meeting #1 was to:

- Introduce the planning process
- Describe the study boundaries and the sub-areas
- Describe the existing ecological resources
- Describe the legal framework that overlays the management of the properties
- Describe current and on-going contract farming arrangements
- Describe preliminary goals and objectives
- Describe and invite attendees to next discovery hikes and public meetings
- Describe ways to communicate with the planning team
- Get feedback via comment cards notes on posters, post-it notes etc.

a. Candelaria Nature Discovery Hikes:

The Candelaria Discovery Hikes were a way to engage more constituents in the conversation about the Preserve while experiencing the place itself. There were two Candelaria Discovery hikes on two separate Saturdays, February 23, 2019 and March 23, 2019 at two locations. Hikes typically lasted an hour and attendance varied between as few as 4 to as many as 20 persons.

Purpose of the Discovery Hikes:

- Present complex issues associated with wildlife management and outdoor recreation in an urban context, sustainable farming, and historic features of the Preserve and ecosystem diversity
- Gather public input for inclusion in planning process.
- Increase advocacy for wildlife diversity and protection of Open Space.
- Promote the planning process and support for CABQ management of open spaces.

The hikes resulted in good discussions about the future of the preserve, the changes in the landscape that are being considered, habitat preservation and development, public access and farming practices. See the discovery hike notes in the Appendix C. Additional discovery hikes where conducted with staff members of the Bosque Ecosystem Monitoring program, Ancestral Land Southwest Conservation Corps, and the Middle Rio Grande Endangered Species Collaborative.

a. Public Meeting #2: June 22, 2019 at the Woodward House

Advertisement:

Send emails to stakeholders, interviewees and previous meeting attendees. Announce meeting on CABQ website. Provide invitations to RGNCSP for distribution.

Audience:

Expected audience will be Neighborhood Association representatives, Open Space Alliance members, land and home owners, wildlife and recreation advocates, city and regional agencies such as the Cuidad Water and Soil District and MRGCD representatives, State Parks and Fish and Wildlife staff persons. Others may include representatives of environmental groups such as the Sierra Club or others with an interest in the Preserve.

Purpose of Meeting:

Educate, involve attendees and solicit input on the management scenario(s).

Meeting Plan:

The proposed public meeting format is an open house with a presentation of 30- 45 minutes. Consultants and CABQ OSD staff will be stationed at different locations around the meeting room next to the alternative and the preferred management options. Audience members will enter and be directed in a coordinated fashion to hear about each alternative and the preferred option. Staff to engage in conversations with attendees to elicit and document comments. Participants can write notes on post-its and adhere them to the boards.

Proposed presentation agenda:

- CABQ and OSD Staff welcomes and notes special attendees, and introduces participants
- Consultants present an overview of the planning effort and study area
- Consultants present alternatives and preferred alternative and discuss the potential or expected outcomes, strengths and weaknesses, costs and monitoring strategies.

- OSD staff presents ways to continue to participate in the on-going planning effort
- Question and answer period

Deliverables:

Public Meeting notes, attendance lists and graphics for posting on websites for public review and comment.

a. Public Meeting #3: September 11, 2019

Advertisement:

Send emails to stakeholders and attendees. Announce meeting on CABQ website. Provide invitations to RGNCSP for distribution.

Audience:

Expected audience will be TAG, general community, land and homeowners, wildlife and recreation advocates, city and regional agencies such as AMAFCA and MRGCD representatives, State Parks and Fish and Wildlife staff persons. Others may include representatives of conservation groups, or others with an interest in the Preserve.

Purpose of Meeting:

Educate and involve public in the preferred alternative management scenario (Presented with actions and anticipated outcomes, phased improvement plan/graphic, long- and short-term monitoring strategies, capital and operating costs)

Meeting Issues:

- Public engagement and project overview
- Preferred management scenario
- Compliance with LWCF
- Management implications for the preserve
- Public access for outdoor recreation- limits and opportunities
- Funding and potential funding requests
- Next Steps in the public process (approvals)

Meeting Plan:

The proposed public meeting format is a presentation of 30-45 minutes with 30 minutes for Q&A. The presentation will introduce the planning team and present information on a large screen to attendees.

Proposed presentation agenda:

- OSD Staff welcomes and notes special attendees, and introduce participants
- Consultants present an overview of the public engagement planning effort and study area

- Consultants present preferred alternative, anticipated outcomes, strengths and weaknesses, monitoring program, costs
- OSD and TAG presents ways to continue to participate in the on-going planning effort
- Question and answer period

Deliverables:

Public Meeting notes, attendance lists and graphics for posting on websites for public review and comment.

a. Summary

The intent of the public outreach/engagement plan is to have strategies and recommendations within this Resource Management Plan that are substantiated by a robust public discussion that was inclusive and transparent. It is the hope of the Planning Team that the public outreach effort creates long-standing community commitment for the stewardship of Candelaria Nature Preserve.

C. NATURE PRESERVES AND WILDLIFE REFUGES IN THE RIO GRANDE VALLEY

Valle del Oro Urban National Wildlife Refuge (Bernalillo County) Valle de Oro (Valencia County). Located in the South Valley of Albuquerque along the Rio Grande. Formerly a commercial dairy, this 570-acre urban National Wildlife Refuge is managed for wildlife with an emphasis on public environmental education and recreation. Consists of former a dairy pastures and agricultural fields that are being restored to wetland habitats. Managed by the U.S. Fish and Wildlife Service since 2013.

1. Whitfield Wildlife Conservation Area (Valencia County)

Located on the east side of Belen along the Rio Grande. Formerly a commercial dairy, this 140-acre semi-urban wildlife preserve is managed for wildlife, with an emphasis on public environmental education and recreation. Consists of pastures and agricultural fields that have been restored to wetland, meadow, and bosque habitats. Managed by the Valencia Soil and Water Conservation District, U.S. National Resources Conservation Service, since 2003.

2. Ladd Gordon Game Management Area (La Joya State Game Refuge) (Socorro County)

Located between Belen and La Joya, a complex of four separate management units along the Rio Grande, covering 2,700 acres. Managed for waterfowl production for hunting. Consists of commercial farmland, wildlife crops, riparian bosque and wetlands. Managed by the New Mexico Department of Game and Fish.

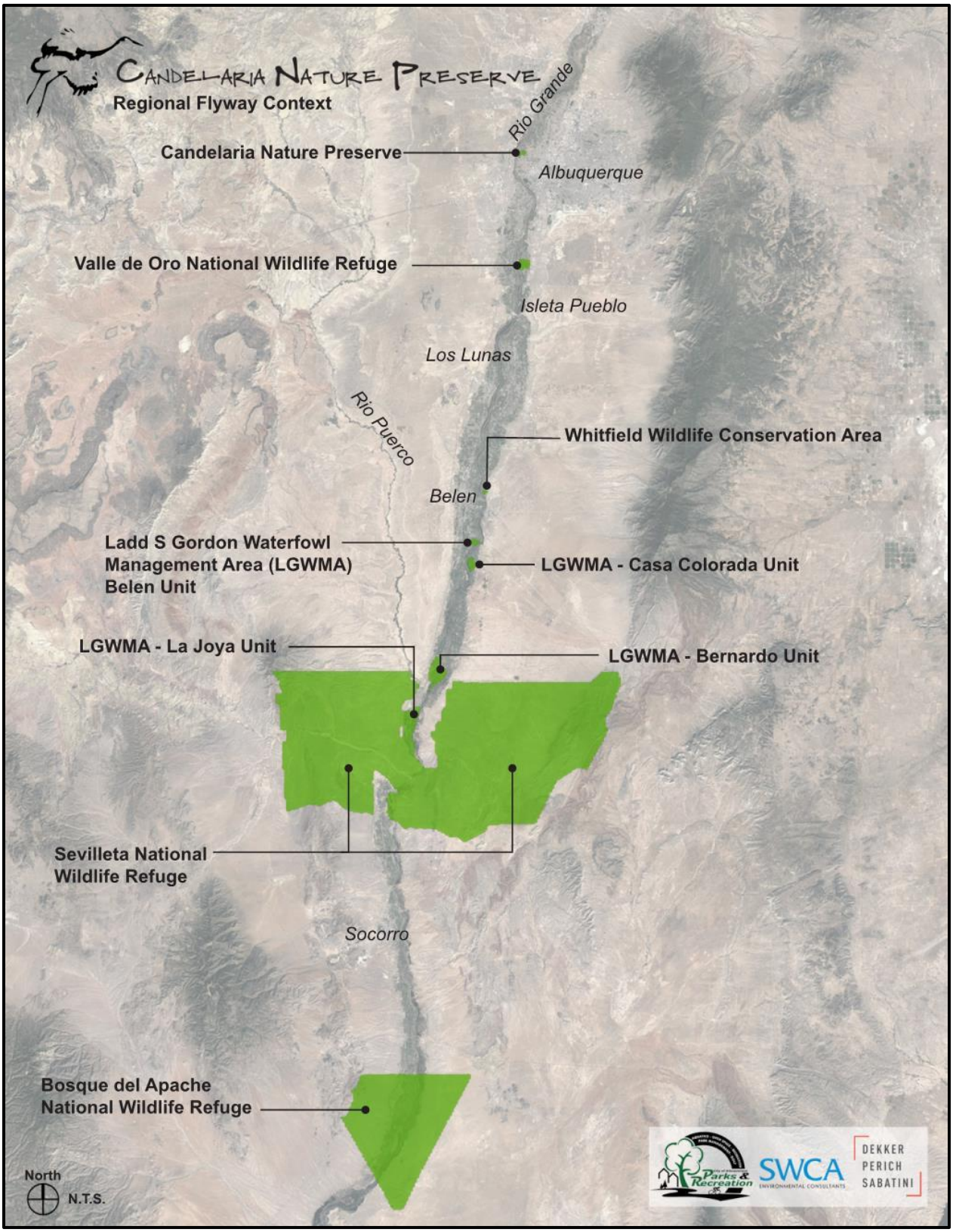


Figure C.1. Wildlife refuges and preserves of the Middle Rio Grande Valley.

3. Sevilleta National Wildlife Refuge (Socorro County)

Located 20 miles north of Socorro, this refuge extends across the Rio Grande valley from the Sierra Ladrones to the Sierra los Pinos. The Sevilleta NWR covers 230,000 acres of mostly natural landscapes ranging from the Rio Grande, across valley bottom grasslands, to montane woodlands. Management is for plant, wildlife, and ecosystem conservation, and environmental education. Managed by the U.S. Fish and Wildlife Service since 1973.

4. Bosque del Apache National Wildlife Refuge (Socorro County)

Located near San Antonio, along the Rio Grande and the adjacent valley. Bosque del Apache NWR covers 57,331 acres of mostly constructed lakes, ponds, wetlands and wildlife cropland, in addition to 30,000 acres of upland desert grassland wilderness areas. Management is for waterfowl production, upland habitats for native vegetation and wildlife, and environmental education and recreation. Managed by the U.S. Fish and Wildlife Service since 1939.

D. ECOLOGICAL CONDITIONS

1. The Abiotic Physical Environment

1.1. Climate

The CNP is located in the MRG valley of central New Mexico at an elevation of 5,000 feet above sea level, with a semi-arid climate, and most of the annual precipitation comes with a summer monsoon. Temperatures are mild, rarely exceeding 100° F or falling below zero. The annual average is about 57° F. the generally low humidity results in an approximate 25°F range between daily highs and lows. Average monthly high and low temperatures at the adjacent RGNCSP from 1994 to present are presented in Figure 4.1. The growing season ranges between 173 and 188 days depending on local elevations. Mean annual precipitation is 11.8 Inches. winter precipitation, generally derived from frontal disturbances, tends to be protracted and of mild intensity. Summer precipitation, typically convective with orographic accentuation, is of short duration and higher rate. Average total monthly precipitation amounts from 1994 to present is presented in Figure 4.2.

The RGNCSP is a volunteer in the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) and the National Water Service (NWS), Albuquerque office precipitation recording program and the United States Geological Survey (USGS) weather reporting station program. The temperature and precipitation data recorded at the RGNCSP is representative of the adjacent CNP.

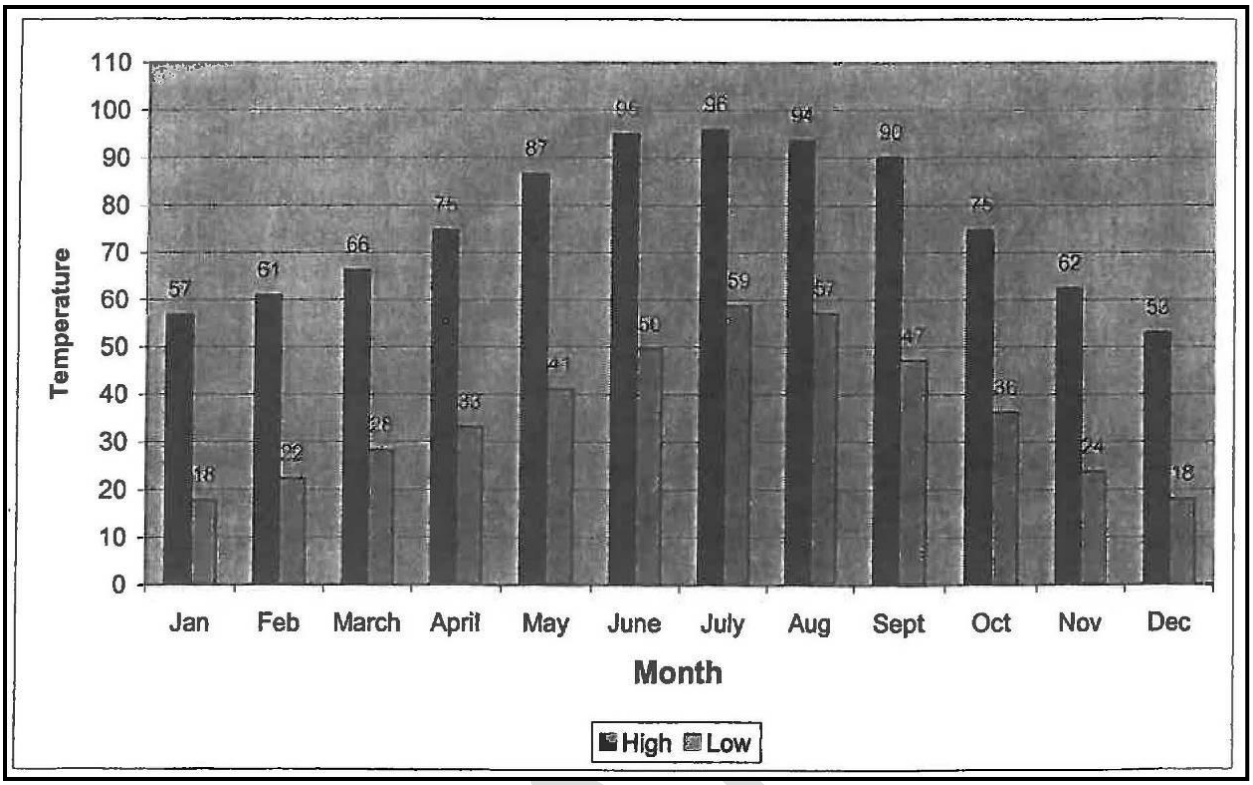


Figure 4.1. Average monthly, daily high and low temperatures recorded at the RGNCSP, 1994-2000.

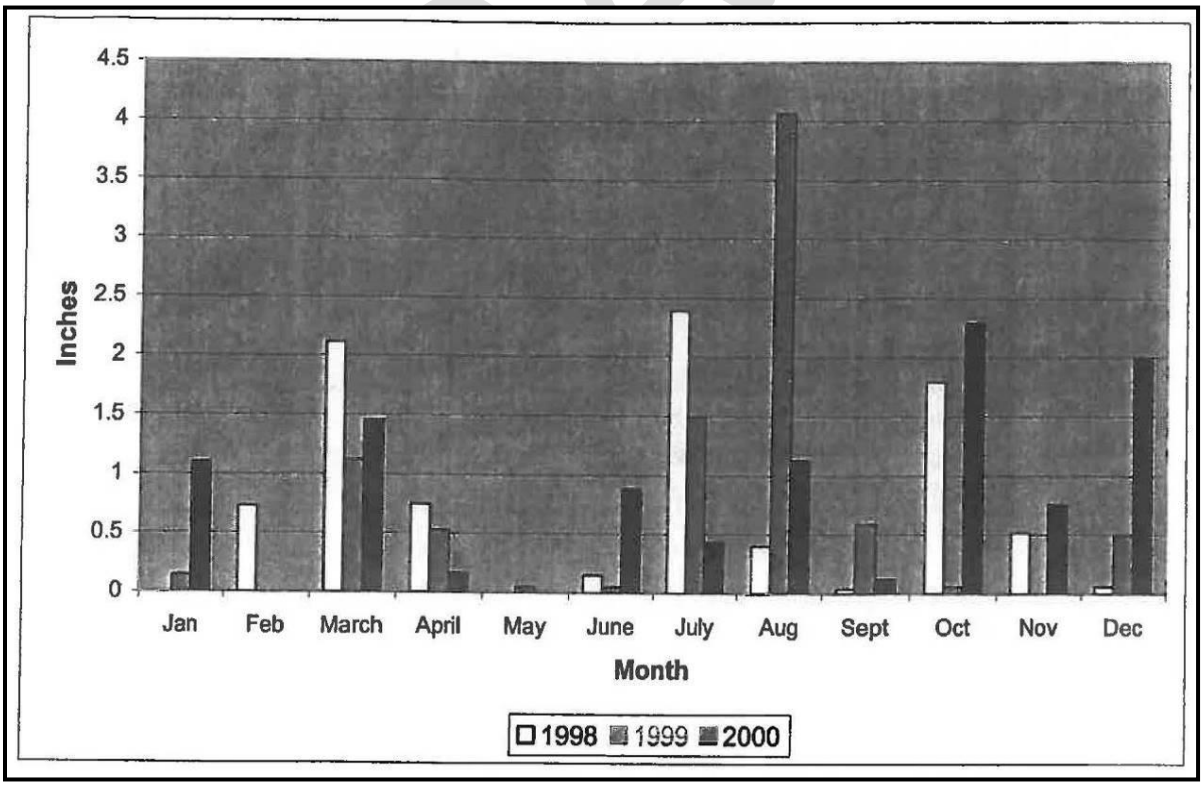


Figure 4.2. Average total monthly precipitation recorded at the RGNCSP, 1994-2000.

1.2. Global Warming and Climate Change

Human-caused global warming, also known as the Enhanced Greenhouse Effect, from the burning of fossil fuels is causing global climate change that is currently impacting the CNP and is forecast to have even greater effects on CNP weather conditions and management practices for the foreseeable future. Climate change for the region will be represented by increasing ambient, ground and ocean temperatures, decreased winter snow-packs and decreased summer snowmelt runoff in rivers, and increased soil temperatures, decreased soil moisture, and increased variation in weather and more extreme weather events (Mann 2019; Melillo et al. 2014; USGCRP 2017, 2018). Gutzler (2013) and Llewellyn and Vaddey (2013) discuss how the climate of the Southwest has been documented as becoming warmer and less predictable, and how drought is becoming more common and more severe than in the past. The average annual ambient temperatures for the Upper Rio Grande and MRG regions of New Mexico (Colorado border to Truth or Consequences, New Mexico) has increased from 1971 to 2012 by 1.4 degrees Celsius (°C) (2.5 degrees Fahrenheit [°F]), and in mountainous areas that increase has been even greater at 1.5°C (2.7°F) (Llewellyn and Vaddey 2013). Winter temperatures (December, January, and February) have been warming by as much as 1.3°C (2.3°F) since 1970 (National Weather Service [NWS] 2015). Long-term episodic droughts have occurred in the Southwest region for centuries (Gutzler 2013), but the region is strongly affected by ongoing and projected century-scale climate change (Llewellyn and Vaddey 2013).

Llewellyn and Vaddey (2013) attribute the climate change observed across the Southwest to human-caused increases in greenhouse gases from burning fossil fuels, and report on a strong regional warming trend in recent temperature data that modifies natural drought/high precipitation fluctuations by enhancing evaporative losses and decreasing snowpack in mountainous regions to the north (see Brown and Mote 2009). Mann (2019) provides a good description of how global warming induced changes in the atmospheric wind patterns globally are causing current human-caused climate change. Recent climate modeling predicts that peak runoff will occur earlier, leaving less water for irrigators during the hot and dry months of the pre-monsoon growing season (Elias et al. 2015). As the climate warms, intense storms are expected to increase in the region (Gutzler 2013), and a greater fraction of total annual precipitation is expected to come from single intense rainfall or snowfall events as compared to more frequent low-intensity storms (Allan and Soden 2008; Intergovernmental Panel on Climate Change 2007; Tebaldi et al. 2006). Petrie et al. (2014) demonstrate that fewer single storm events are determining precipitation amounts in central and southern New Mexico, especially during the monsoon season, and that the number of such storms has declined and become more variable over the last decade. These fewer but more intense events are also being documented in the region by others (Allan and Soden 2008; Groisman and Knight 2008; Mann 2019). The periodic drought and intense rainfall patterns that are projected for the region (Alexander et al. 2006; Gutzler 2013; Gutzler and Robbins 2011; Hurd and Coonrod 2008) are expected to result in significantly diminished stream flow and drier surface conditions (Llewellyn and Vaddey 2013; Seager et al. 2007; Stromberg et al. 2009), causing the Southwest's climate to become even more arid than it currently is over the coming decades. For example, Figure 4.3 shows how ambient temperatures have risen across the Southwest from 2000 to 2013, relative to the long-term average.

The CNP is located on the Rio Grande floodplain, and the surface water and groundwater are both connected to, and dependent upon, Rio Grande flow rates (Crawford et al. 1993). Climate change has already caused reductions and disruptions in Rio Grande flow, and such declines in available ground and surface waters are predicted for the MRG Basin, including the CNP (Llewellyn and Vaddey 2013). The best predictive computational model estimates for expected water availability for the Southwest and the MRG/CNP are presented in Figure 4.4. Those predictions show that both surface and groundwater availability will decline over the next 50 years. Increasing temperatures alone also will cause increased soil water deficits, and will cause increases in both surface evaporation of water, and transpiration of water from vegetation.

Climate change is already creating warmer and drier conditions, along with increased variation and extremes in weather conditions. This trend is expected to continue and to intensify in future years. The implications of climate change are very important relative to managing the CNP, in that water availability will decrease in coming years, and shifts in the geographic distributions of plant and animal species also will shift, as they already are. Associated changes to expect are the composition and abundance of both plants and animals, including shifts in noxious weeds and potentially other non-native invasive species. Any ecological restoration plans will need to consider the over-arching current and future effects of increasing climate change (e.g., Mann 2019; Seavy et al. 2009; USGCRP 2017, 2018).

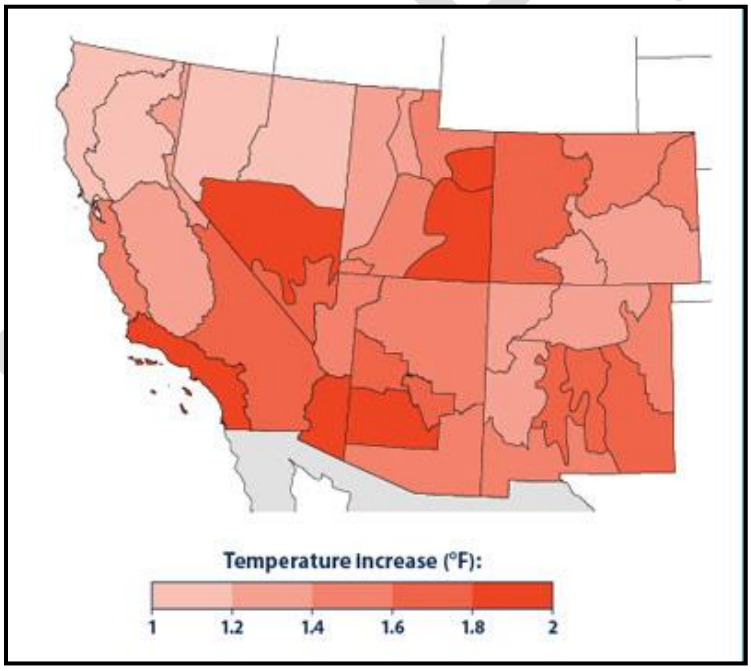


Figure 4.3. Average temperatures across the entire Southwest have increased in recent years, with some areas increasing by up to 2°F. This map shows the average temperature from 2000-2013 relative to the long-term average from 1895-2013. Source: EPA (2015).

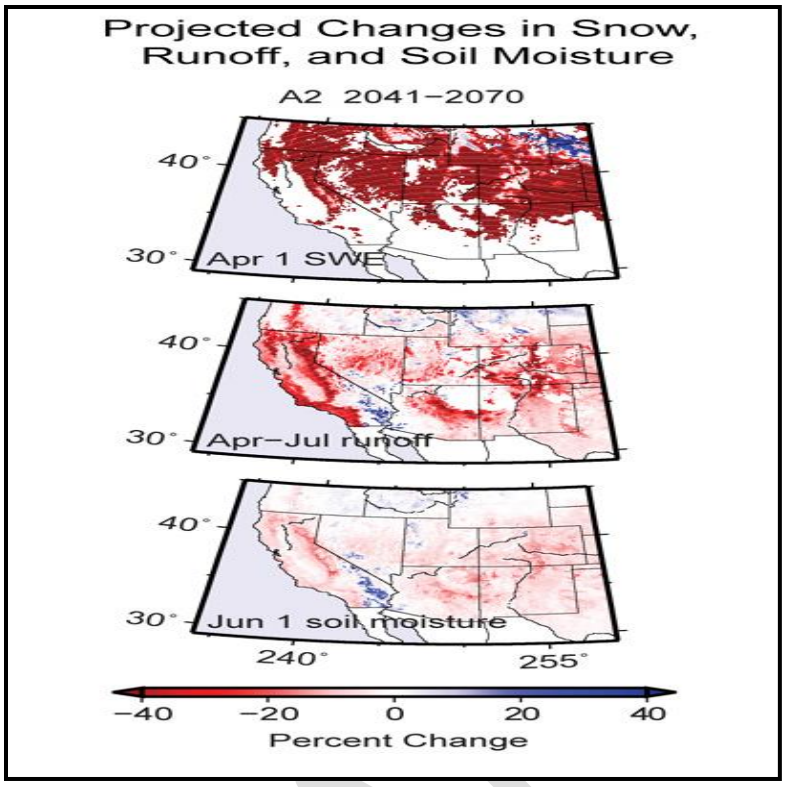


Figure 4.4. Declines in snowpack, runoff, and soil moisture are projected to occur if greenhouse gas emissions remain high. The maps show the change in conditions between the historic (1971-2000) and the expected mid-century (2041-2070). Sources: Melillo et al. (2014); USGCRP (2014).

1.3. Soils

Since acquisition of the Preserve in 1977, the Natural Resources Conservation Service (NRCS) has been providing technical assistance to the OSD. In 1995, an NRCS soil report was generated to describe the soils at CNP to assist with the development of this management plan for wildlife crops and general agricultural use. The soils maps and information about soil characteristics also is important for planning wildlife habitat vegetation plantings and maintenance. Six distinct soil types were found on the property, including Candelaria South and the Tree Farm (Table 1; Figure 4.5). A recent soil survey was conducted by GeoSystems Analysis, Inc. (GSA), in July of 2018. The purpose of the GSA survey was to verify the older 1995 soils map, and to install soil chemistry samples and to install groundwater monitoring well. The GSA soil provided a current comparison to the previous NRCS mapping and was specific to the farmed areas of CNP. Descriptions of the soils from the GSA report describing the soils and their characteristics are presented in Appendix B. The GSA report did not include Candelaria South or the Tree Farm, but the 1995 NRCS soil survey did.

Table 1. Soils at Candelaria Nature Preserve and surrounding area.

Map Unit Symbol	Map Unit Name	Acres in CNP	Percent of CNP
Af	Agua loam MLRA 42	4.1	3.3%
Ag	Agua silty clay loam MLRA 42	3.2	2.5%
Br	Brazito fine sandy loam MLRA 42	29.3	23.3%
Bs	Brazito silty clay loam MLRA 42	38.0	30.3%
Ge	Gila clay loam MLRA 42	41.2	32.8%
Gm	Glendale clay loam, 0 to 1 percent slopes MLRA 42.1	9.8	7.8%
	Total	**125.5**	**100.0%**

Soils of the CNP are deep, and slopes are gentle. Permeability rates generally increase towards the west and southsides of the farm. Permeability is moderately slow in the Glendale clay loam, moderate in the Gila clay loam. Permeability is rapid below the 9 inch layer of Brazito silty clay loam, and rapid all of the way through the Brazito fine sandy loam on the west sand south sides of the farm. The higher permeability rate of the Brazito soils indicates that water enters the soil rapidly, but that the water may percolate so far beyond the root zone of the plants that it may not be available for plant growth and can easily be wasted by excessive irrigation. In addition, the Brazito soils have low Available Water Capacity, and are very susceptible to drying out during drought. The Brazito soils are also much less productive for growing crops such as alfalfa, sweet corn, sorghum, other seed and grain crops, and pasture.

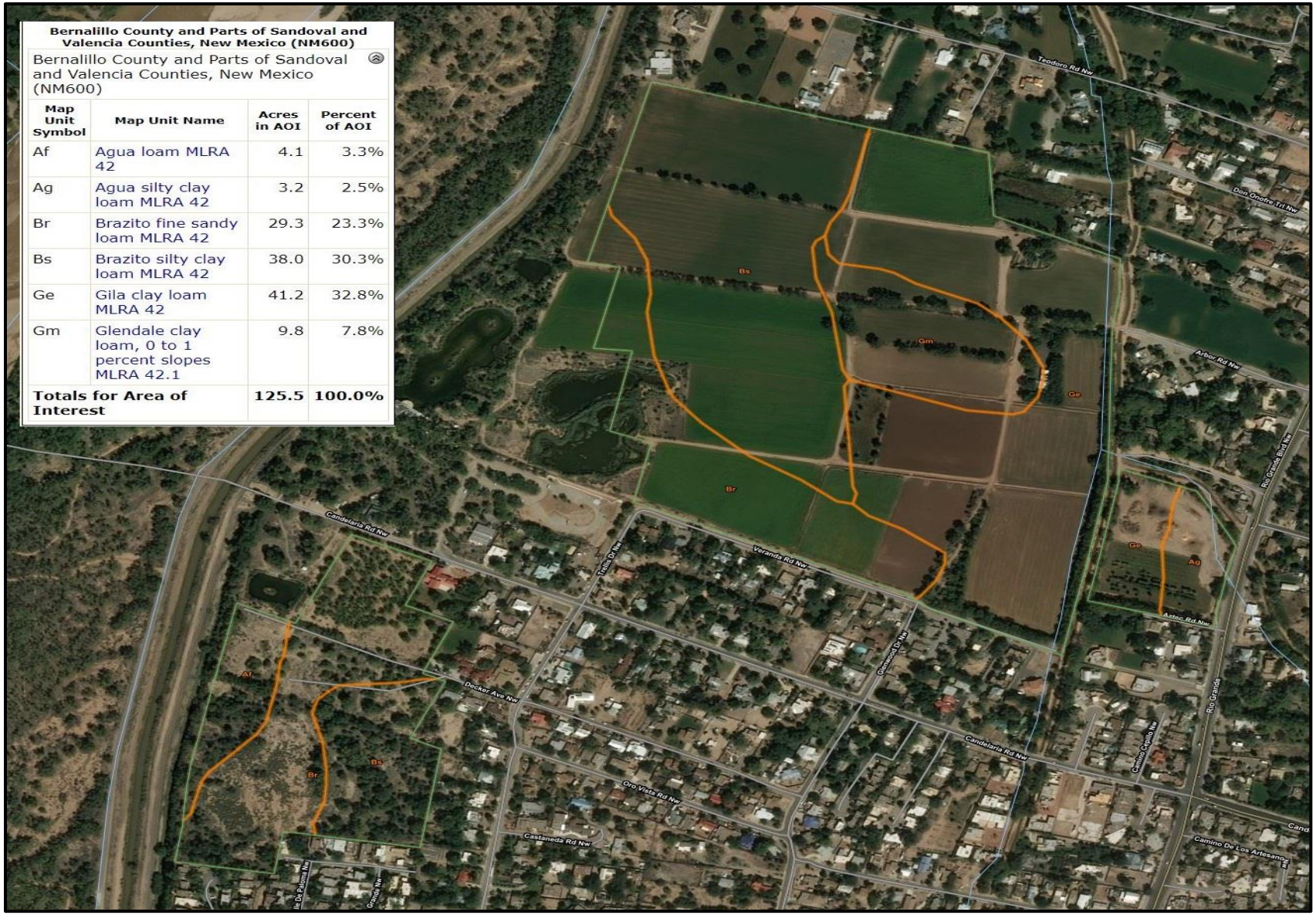


Figure 4.5. 1995 soils map produced by the NRCS.

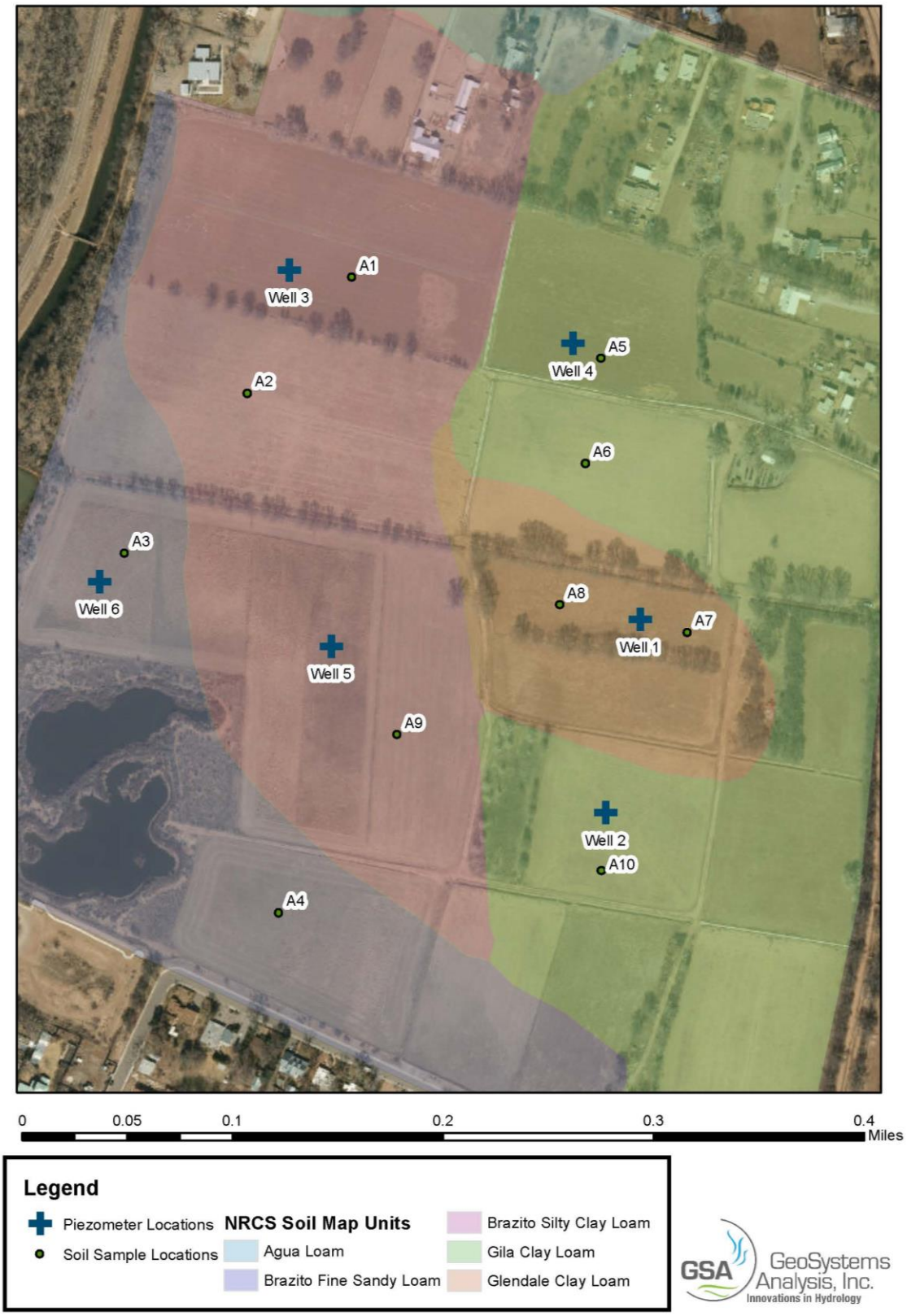


Figure 4.6. Soils map, including locations of soil samples and groundwater monitoring wells installed in 2018 (GeoSystems Analysis, Inc. 2018).

The permeability and poor drought tolerance of the Brazito soils combined with the variability in rainfall indicate that the success of agricultural and wildlife crops depends on efficient use of the irrigation system. In order to achieve this, application of water in the right amount at the right time is critical. Fields must be properly laser leveled and the ditches must be kept in good working condition. The ability to work closely with the MRGCD during the irrigation period is imperative in order for the farmer to efficiently meet the demands of these fields. It should also be noted that three of the soils are susceptible to severe blowing hazards, and the Brazito silty clay loam may create moderate blowing hazards. To reduce the potential for aeolian erosion and to maintain air quality, farm operations need to minimize the time during which soils are left bare.

1.4. Surface Water and Groundwater

The CNP lies within the 100-500 year floodplain of the Rio Grande according to the 1985 FEMA Map. As the Bureau of Reclamation and the MRGCD started work in the 1920s by adding jetty jacks and levees they have channelized the Rio Grande. This changed the river from a more traditional braided river to a meandering channelized system. The results of these changes to the river severed the hydrologic connection between the floodplain (where CNP exists today) and the Rio Grande. Upstream dams and diversion structures have been constructed in order to detain water until the irrigation season, which typically runs from March to October. During this time, irrigators who have water rights will receive allocations of 3 acre-feet per acre of land per irrigation season.

The MRGCD constructed a lateral channel on the east side of CNP known as the Duranes lateral, which transports surface water from the Angostura Diversion Dam, approximately 25 miles north of the site on the Rio Grande. There are four head gates on the lateral that distribute water to the fields. The Albuquerque Riverside Drain runs along the west side of the property and transports excess ditch and groundwater from irrigation back to the river.

In 1981, the RGNCSP built the 2.5-acre Observation Pond adjacent to the RGNCSP Visitor Center and fills this pond from a 150-foot-deep well, which is operated by electricity and pumps between 60–75 gallons per minute. In 1991, the RGNCSP built a 0.42-acre pond north of the Visitor Center. This north pond is deep and fed by seepage from shallow groundwater. The 0.56-acre Discovery Pond, south of the Visitor Center and within the South Candelaria area of CNP is filled from a solar-powered well pump. In 2001, the OSD and cooperating agencies constructed the 5-acre Candelaria wetland ponds east of the RGNCSP and southwest of the farm fields. The 150-foot-deep well fills these wetland ponds. Furthermore, a 175-foot well has been installed near the Woodward House to provide approximately 25 gallons per minute for drip irrigation in farm fields near the house.

1.4.1. Water Quality and Depth

Volunteers from the Friends of the RGNCSP group regularly monitor water quality from the 150’ well, the RGNCSP ponds, and the CNP wetlands near the farm fields. Shallow groundwater monitoring occurs on a well site that is on the east side of the Riverside Drain. This well gives a good indication of groundwater quality and depth in the general area. In 2018, GSA installed six

groundwater monitoring wells (see Figure 4.6) within some of the farm fields to measure groundwater depth. The report by Geosystems (Appendix B) shows the groundwater varies in each field but averages a depth of 7–14 feet. There was a water quality study conducted and finalized by Aquatic Consultants Inc. in October of 2012 entitled "Rio Grande Nature Center Lake Assessments." The study was warranted on the basis that the ponds and wetlands on the CNP property were of poor water quality due to heavy algae blooms. Scientists gathered information that included: lake (pond) management history, water quality including hardness, alkalinity, pH, and turbidity, lab analysis of the water samples, temperature/dissolved oxygen profiles, sonar and GPS transects to accurately map the contours of the "lakes," "lake" volume and area measurements, aquatic vegetation algae identification and quantification, evaluation of water source and water conveyance, sludge and sediment quantification, and habitat evaluation.

The water quality samples taken in all four "lakes" had very high levels of nitrogen. This elevated nitrogen that is fueling the intense phytoplankton blooms and limiting photo penetration into the water. Thus, the shading is not allowing beneficial species of rooted aquatic vegetation to grow on the "lake" bottom which would be the primary food source for migratory waterfowl. Currently, available food sources for migratory waterfowl are essentially nonexistent in all four "lakes" at the CNP (ACI 2012). The assessment provides recommendations that deal directly with moving suspended nitrogen out of the ponds whereby increasing photo penetration and allowing beneficial plant species to grow and outcompete the phytoplankton for remaining nitrogen.

1.4.2. Water Rights

On March 19, 1907, the New Mexico Territorial Engineer declared all surface waters public and took jurisdiction over the administration and further use of surface waters. From that date on any new uses of surface waters required application and approval of a permit through first the Territorial Engineer Office and subsequently the New Mexico State Engineer Office (SEO). However, any water usage pre-dating March 19, 1907, fall outside of SEO jurisdiction. Even today in 2019, individuals or governmental agencies such as the City of Albuquerque, still must file declarations of pre-1907 surface water right claims. The SEO uses certain criteria when evaluating a pre-1907 surface water right claim for transfer applications. This includes data from the Rio Grande Drainage Survey Maps from 1917-1918, MRGCD appraisal sheets and accompanying plane-table surveys from 1926-1927. It also uses MRGCD re-appraisals from 1941 and aerial photographs from 1935, 1947, 1955, and 1963. Around 2004, the SEO came up with a new policy that started to also consider further aerial photographic research to determine if abandonment of surface water rights has occurred. The SEO considers abandonment if structures appear in the photographic record or irrigated lands remain fallow for a period of 17 years or more. If the land appears as cultivated in 1917-1918 and continues as such through the data trail, then the land meets the criteria for a prior to 1907 surface water right claim. The Federal Government survey crews did not cover any land inside of Spanish Land Grants. (Frasier; Water Resource Management 2004).

Candelaria Nature Preserve has two types of water rights associated with the property. There are surface water rights and there are ground/well water rights. Research was conducted by meeting with Gary Stansifer of the SEO. The surface water rights research shows that the eastern portion

of the property have 22 to 45 acres of a “possible declared” pre-1907 water right (see map below). This information comes from a 1917 State Engineer Rio Grande Drainage Survey Map, sheet No. 9 and is known as “Cultivated Class I.” The remainder of surface water rights for CNP are water rights owned and managed by the MRGCD. The MRGCD allows the Open Space Division to utilize their water right which dates back to 1926-1927. The MRGCD’s Plane Table Photo-negative F-10, p. 7 has classified about 45 acres as irrigated pasture, hay, grain, and alfalfa which allows OSD to use this water right for a service delivery fee each year. Although 22 acres are declared as pre-1907, it is assumed all 45 acres shown on the historic maps are considered a pre-1907 water right (Figure 4.7). In all legality, having a “right” under the MRGCD permit essentially gives the water user a right to water, but not an actual water right. (Albert Ward, letter to New Mexico Parks and Recreation Commission Planning Division by the SEO; 1977).

Other areas of the CNP that do not have a water right associated with it is 2.5 acres in the southeast corner of the property. This 2.5 acres were under the declared pre-1907 permit #04712 but in 1999 an offset was needed at one of the groundwater ponds and this pre-1907 water was transferred from permit #04712 to well permit RG-73373. To offset this 2.5 acres that have no water rights, the Open Space Division has had to lease water from the MRGCD’s water bank to water this acreage. All other areas of the CNP are considered unirrigated bosque land to the Office of the State Engineer and or MRGCD and cannot be watered by surface water. There are several wells on the property and groundwater rights are permitted into wells.

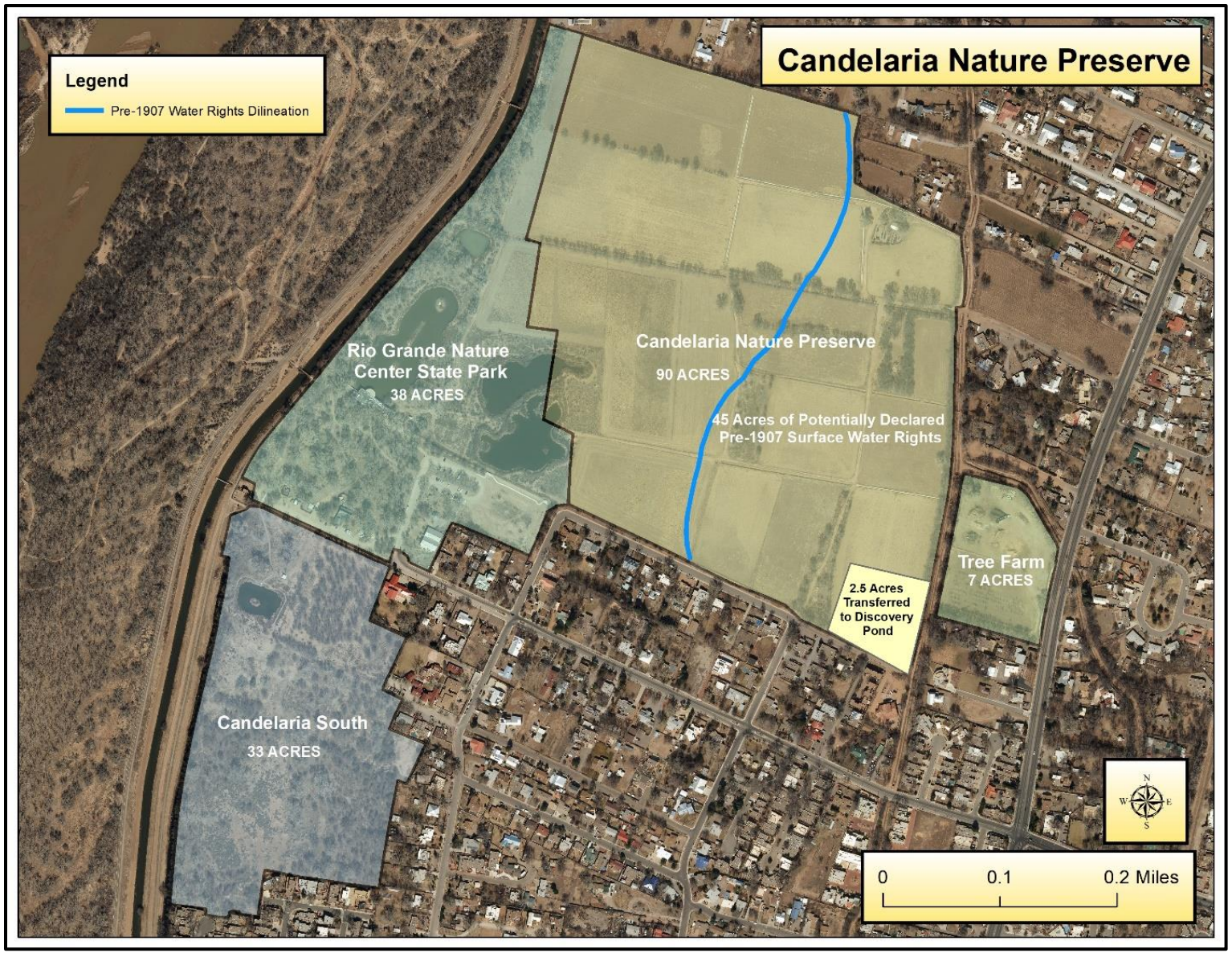


Figure 4.7. Water Rights at the Candelaria Nature Preserve. Data from the New Mexico Office of the State Engineers.

Observation Pond and Wetlands

The well for the Observation Pond received a SEO permit approved March 11, 1981 under permit # RG-35823. The permit transferred 35.1 acre-feet per year to the well. The SEO analysis assumed a pond area of 4.5 acres, and a total of 29.58 acre-feet/year evaporated from the pond. The remaining water was for an annual filling. The SEO determined that 16.71 acres were required to be retired from irrigation, and they have been. The Observation Pond was expected to be 4.5 acres in size but was built at only 2.54 acres. Therefore, only 16.33 acre-feet permitted for that well were needed, and 17.32 acre-feet of these excess rights are currently used for the Candelaria wetlands, as approved by the State Engineer in 2002. The remaining 6.95 acre-feet needed for the Wetland is being provided through a lease from the City's master permit, RG-960, which is now maintained by the Albuquerque Bernalillo County Water Utility Authority.

North Pond

The North Pond at the RGNCSP is permitted by the SEO under file RG-35823 as a 0.67-acre pond with a depth of about seven feet. It is supplied with water through seepage from the shallow groundwater in the area. The pond was actually built at a size of 0.42 acres. Approval was given by the SEO on December 29, 1992 after getting the water rights from the New Mexico State Highway and Transportation Department (now the New Mexico Department of Transportation) through well # RG-1282-A located on Map 148 of NMDOT land. This pond was underwritten by the NMDOT as a mitigative measure to offset *bosque* impacts and loss associated with construction of the Paseo Del Norte River crossing.

Discovery Pond

Permits 0620 and 1690 were moved into well # RG-35823-S and was approved on January 7, 2000, for the diversion of 3.28 acre-feet of water from well RG-35823. The well has a 4-inch casing and was drilled approximately 30 feet deep for the purpose of offsetting evaporative losses from a 0.80-acre pond located in the SW corner of the RGNCSP. Known as the Discovery Pond, it was actually built to a size of 0.56 acres. The transfer of permits 0620 and 1690 was from Tract A-1-B, Map 34 (MRGCD). Permit 04712 and RG-73373 was approved February 7, 2000, for the diversion of 7.5 acre-feet per year for the purpose of supplementing the surface water used to irrigate the 2.5 acres of land at the southeast corner of the CNP property.

2. The Biotic Environment: Vegetation and Wildlife

2.1. Vegetation

Vegetation is not only a natural resource by itself, but also is important in providing habitats for wildlife. Historically, the MRG was a somewhat sinuous and braided river system that had a tendency to aggrade. The river channel migrated freely across a wide floodplain (2–6 km [1.2–3.7 miles) (Crawford et al. 1993) supporting a wide diversity of riparian vegetation types, such as forests, shrublands, and wetlands (Scurlock 1998). Information prior to European settlement was largely anecdotal (Hink and Ohmart 1984), but it is generally understood that when Europeans arrived in the sixteenth century, the dominant plant communities of the Rio Grande bosque included Rio Grande cottonwood with an understory dominated by willow (*Salix* sp.) and inland saltgrass (*Distichlis spicata*) (Scurlock 1998). Although humans have used the Rio Grande

riparian area for centuries, serious human alteration of the floodplain did not begin until the nineteenth century, with livestock grazing, extensive logging, and increased demand for irrigated agriculture (Crawford et al. 1993; Scurlock 1998).

Hydrology strongly influences plant species composition of Rio Grande riparian ecosystems. Willow-dominated communities require frequent surface saturation and shallow groundwater for survival (Corps et al. 2006), while cottonwood-dominated communities require spring overbank flooding every few years to scour away existing vegetation and make new seedbeds for seedling establishment and early success (Crawford et al. 1993). Overbank flooding is now infrequent along much of the MRG, and therefore suitable wet substrate for Rio Grande cottonwood reproduction and establishment has become limited.

Hink and Ohmart (1984) conducted an extensive biological survey of the MRG, including an intensive assessment of the reach from Bernalillo to the Jarales Bridge (New Mexico Highway 346). Vegetation was assigned to various community-structural types based on initial qualitative assessments of transects and subsequent quantifications by vegetation measurements, including density, relative cover, and relative frequency (Hink and Ohmart 1984). Hink and Ohmart reported cottonwood forest of structure Type I to be the most abundant vegetation in their intensive study area: mixed to mature age class stands dominated by Rio Grande cottonwood 15 to 18 m (50–60 feet) tall, with well-developed woody understory foliage layers, providing relatively dense vegetation canopy foliage from ground level to the tops of trees. Non-native Russian olive (*Elaeagnus angustifolia*) was the most common understory species often found in association with non-native saltcedar (*Tamarix* sp.). Community types throughout the MRG were largely cottonwood dominated with varying understory associations, including cottonwood/coyote willow (*Salix exigua*), cottonwood/Russian olive, cottonwood/juniper (*Juniperus* sp.), and species associated predominantly with the sandbar and river channel, and much of the MRG bosque was characterized by thick, mixed native and non-native shrubs and trees. The midstory vegetation was dominated by Russian olive, scattered saltcedar, and fourwing saltbush (*Atriplex canescens*). Canopy vegetation, where present, was dominated by scattered Rio Grande cottonwood with occasional non-native Siberian elm (*Ulmus pumila*). Understory herbaceous vegetation was sparse in areas that have thick woody growth; however, in areas that are more open, alkali sacaton (*Sporobolus airoides*) and giant sacaton (*S. wrightii*) dominated.

The establishment of non-native riparian trees along the riparian zone of the MRG has become a significant environmental and natural resource management concern (Parker et al. 2005). Exotic trees, shrubs, and herbaceous species that are not dependent on flood cycles for seedling establishment have invaded the riparian ecosystems, subsequently displacing native species throughout the river corridor (Muldavin et al. 2004). An increase in non-native vegetation has been identified as the most significant indicator of failing ecological health in the riparian ecosystem.

In many areas, saltcedar has replaced native stands of cottonwood, decreasing habitat for the federally and state endangered southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher) and many Neotropical birds, since its introduction in the twentieth century (Smith et al. 2006). Russian olive was introduced to the MRG between 1900 and 1915 (Hink and Ohmart 1984); the species spread throughout the MRG to become a dominant component of riparian

vegetation by 1960 (Campbell and Dick-Peddie 1964). Like saltcedar, Russian olive is highly competitive due largely to its ability to survive environmental stresses such as low light and drought conditions. Hink and Ohmart (1984) and Dick-Peddie (1993) note that Russian olive is the dominant invasive tree found along riparian reaches north of Albuquerque, while saltcedar tends to proliferate along more southern reaches.

2.1.1. Agricultural Fields

A variety of wildlife and commercial crops have been planted at the CNP, including fescue grass, sorghum, alfalfa, and millet. This plan is being developed to grow plants and crops for wildlife and is a change in the way that the farm had been managed. Crops planted in the future will be determined by availability and funding. OSD will monitor the agricultural fields to determine wildlife use for the for the greatest benefit to wildlife. Crops will gradually be phased out as native wildlife vegetation habitats are restored.

2.1.2. Wildlife Habitat Areas

Wildlife habitat areas include the RGNCSP wetland, neighboring grassland and moist soil areas, as well as hedgerows and tree groves. In addition, the Cottonwood Restoration Area just north of the Discovery Pond, has been planted with the native Rio Grande cottonwood (*Populus fremonti, wislizenii*) and pasture grass, and the elm rows and groves consist mainly of the non-native Siberian elm (*Ulmus pumila*).

2.1.3. Non-Native Plant Species

Many species of non-native, and often invasive plant species have been introduced to the CNP region by humans. These non-native plant species compete with native plant species for resources and in many cases have caused declines in native species, and dominated disturbed environments that once supported native species. Primary species of concern include the trees/shrubs saltcedar, Russian olive and Siberian elm. There are many non-native invasive forbs and grasses, primary species of concern include kochia (*Bassia*), prickly Russian thistle, puncture vine, Bermuda grass, cheat grass, and tumble mustard. A listing of New Mexico noxious weeds is available from the New Mexico Department of Agriculture. Efforts should be made to manage non-native plant species at the lowest levels possible, to avoid competition and replacement of native plant species.

2.2. Wildlife

Crawford et al. (1993), Scurlock (1998) provide detailed accounts of terrestrial riparian fauna historically associated with the MRG. Lists of the principal animal species of the Albuquerque Reach, are available from a number of sources (Hink and Ohmart 1984; Crawford et al. 1993; Chung-MacCoubrey and Bateman 2006; Corps et al. 2006; Smith et al. 2006; Walker 2006; Bateman, Chung-MacCoubrey et al. 2008; Bateman, Chung-MacCoubrey, and Snell 2008; Bateman, Harner, et al. 2008; Cartron et al. 2008; Bateman et al. 2009). Many of the more recent studies cited above have addressed the effects of MRG bosque habitat restoration practices on the fauna. Cartron et al. (2008) provide complete accounts of vertebrate species and many invertebrates of the MRG bosque, along with biological and ecological information for each species. The following sections describe various elements of the fauna.

2.2.1. Arthropods (insects, spiders, scorpions, centipedes, crustaceans)

The MRG bosque supports characteristic assemblages of arthropods associated with different meso- and micro-habitats. Cartron et al. (2008) present many of the common arthropods of the MRG bosque, including the CNP. Two of the dominant macroarthropods of the riparian bosque are introduced isopods (pill bugs and woodlice, Crusteacea). Both species are detritivores that feed on organic forest floor litter and often occur in very high densities, potentially competing with native detritivore arthropods for habitat and food resources. Ellis et al. (1999) have found the species, composition, and richness of MRG bosque ground-dwelling arthropods to be similar between native cottonwood and saltcedar habitats, but cottonwood habitats supported greater densities of non-native isopods. Numerically dominant MRG bosque arthropods include the two species of non-native isopods, and a number of native spider, beetle, and cricket species. Cartron et al. (2003) have comparatively studied the ground arthropod fauna of a series of regularly flooded and non-flooded MRG bosque sites. The authors have found carabid ground beetles to be consistently associated with regularly flooded sites, while other arthropods were not. Eichhorst et al. (2006) provide a listing of ground-dwelling macroarthropod species recorded from a number of Bosque Ecosystem Monitoring Program (BEMP) sites across the MRG bosque, along with summaries of species richness and abundance from a number of sites.

2.2.2. Amphibians and Reptiles

The Hink and Ohmart (1984) found that reptile and amphibian populations tend to be greater in areas of open vegetation along the MRG bosque. Common species include the eastern fence lizard (*Sceloporus cowlesi*), New Mexican whiptail (*Aspidoscelis neomexicanus*), and Woodhouse's toad (*Anaxyrus woodhousei*). A principal species favoring denser vegetation and moister areas is the Great Plains skink (*Eumeces obsoletus*), and open water supports bullfrogs (*Rana catesbeiana*), chorus frogs (*Pseudacris triseriata*), and tiger salamanders (*Ambystoma tigrinum*) (Hink and Ohmart 1984, Cartron et al. 2008). More recent studies of MRG bosque reptiles and amphibians (Chung-MacCoubrey and Bateman 2006; Bateman, Chung-MacCoubrey, and Snell 2008; Bateman, Chung-MacCoubrey et al. 2008; Bateman, Harner et al. 2008; Bateman et al. 2009) have focused on the effects of habitat restoration projects involving exotic tree and wildfire fuels reduction on reptile and amphibian communities. Those studies have found no effects of restoration activities on snakes (Bateman et al. 2009) in contrast to significant but variable (both positive and negative) effects on lizards (Bateman, Chung-MacCoubrey, and Snell 2008), both positively and negatively affecting different species.

Among the reptiles, the lizards are quite common and an important part of the food chain. The snake species are not dangerous, and may help control small mammal populations. Turtles have moved into the Candelaria Wetland and are now part of that ecosystem. The wetland has also attracted an array of amphibians. Tiger salamanders live in the wetland and woodhouse toads lay eggs there. Protecting water quality and aquatic invertebrates are critical for maintaining the reptilian and amphibious residents of the wetland; and preserving the link between the wetland and bosque is probably important for the amphibians that come seasonally.

2.2.3. Birds

Throughout the year, riparian communities of the MRG provide important habitat during breeding and migration for many bird species. Hink and Ohmart (1984) have recorded 277 species of birds within 262 km (163 miles) of the MRG bosque habitat. The surveys made of the

wider MRG and the authors' intensive survey section (Bernalillo to the NM 346 Bridge) have identified principal resident species associated with cottonwood communities of the MRG; examples include mourning dove (*Zenaida macroura*), black-chinned hummingbird (*Archilochus alexandri*), Gambel's quail (*Callipepla gambelii*), northern flicker (*Colaptes auratus*), ash-throated flycatcher (*Myiarchus cinerascens*), and ring-necked pheasant (*Phasianus colchicus*). Of the six vegetation communities identified under the Hink and Ohmart classification, the preferred cover type for a large proportion of the bird species surveyed is cottonwood/coyote willow and cottonwood/Russian olive. Ohmart and Anderson (1986) suggest that species and abundance of birds of the MRG, most notably insectivorous species, increase with higher foliage density in the middle and upper vegetative layers. Vegetation change in the MRG bosque from dynamic stands of young native willow and cottonwood to mature stands of saltcedar, Russian olive, and older cottonwood trees probably has had a great effect on avian communities (Mount et al. 1996). Walker (2006) conducted a comparative study of MRG bird communities associated with native cottonwood bosque and exotic saltcedar stands, finding that cottonwood bosque habitats support considerably more species of birds than saltcedar stands. In addition, Finch et al. (2006) and Bateman, Chung-MacCoubrey, et al. (2008) have reported on the effects of MRG bosque habitat restoration activities involving the removal of exotic trees and fire fuels. The authors have found bird species that utilized mid-level vegetation structure for nesting initially declined following restoration activities but speculate densities of those species should increase again as understory woody vegetation develops following restoration.

In the fall, Canada geese and sandhill cranes are the most visible birds at the farm, as several hundred come to feed on the wildlife crops during their annual migration, and many spend most of the winter in the immediate area. There is also a large group of Canada geese that reside permanently at the RGNCSP ponds, and now also frequent the Candelaria Wetland year-round.

2.2.4. Mammals

Several native medium to large mammals associated with the riparian habitat of the MRG are beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), porcupines, coyote (*Canis latrans*), gray fox (*Urocyon cinereoargentus*), bobcat (*Lynx rufus*), and striped skunk (*Mephitis mephitis*). Principal small mammal species of the entire Albuquerque Reach are the native white-footed mouse (*Peromyscus leucopus*) and western harvest mouse (*Reithrodontomys megalotis*), as well as the non-native house mouse (*Mus musculus*) (Hink and Ohmart 1984). The abundance and distribution of small mammal species relates to the structure and mosaic of the vegetation community and the moisture regime of the riparian belt (Crawford et al. 1993). Ellis, Crawford, et al. (1997) and Ellis, Molles, et al. (1997) have found both saltcedar and cottonwood MRG bosque habitats to be dominated by white-footed mice, but the saltcedar habitats have supported more rodent species, including the more typically upland species and the non-native house mouse. The authors have found the white-throated woodrat (*Neotoma albigula*) to be only associated with cottonwood habitats. Additionally, Bateman, Harner, and Chung-MacCoubrey (2008) report bat activity is higher in MRG bosque sites where exotic trees and fire fuels were removed compared to non-treated site. Both domestic and feral species of mammals occur throughout the MRG bosque. Feral domestic cats and dogs pose a potential threats as predators to many native animal species.

Small mammals, particularly rock squirrels, pocket gophers, and house mice, make up the majority of the mammal population at the CNP. Coyotes frequent the property, and a small

number of tawny-bellied cotton rats have been found near the wetland. Coyotes also appear to have plenty of suitable habitat in the area, and are sufficiently abundant. The tawny-bellied cotton rat, in contrast, has become scarce in the MRG valley, largely because the sacaton grasslands it favors have disappeared. The OSD is attempting to re-create this type of habitat as a buffer area around the wetland, and this could favor this rare species. Other small mammals, such as skunks, raccoons, weasels, porcupines and beavers, generally reside in the bosque near the farm rather than the farm itself, as that is their preferred habitat.

2.2.5. Non-Native Wildlife Species

Animal species that have been introduced to the CNP area by humans include: feral domestic dogs and cats, house sparrows, European starlings, ring-necked pheasants (a state game species that is not native and competes with native quail, but is largely limited to human disturbed habitats), Eurasian collared dove, isopods, house spiders, brown dog ticks, and European earwigs. The American bullfrog is a predator from the eastern United States that has become invasive of aquatic habitats across New Mexico, and is eliminating native amphibians such as the Northern leopard frog. All efforts should be made to discourage these non-native species from occurring on the CNP and competing with, or potentially preying upon, native species.

2.3. Threatened, Endangered, and other Special Status Animal Species

Several federally listed and New Mexico state listed plant and animal species are known to occur in the vicinity of the CNP. 1 lists some of the USFWS and New Mexico Department of Game and Fish (NMDGF) threatened and endangered species occurring in or near the bosque in Bernalillo County, New Mexico (NMDGF 2019; USFWS 2019).

Table 2.1. Special Status Species Occurring in Bernalillo County, New Mexico

Common Name	Scientific Name	Status
Rio Grande silvery minnow	*Hybognathus amarus*	USFWS E State E
Common black-hawk	*Buteogallus anthracinus*	State T
Yellow-billed cuckoo	*Coccyzus americanus*	USFWS T
Southwestern willow flycatcher	*Empidonax traillii extimus*	USFWS E State E
Bald eagle	*Haliaeetus leucocephalus*	State T
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	USFWS E

Sources: Cartron et al. (2008), Cartron (2010).
Listing status: E = endangered, T = threatened; PT = proposed threatened.

E. SITE DESIGN, GOALS, AND PROTOCOLS

The creation of wildlife habitat is an important part of the CNP's mission. Priorities for habitat improvements should be based on two criteria: 1) those that benefit the widest range of native species, and 2) those that increase the numbers of native populations. Due to loss of wetlands along the river, one highly desired ecological interaction at the preserve has been to create wetland habitat on the preserve for the diversity of waterfowl, shore and wading birds, small mammals, reptiles, amphibians and invertebrates that depend on wetlands and are compatible with farming for wildlife foods. The OSD has addressed this by building the Candelaria Wetland. The existing Siberian elm groves and cottonwood restoration area provide bird perches and nest sites, and additional habitat.

Farming as an operational/management model is still under discussion as of the writing of this draft report. Many stakeholders consider farming incompatible with wildlife habitat protection and/or development while others consider farming an efficient and cost-effective management alternative. This draft report attempts to examine the alternatives to allow for further in-depth conversation about the continuance of farming on CNP.

Selection of further habitat improvements needs to be refined through additional research at the site. With the exception of some bird species, little is known about individual species numbers. At this point, any special status species or species that are known to be in decline, and that could thrive at the CNP site, should be considered as possible species.

Attention needs to be given to developing proper species assemblages for a given habitat type. For instance, grassland areas should have the proper species mix to replicate grassland habitat typical of the region. Since this site has limited space, species spatial requirements should also be factored into any habitat development design. And most of the property is operated as a farm, so native species and habitat types will need to be compatible with farming to some extent.

1. Restored Wildlife Habitats

1.1. Candelaria Wetland

The 5-acre Candelaria Wetland, consisting of two connected cells, was constructed in the southwest comer of the CNP in 2001. These fields were chosen as the site for the wetland because they are adjacent to the RGNCSP parking area and visible from a viewing blind there. The location of the wetland at the downhill end of the fields does not impede irrigation of the rest of the fields, from the ditches on the uphill sides. Furthermore, these fields have sandy soils, were the most difficult to irrigate, and had a history of weed problems and low agricultural productivity. However, the original plans for the Candelaria Wetland were for sediments from berms of excavated soils to create the ponds, to gradually erode back into the pond depressions, so that the excavated ponds would eventually become a shallow water marsh rather than open ponds. Since the construction of the ponds, they remain open water. Therefore, the intended goals for the Candelaria Wetland was not achieved, and they remain as pond habitats today.

The Candelaria Wetland is now part of a set of aquatic habitats, which includes three ponds nearby at the RGNCSP, and the nearby Rio Grande. It also connects to farmland and bosque ecosystems. The Candelaria Wetland created a matrix of deep, open water and shallow, vegetated

areas, to support a broad variety of native vegetation and bird life. The shallow water areas are designed specifically to attract shore and wading birds, which do not enjoy extensive habitat at the three RGNCSP ponds. The Candelaria Wetland owes its existence to the dedication and cooperation of several parties. The wetland was designed by Hydra Aquatic Ecological Consultants, and sited with the help of the U.S. Fish and Wildlife Service. In 2001, OSD crews excavated the native soils to the desired topographical relief, guided by the design. OSD crews placed an impermeable liner, purchased with funding from the US Fish and Wildlife Service, over the bottom of the wetland, and backfilled native soil over the liner to a depth of approximately one foot. OSD installed a pipe between the cells to allow water to flow between them, and installed one drainpipe in the west side each cell, to flush algae-causing nutrients from of the wetland into adjacent moist soil areas. Excess soil from excavation was used to create berms around the wetland, to contain the water and provide space for planting vegetation. The wetland was filled with well water from the RGNCSP, without introducing the non-beneficial organisms (invasive weed seeds, non-native fish, and bullfrogs) that are present in ditch water. In the spring of 2001, and with funding from the General Electric Fund Environmental Stewardship Program, the Friends of the RGNCSP purchased native wetland plants, and worked with the OSD and students from Rio Grande High School to organize volunteers and plant the vegetation in the shallow water areas and moist banks of the wetland.

Since the completion of the wetland in 2001, scientists and volunteers working with the Friends of the RGNCSP have created a Wetland Monitoring Team to monitor the vegetation, wildlife, water quality and soils in and around the wetland. The Wetland Team has also removed non-native or nuisance species, placed logs for turtles, and planted additional wetland vegetation. Monitoring completed by the Wetland Monitoring Team indicates that the steep slopes of the berm around the wetland has created a very narrow moist soil zone, restricting the growth of moist soil plant species and limiting the use of this area by native wildlife species.

Candelaria Wetland Protocols:

- *In general, the roadway around the wetland shall be used as a trail for foot traffic during educational programs or monitoring activities. The roadway will be closed to regular use by farm equipment and vehicles, with the exception of maintenance vehicles to maintain the wetlands.*
- *When necessary, vehicles may access the roadways on the southeast side of the wetland in order to travel between the gate at Veranda Rd. and the farm road on the southwest edge of the farm, and between the Veranda gate and the farm road running east from the wetland. Vehicles may also use the roadways as necessary for maintenance activities.*
- *Guided educational programs at the wetland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through July. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP Wetland Monitoring Team) prior to scheduling guided educational programs around the wetland.*
- *The OSD and other approved parties may access the wetland for the purpose of routine filling and maintenance at any time, year-round, but should avoid disturbing wildlife, especially from November through May.*

- *In general, the wetland shall be filled, and water flushed, using water from the adjacent well, from April-October, and once every month from November- March. The wetland shall be filled so that the water level reaches the top of the pipe between the two cells.*
- *Only approved parties may conduct monitoring activities at the wetland, and only according to a schedule and plan approved by the OSD. The OSD shall consult the Wetland Monitoring Team prior to approving any additional monitoring of the wetland by third parties.*
- *Parties interested in undertaking additional projects or habitat improvement activities at the wetland must gain prior approval of the OSD.*
- *Species planted in and around the wetland will be approved by RGNCSP in consultation with OSD.*
- *Exotic trees, such as Siberian elm, Russian olive, and tamarisk shall be removed and treated from the lined area of the wetland.*

1.2. Grasslands Adjacent to the Candelaria Wetland

OSD staff has worked with the contract farmer to plant the irrigated field areas immediately to the north, east and south of the wetland cells with native grasses. These grassland areas are intended to simulate a natural meadow attractive to shore and wading birds, and to provide a less-mechanized buffer area between the wetland and adjacent cropland. Weeds that continue to compete heavily with the grasses will necessitate mitigation. Unless other techniques are found to facilitate the establishment of grasses these areas will need to be maintained periodically to control weeds, until the grasses are established.

Grassland Protocols:

- *The roads around the grasslands shall serve as access routes to the grasslands for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the grassland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the grassland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year-round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the grasslands shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The grassland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the wetland will be approved by RGNCSP in consultation with OSD.*
- *Monitoring activities at the grassland areas may only proceed according to a schedule and plan approved by the OSD and RGNCSP.*
- *Parties interested in undertaking additional projects or habitat improvement activities at the grasslands must gain prior approval of the OSD and RGNCSP.*

1.3. Hedgerow Habitat Improvements

The purpose of hedgerows is to provide perches, protective ground cover, fruit and movement corridors for wildlife, particularly songbirds and pheasants. Hedgerows may also serve as windbreaks. The hedgerows will be enhanced with more plants and with more plant species to improve the diversity and function of the hedgerows as wildlife habitat. Plant species recommended for new hedgerows are presented in Table 6.6. Hedgerows also will be planted over the next 20 years to increase the array of hedgerows along all existing roads and ditches. The primary function of the hedgerows will be as to serve as wildlife movement corridors and provide additional wildlife food and vertical vegetation structure. The protocols listed below will apply to the existing and newly planted hedgerows. However, additional goals of increasing hedgerow physical structural diversity and hedgerow plant species diversity will be considered part of their wildlife habitat function. Also, attention will be made to increase the abundance and taxonomic diversity of flowering plants for pollinators. Newly planted hedgerows will be planned over the next 20 years to provide a landscape network of wildlife corridors for movement, and habitat for food and shelter. A 20-year multi-phase plan will be developed to determine the best landscape arrays, and plant species compositions of hedgerows, relative to adjacent habitats, and relative to serving as visual barriers, based on wildlife and visitor routes and activities.

Table 6.6. Plant species recommended for planting in the new Hedgerow Habitats.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
Oak-leaf thorn-apple	*Datura quercifolia*	Solanaceae	Forb	Annual/Biennial
Threadleaf groundsel	*Senecio flaccidus*	Asteraceae	Forb	Perennial
Hairy golden-aster	*Heterotheca villosa*	Asteraceae	Forb	Perennial
Copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	Forb	Perennial
Fleabane	*Erigeron divergens, E. flagellaris*	Poaceae	Forb	Perennial
Sacred thorn-apple	*Datura wrightii*	Solanaceae	Forb	Perennial
Blue grama	*Bouteloua gracilis*	Poaceae	Grass	Perennial
Side-oats grama	*Bouteloua curtipendula*	Poaceae	Grass	Perennial
Scratchgrass	*Muhlenbergia asperifolia*	Poaceae	Grass	Perennial
Western wheatgrass	*Pascopyrum smithii*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
Spike dropseed	*Sporobolus contractus*	Poaceae	Grass	Perennial
Sand dropseed	*Sporobolus cryptandrus*	Poaceae	Grass	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
Alkali sacaton	*Sporobolus airoides*	Poaceae	Grass	Perennial
Little-leaf sumac	*Rhus microphylla*	Anacardiaceae	Shrub	Perennial
Skunkbush sumac	*Rhus trilobata*	Anacardiaceae	Shrub	Perennial
Rabbitbrush	*Ericameria nauseosua*	Asteraceae	Shrub	Perennial
Willow baccharis	*Baccharis salicifolia*	Asteracea	shrub	Perennial
Four-wing saltbush	*Atriplex canescens*	Chenopodiaceae	Shrub	Perennial
Golden current	*Ribes aureum*	Grossulariaceae	Shrub	Perennial
New Mexico desert olive	*Forestiera pubescens*	Oleaceae	Shrub	Perennial
Apache plume	*Fallugia paradoxa*	Rosaceae	Shrub	Perennial
Pale wolfberry	*Lycium pallidum*	Solanaceae	Shrub	Perennial
Torrey's wolfberry	*Lycium torreyi*	Solanaceae	Shrub	Perennial
Desert willow	*Chilopsis linearis*	Bignoniaceae	Tree	Perennial
Net-leaf hackberry	*Celtis reticulata*	Cannabaceae	Tree	Perennial
Screw-bean mesquite	*Prosopis pubescens*	Fabaceae	Tree	Perennial
Black locust	*Robinia pseudoacacia*	Fabaceae	Tree	Perennial
Rio Grande cottonwood	*Populus deltoides wislizenii*	Salicaceae	Tree	Perennial
Peachleaf willow	*Salix amygdaloides*	Salicaceae	Tree	Perennial
Coyote willow	*Salix exigua*	Salicaceae	Tree	Perennial
Goodding's willow	*Salix gooddingii*	Salicaceae	Tree	Perennial
Thicket creeper	*Parthenocissus vitacea*	Vitaceae	Vine	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Hedgerow Protocols:

- *With the exception of restoration and maintenance activities, the hedgerows shall be off-limits to farm operations, vehicular and foot traffic, with the exception of the roadways around them.*

- *Educational programs around the hedgerows shall be limited to observational tours and monitoring, only on adjacent roadways, and should avoid disturbing bird life, especially during the winter migration and nesting seasons from November-May.*
- *The OSD and approved parties may access the hedgerows for the purpose of monitoring and routine maintenance, including planting irrigating, pruning and weeding at any time, year-round, although activities are to be minimized from November through May, to avoid disturbing wintering bird populations.*
- *The hedgerows shall be irrigated from adjacent ditches, as needed during the irrigation season. Some may also be drip- irrigated from nearby wells, as necessary.*
- *Species planted in and around the wetland will be approved by OSD.*
- *Monitoring activities at the grassland areas may only proceed according to a schedule and plan approved by the OSD.*

1.4. Bosque

The existing bosque will be enhanced with more plants and with more plant species to improve the diversity and function of the existing bosque as wildlife habitat. Plant species recommended for planting are presented in Table 6.7. Additionally, new bosque habitat also will be planted over the next 20 years on the cropland adjacent to, and immediately east of the existing bosque habitats to increase the size of the existing bosque habitat. The primary function of the new bosque habitat, will be to serve wildlife that need woodland habitats and to provide additional wildlife food and vertical vegetation structure. The protocols listed below will apply to the existing and newly planted bosque. However, additional goals of increasing bosque physical structural diversity, and bosque plant species diversity will be considered part of the bosque wildlife habitat function. Also, attention will be made to increase the abundance and taxonomic diversity of flowering plants for pollinators. Newly planted bosque species will be planned over the next 20 years to provide a landscape network of wildlife corridors for movement, and habitat for food and shelter. A 20-year multi-phase plan will be developed to determine the best landscape arrays, and plant species compositions of bosque, relative to adjacent habitats.

Table 6.7. Plant species recommended for planting in the Riparian Woodland Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
Navajo tea	*Thelesperma megapotamicum*	Asteraceae	Forb	Annual
spectacle pod	*Dimorphocarpa wislizennii*	Brassicaceae	Forb	Annual
Rocky Mountain beeplant	*Cleome serrulata*	Capparaceae	Forb	Annual
Clammyweed	*Polanisia dodecandra trachysperma*	Capparaceae	Forb	Annual
sandbells	*Nama hispidum*	Hydrophyllaceae	Forb	Annual
velvetweed	*Gaura parviflora*	Onagraceae	Forb	Annual
blue trumpets	*Ipomopsis longiflora*	Polemoniaceae	Forb	Annual
warty caltrop	*Kallstroemia parviflora*	Zygophyllaceae	Forb	Annual
oak-leaf thorn-apple	*Datura quercifolia*	Solanaceae	Forb	Annual/Biennial
horsetail milkweed	*Asclepias subverticillata*	Asclepiadaceae	Forb	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
Indian hemp	*Apocynum cannabinum*	Apocynaceae	Forb	Perennial
hairy golden-aster	*Heterotheca villosa*	Asteraceae	Forb	Perennial
wooly paperflower	*Psilostrophe tagetina*	Asteraceae	Forb	Perennial
green Mexican-hat	*Ratibida tagetes*	Asteraceae	Forb	Perennial
threadleaf groundsel	*Senecio flaccidus*	Asteraceae	Forb	Perennial
Riddell's groundsel	*Senecio riddellii*	Asteraceae	Forb	Perennial
white-heath aster	*Symphotrichum ericoides*	Asteraceae	Forb	Perennial
lacy sleep-daisy	*Xanthisma spinolusum*	Asteraceae	Forb	Perennial
freckled milkvetch	*Astragalus lentiginosus*	Fabaceae	Forb	Perennial
American licorice	*Glycyrrhiza lepidota*	Fabaceae	Forb	Perennial
prairie flax	*Linum lewissi*	Linaceae	Forb	Perennial
adonis blazingstar	*Metzelia multiflora*	Loasaceae	Forb	Perennial
copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	Forb	Perennial
scarlet beeblossom	*Gaura coccinea*	Onagraceae	Forb	Perennial
Hooker's evening primrose	*Oenothera elata hirsutissima*	Onagraceae	Forb	Perennial
pale evening primrose	*Oenothera pallida*	Onagraceae	Forb	Perennial
fleabane	*Erigeron divergens, E. flagellaris*	Poaceae	Forb	Perennial
yerba mansa	*Anemopsis californica*	Saururaceae	Forb	Perennial
sacred thorn-apple	*Datura wrightii*	Solanaceae	Forb	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
giant sacaton	*Sporobolus wrightii*	Poaceae	Grass	Perennial
scratchgrass	*Muhlenbergia asperifolia*	Poaceae	Grass	Perennial
side-oats grama	*Bouteloua curtipendula*	Poaceae	Grass	Perennial
Indian ricegrass	*Achnatherum hymenoides*	Poaceae	Grass	Perennial
blue grama	*Bouteloua gracilis*	Poaceae	Grass	Perennial
scratchgrass	*Muhlenbergia asperifolia*	Poaceae	Grass	Perennial
Western wheatgrass	*Pascopyrum smithii*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
spike dropseed	*Sporobolus contractus*	Poaceae	Grass	Perennial
sand dropseed	*Sporobolus cryptandrus*	Poaceae	Grass	Perennial
alkali sacaton	*Sporobolus airoides*	Poaceae	Grass	Perennial
little-leaf sumac	*Rhus microphylla*	Anacardiaceae	Shrub	Perennial
skunkbush sumac	*Rhus trilobata*	Anacardiaceae	Shrub	Perennial
rabbitbrush	*Ericameria nauseosua*	Asteraceae	Shrub	Perennial
winterfat	*Krascheninnikovia lanata*	Chenopodiaceae	Shrub	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
broom dalea	*Psorothamnus scoparius*	Fabaceae	Shrub	Perennial
golden current	*Ribes aureum*	Grossulariaceae	Shrub	Perennial
New Mexico desert olive	*Forestiera pubescens*	Oleaceae	Shrub	Perennial
pale wolfberry	*Lycium pallidum*	Solanaceae	Shrub	Perennial
Torrey's wolfberry	*Lycium torreyi*	Solanaceae	Shrub	Perennial
starvation prickly pear	*Opuntia polyacantha*	Cactaceae	Succulent	Perennial
Plains prickly pear	*Opuntia phaeacantha*	Cactaceae	Succulent	Perennial
Pott's prickly pear	*Opuntia pottsii*	Cactaceae	Succulent	Perennial
desert willow	*Chilopsis linearis*	Bignoniaceae	Tree	Perennial
net-leaf hackberry	*Celtis reticulata*	Cannabaceae	Tree	Perennial
screw-bean mesquite	*Prosopis pubescens*	Fabaceae	Tree	Perennial
black locust	*Robinia pseudoacacia*	Fabaceae	Tree	Perennial
Rio Grande cottonwood	*Populus deltoides wislizenii*	Salicaceae	Tree	Perennial
Goodding's willow	*Salix gooddingii*	Salicaceae	Tree	Perennial
peachleaf willow	*Salix amygdaloides*	Salicaceae	Tree	Perennial
coyote willow	*Salix exigua*	Salicaceae	Tree	Perennial
thicket creeper	*Parthenocissus vitacea*	Vitaceae	Vine	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Bosque Protocols:

- *With the exception of restoration and maintenance activities, the bosque area shall be off-limits to operations, heavy equipment and vehicular traffic.*
- *Educational programs in the bosque area shall avoid disturbing wildlife, especially during the winter bird migration and bird nesting seasons from November through May.*
- *The OSD and approved parties may access the bosque area for the purpose of routine maintenance, including planting thinning removing dead and down wood and exotic plant species at any time, year-round, although activities are to be minimized from November through May to avoid disturbing wintering and nesting bird populations.*
- *Unless otherwise approved, species planted in the bosque area shall be limited to those in Table 6.7.*
- *Monitoring activities in the bosque area may only proceed according to a schedule and plan approved by the OSD.*

These newly proposed habitats are intended to be developed over the next 20 years on existing crop fields and would greatly increase the diversity of habitats for wildlife on the CNP. These newly proposed habitats represent reference environments or habitats that were historically

common and available to wildlife before the regulation (dams, levees, ditches) of the Rio Grande in the 1900's (Watson 1921, Scurlock 1998). These newly proposed habitats also are representative of modern variations of those historic habitats that occur today, but are no longer connected to annual flooding cycles of the Rio Grande, nor are as biologically diverse as they were historically, and are now largely dominated by non-native invasive weed/tree species (Cartron et al. 2008; Crawford et al. 1993). The overall goals of restoring these habitats are to increase the natural biological diversity of the CNP, using historic and current MRG floodplain environments as reference models. The proposed new additions to bosque habitat and hedgerow habitats stated above, also follow this overall goal of further increasing the biological diversity of the CNP. Additionally, plant species proposed for planting as part of restoration, would be species that not only occurred in such habitats historically, but also are able to exist on the CNP today, and may be managed to persist or be replaced by other species as climate change continues to affect the biota of the region. Current human-caused climate change is already reducing available Rio Grande water, causing increasing atmospheric and soil temperatures, drought, and changes in the timing, amounts, and intensity of precipitation (see Chapter 4). Restoration of habitats for wildlife will require careful planning for the most appropriate plant species to use, appropriate irrigation and watering of plants with limited water, and the ability to shift species compositions over time as climate and water availability change.

These newly proposed habitats for wildlife include: 1) Damp Soil Wetland, 2) Ephemeral Wetland, 3) Damp Soil Grassland, 4) Dry Soil Grassland, 5) Salt Shrubland, 6) Arroyo Margin Shrubland, and 7) Sand Bar descriptions, lists of potential plant species, and management plans for each are stated below.

1.5. Damp Soil Wetland Habitat

Description. Juncus-Houttuynai (Rush-Yerba Mansa) Association of Watson (1912); Wetland/Open Area (wet/dry) habitats of Cartron et al. (2008); wetlands at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande by former river channel oxbows, where water levels vary, but the bottom of the oxbow is close to the water table and fluctuates between damp and inundated. Damp soil wetlands have damp clay, silty to sandy soil with occasional shallow (<3-feet deep) standing water approximately every 2 months throughout the year. Naturally high water would be during the late spring Rio Grande runoff in May/June. With river regulation and climate change, that is no longer the case. To mimic the occasional flooding periods, the Damp Soil Wetland would be flood irrigated on a schedule to best support the greatest number of obligate wetland plant species listed in Table 6.8. Typical plant species would include obligate wetland graminoid rushes, sedges and grasses, several obligate wetland forb species, and several phreatophyte shrub and tree species. This wetland will represent a range of early seral (all herbs) to a late seral (shrubs and trees) damp soil wetland, and the vegetation structure that is open, dominated by herbs, with scattered individual and clumps of shrubs and trees. Plant species recommended for planting in the Damp Soil Wetland Habitat are presented in Table 6.8.

Table 6.8. Plant species recommended for planting in the Damp Soil Wetland Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
rough cocklebur	*Xanthium strumarium*	Asteraceae	Forb	Annual
showy milkweed	*Asclepias speciosa*	Asclepiadaceae	Forb	Perennial
Western goldentop	*Euthamia occidentalis*	Asteraceae	Forb	Perennial
Pecos sunflower	*Helianthus paradoxus*	Asteraceae	Forb	Perennial
blueweed	*Helianthus ciliaris*	Asteraceaee	Forb	Perennial
smooth horsetail	*Equisetum laevigatum*	Equisetacea e	Forb	Perennial
American water horehound	*Lycopus americanus*	Lamiaceae	Forb	Perennial
field mint	*Mentha arvensis*	Lamiaceae	Forb	Perennial
yerba mansa	*Anemopsis californica*	Saururaceae	Forb	Perennial
roundleaf monkeyflower	*Mimulus glabratus*	Scrophulariaceae	Forb	Perennial
American brooklime	*Veronica americana*	Scrophulariaceae	Forb	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
vine-mesquite	*Panicum obtusum*	Poaceae	Grass	Perennial
common reed	*Phragmites australis*	Poaceae	Grass	Perennial
giant sacaton	*Sporobolus wrightii*	Poaceae	Grass	Perennial
cosmopolitan bulrush	*Bolboschoenus maritimus*	Cyperaceae	Grass/Graminoid	Perennial
Emory's sedge	*Carex emoryi*	Cyperaceae	Grass/Graminoid	Perennial
woolly sedge	*Carex pellita*	Cyperaceae	Grass/Graminoid	Perennial
marshy spike-rush	*Eleocharis palustris*	Cyperaceae	Grass/Graminoid	Perennial
toad rush	*Juncus bufonius*	Juncaceae	Grass/Graminoid	Perennial
Dudley's rush	*Juncus dudleyi*	Juncaceae	Grass/Graminoid	Perennial
Torrey's rush	*Juncus torreyi*	Juncaceae	Grass/Graminoid	Perennial
Great Plains seep-willow	*Baccharis salicina*	Asteracea	shrub	Perennial
false indigo bush	*Amorpha fruticosa*	Fabaceae	Shrub	Perennial
desert willow	*Chilopsis linearis*	Bignoniacea e	Tree	Perennial
coyote willow	*Salix exigua*	Salicaceae	Tree	Perennial
Goodding's willow	*Salix gooddingii*	Salicaceae	Tree	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
Rio Grande cottonwood	*Populus deltoides wislizenii*	Salicaceae	Tree	Perennial
peachleaf willow	*Salix amygdaloides*	Salicaceae	Tree	Perennial
coyote willow	*Salix exigua*	Salicaceae	Tree	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Permanent wetlands were once common among old oxbow channels adjacent to the Rio Grande. Such wetlands are now rare, and there is much need to restore/create more wetland habitats to support greater species diversities and abundances of native wildlife in the Albuquerque region. The Damp Soil Wetland will provide habitats for wetland associated animal species, including; many arthropods, other invertebrates such as annelid worms, wetland specialist amphibians, reptiles, birds and mammals). Such species do not occur in other, drier or aquatic habitats. Without wetlands, these species will not occur in the area. Wetlands additionally provide important habitat for generalist species, where a great abundance of other more habitat-specific (wetland) species also occur.

Design. The Damp Soil Wetland would be constructed in the crop fields immediately to the east of the existing RGNCSP ponds and Candelaria Wetland ponds. The soils of this area are sandy and well drained, and the water table is at approximately 6-8 feet below the soil surface (see Chapter 3). The Damp Soil Wetland would take approximately 20 years for plantings to spread and for perennial woody species to become mature. All stages of natural ecological succession for an MRG wetland would be planted and maintained, from open graminoid areas, to perennial herb patches, and woody shrub and tree patches. The Damp Soil Wetland will be designed to have no transport of water to the Candelaria Wetland or RGNC ponds.

Implementation. Earthmoving equipment will be needed to excavate a shallow simulated oxbow depression (2–4 feet deep, 100 feet wide, and 1,000 feet long) across the existing field. Soil from the excavation would be moved to the side margins, and spread to a distance of about 100 feet away from the depression on both sides, in uneven depths of 1 to 2 feet deep, with slightly sloping margins to simulate shorelines. The Candelaria Wetland ponds were excavated to depths of about 6 feet, with the assumption that excavated soils piled as berms around the ponds would erode back into the ponds, but that did not happen. Based on that experience, the excavated soils around the Damp Soil Wetland perimeter, should stay in place for many years, especially once vegetation has grown over the soil surfaces. A planting design will be produced, and select plant species from Table 6.8 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the soils in the bottom of the simulated oxbow depression remain damp at all times, and periodically flooded up to 2 feet deep.

Maintenance. Following construction and initial Phase 1 vegetation plantings, the primary maintenance needs will be the periodic flood irrigating of the Damp Soil Wetland, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan. Monitoring should also be employed to evaluate the water table (piezometer wells), soil condition (soil particle size and chemistry sampling), soil movement (erosion from the excavated soil, and sedimentation of the simulated oxbow depression) over the next 20 years.

Damp Soil Wetland Protocols:

- *The roads around the Damp Soil Wetland shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Damp Soil Wetland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting, irrigating and mowing at any time, year round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the Damp Soil Wetland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The Damp Soil Wetland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the Damp Soil Wetland areas will be approved by OSD.*
- *Monitoring activities at the Damp Soil Wetland areas areas may only proceed according to a schedule and plan approved by the OSD.*

1.6. Ephemeral Wetland Habitat

Description. Juncus-Houttuynai (Rush-Yerba Mansa) Association of Watson (1912), but with less periodic flooding, and drier than the Damp Soil Wetland above; Wetland/Open Area (wet/dry) habitats of Cartron et al. (2008); drier portions of the wetlands at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande by former river channel oxbows, where water levels vary, and the bottom of the oxbow is not close to the water table, most water is from summer rainstorms rather than groundwater. Ephemeral Wetlands have damp to dry clay, silty to sandy soil with occasional shallow (< 2 feet deep) standing water approximately two to three times during the summer growing season, mostly during the late summer monsoon period. Naturally high water may also occur during the late spring Rio Grande runoff in May/June. With river regulation and climate change, that is no longer the case. To mimic the occasional early and late summer flooding periods, the Ephemeral Wetland would be flood irrigated on a schedule to best support the greatest number of obligate and facultative wetland plant species listed in Table

6.9. Typical plant species would include obligate/facultative wetland graminoid rushes, sedges and grasses, several facultative wetland forb species, and several phreatophyte shrub and tree species. This ephemeral wetland will represent a range of early seral (all herbs) to a late seral (shrubs and trees) damp to dry soil wetland, and the vegetation structure that is open, dominated by herbs, with scattered individual and clumps of shrubs and trees. Plant species recommended for planting in the Ephemeral Wetland Habitat are presented in Table 6.9.

Table 6.9. Plant species recommended for planting in the Ephemeral Wetland Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
curlycup gumweed	*Grindelia squarrosa*	Asteraceaee	Forb	Annual
annual sunflower	*Helianthus annuus*	Asteraceaee	Forb	Annual
Rocky Mountain beeplant	*Cleome serrulata*	Capparaceae	Forb	Annual
Clammyweed	*Polanisia dodecandra trachysperma*	Capparaceae	Forb	Annual
blue lettuce	*Mulgedium pulchellum*	Asteraceaee	Forb	Annual/Biennial
Indian hemp	*Apocynum cannabinum*	Apocynaceae	Forb	Perennial
horsetail milkweed	*Asclepias subverticillata*	Asclepiadaceae	Forb	Perennial
showy milkweed	*Asclepias speciosa*	Asclepiadaceae	Forb	Perennial
Western goldentop	*Euthamia occidentalis*	Asteraceae	Forb	Perennial
blueweed	*Helianthus ciliaris*	Asteraceaee	Forb	Perennial
seaside heliotrope	*Heliotroium curassavicum*	Boraginaceae	Forb	Perennial
alkali mallow	*Malvella leprosa*	Malvaceae	Forb	Perennial
yerba mansa	*Anemopsis californica*	Saururaceae	Forb	Perennial
bearded sprangletop	*Leptochloa fusca fascicularis*	Poaceae	Grass	Annual
Inland saltgrass	*Distichlis spicata stricta*	Poaceae	Grass	Perennial
giant sacaton	*Sporobolus wrightii*	Poaceae	Grass	Perennial
vine-mesquite	*Panicum obtusum*	Poaceae	Grass	Perennial
Canada wildrye	*Elymus canadensis*	Poaceae	Grass	Perennial
scratchgrass	*Muhlenbergia asperifolia*	Poaceae	Grass	Perennial
Western wheatgrass	*Pascopyrum smithii*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
alkali sacaton	*Sporobolus airoides*	Poaceae	Grass	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
goldenweed	*Isocoma pluriflora*	Asteraceae	Shrub	Perennial
false indigo bush	*Amorpha fruticosa*	Fabaceae	Shrub	Perennial
desert willow	*Chilopsis linearis*	Bignoniaceae	Tree	Perennial
screw-bean mesquite	*Prosopis pubescens*	Fabaceae	Tree	Perennial
peachleaf willow	*Salix amygdaloides*	Salicaceae	Tree	Perennial
coyote willow	*Salix exigua*	Salicaceae	Tree	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Ephemeral wetlands were once common among old oxbow channels on the floodplain near the Rio Grande. Such wetlands are now rare, and there is much need to restore/create more wetland habitats to support greater species diversities and abundances of native wildlife in the Albuquerque region. The Ephemeral Wetland will provide habitats for wetland associated animal species, including; many arthropods, wetland specialist amphibians, reptiles, birds and mammals. Such species do not occur in other, drier or aquatic habitats, and some prefer ephemeral wetlands over permanent wetlands. Without wetlands, these species will not occur in the area. Wetlands additionally provide important habitat for generalist species, where a great abundance of other more habitat-specific (wetland) species also occur.

Design. The Ephemeral Wetland would be constructed in the crop fields immediately to the east of the existing RGNC ponds and Candelaria Wetland ponds, and adjacent to the Damp Soil Wetland. The soils of this area are sandy and well drained, and the water table is at approximately 6-8 feet below the soil surface (see Chapter 3). The Damp Soil Wetland would take approximately 20 years for plantings to spread and for perennial woody species to become mature. All stages of natural ecological succession for a MRG wetland would be planted and maintained, from open graminoid areas, to perennial herb patches, and woody shrub and tree patches. The Ephemeral Wetland will be designed to have no transport of water to the Candelaria Wetland or RGNC ponds.

Implementation. Earth-moving equipment will be needed to excavate a shallow 1-3 foot deep, and 100 foot wide, by 1,000 feet long, simulated oxbow depression across the existing field. Soil from the excavation would be moved to the side margins, and spread to a distance of about 100 feet away from the depression on both sides, in uneven depths up to 1 foot deep, with slightly sloping margins to simulate shorelines. The Candelaria Wetland ponds were excavated to depths of about 6 feet, with the assumption that excavated soils piled as berms around the ponds would erode back into the ponds, but that did not happen. Based on that experience, the excavated soils around the Ephemeral Wetland perimeter, should stay in place for many years, especially once vegetation has grown over the soil surfaces. A planting design will be produced, and select plant

species from Table 6.9 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the soils in the bottom of the simulated oxbow depression are damp for several weeks at a time during the early and late summer, but periodically dry at the surface between irrigation events. Natural rainstorms should also fill the bottom of the ephemeral wetland for short periods, and may preclude the need for irrigation.

Maintenance. Following construction and initial Phase 1 vegetation plantings, the primary maintenance needs will be the periodic flood irrigating of the Ephemeral Wetland, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan. Monitoring should also be employed to evaluate the water table (piezometer wells), soil condition (soil particle size and chemistry sampling), soil movement (erosion from the excavated soil, and sedimentation of the simulated oxbow depression) over the next 20 years.

Ephemeral Wetland Protocols

- *The roads around the Ephemeral Wetland shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Ephemeral Wetland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the Ephemeral Wetland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The Ephemeral Wetland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Unless otherwise approved, species planted in the Ephemeral Wetland areas shall be limited to those on Table 6.9.*
- *Species planted in and around the Ephemeral Wetland areas will be approved by OSD.*
- *Monitoring activities at the Ephemeral Wetland areas may only proceed according to a schedule and plan approved by the OSD.*

1.7. Damp Soil Grassland Habitat

Description. Juncus-Houttuynai (Rush-Yerba Mansa) Association of Watson (1912), but upper portions that are dryer than wetland areas; Wetland/Open Area (wet/dry) habitats of Cartron et al. (2008); saltgrass area at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande on the former floodplain near the river, where water levels vary, but tend to be drier than wetlands. Damp Soil Grasslands have damp to dry clay, silty to sandy soil that is wet approximately 2-3 times during the summer growing season, mostly during the late summer monsoon period. Naturally high water may also occur during the late spring Rio Grande runoff in May/June. With river regulation and climate change, that is no longer the case. To mimic the occasional early and late summer flooding periods, the Damp Soil Grassland would be flood irrigated on a schedule to best support the greatest number of obligate and facultative damp grassland plant species listed in Table 6.10. Typical plant species would include obligate/facultative damp soil grasses, several facultative damp soil forb species, and several shrub and tree species. This Damp Soil Grassland will represent a range of early seral (all herbs) to a late seral (shrubs and trees) damp to dry soil grassland, and the vegetation structure that is open, dominated by herbs, with scattered individual and clumps of shrubs and trees. Plant species recommended for planting in the Damp Soil Grassland Habitat are presented in Table 6.10.

Table 6.10. Plant species recommended for planting in the Damp Soil Grassland Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
curlycup gumweed	*Grindelia squarrosa*	Asteraceaee	Forb	Annual
horsetail milkweed	*Asclepias subverticillata*	Asclepiadaceae	Forb	Perennial
yerba mansa	*Anemopsis californica*	Saururaceae	Forb	Perennial
blueweed	*Helianthus ciliaris*	Asteraceaee	Forb	Perennial
Indian hemp	*Apocynum cannabinum*	Apocynaceae	Forb	Perennial
prairie flax	*Linum lewissi*	Linaceae	Forb	Perennial
alkali mallow	*Malvella leprosa*	Malvaceae	Forb	Perennial
bearded sprangletop	*Leptochloa fusca fascicularis*	Poaceae	Grass	Annual
Inland saltgrass	*Distichlis spicata stricta*	Poaceae	Grass	Perennial
alkali sacaton	*Sporobolus airoides*	Poaceae	Grass	Perennial
giant sacaton	*Sporobolus wrightii*	Poaceae	Grass	Perennial
blue grama	*Bouteloua gracilis*	Poaceae	Grass	Perennial
sliver bluestem	*Bothriochloa laguroides*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
sand dropseed	*Sporobolus cryptandrus*	Poaceae	Grass	Perennial
vine-mesquite	*Panicum obtusum*	Poaceae	Grass	Perennial
goldenweed	*Isocoma pluriflora*	Asteraceae	Shrub	Perennial
Four-wing saltbush	*Atriplex canescens*	Chenopodiaceae	Shrub	Perennial
winterfat	*Krascheninnikovia lanata*	Chenopodiaceae	Shrub	Perennial
pale wolfberry	*Lycium pallidum*	Solanaceae	Shrub	Perennial
Torrey's wolfberry	*Lycium torreyi*	Solanaceae	Shrub	Perennial
greasewood	*Sarcobatus vermiculatus*	Chenopodiaceae	Shrub	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Damp Soil Grasslands were once common adjacent to old oxbow channels and on the floodplain near the Rio Grande. Such grasslands are now rare, and there is much need to restore/create more grassland habitats to support greater species diversities and abundances of native wildlife in the Albuquerque region. The Damp Soil Grassland will provide habitats for grassland associated animal species, including; many arthropods, reptiles, birds and mammals. Without grasslands, these species will not occur in the area. Grasslands additionally provide important habitat for generalist species, where a great abundance of other more habitat-specific (grassland) species also occur.

Design. The Damp Soil Grassland would be constructed in the crop fields immediately to the east of the existing RGNC ponds and Candelaria Wetland ponds, and adjacent to the Damp Soil Wetland. The soils of this area are sandy and well drained, and the water table is at approximately 6-8 feet below the soil surface (see Chapter 3). The Damp Soil Wetland would take approximately 10 years for plantings to spread and for perennial woody species to become mature. All stages of natural ecological succession for a MRG damp grassland would be planted and maintained, from open grassy areas, to perennial herb patches, and woody shrub and tree patches.

Implementation. A planting design will be produced, and select plant species from Table 6.10 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the soils are damp for several weeks at a time during the early and late summer, but periodically dry at the surface between irrigation events.

Maintenance. The primary maintenance needs will be the periodic flood irrigating of the Damp Soil Grassland, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan.

Damp Soil Grassland Protocols.

- *The roads around the Damp Soil Grassland shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Damp Soil Grassland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year*

round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.

- *Guided educational programs in the Damp Soil Grassland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The Damp Soil Grassland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the Damp Soil Grassland areas will be approved by OSD.*
- *Monitoring activities at the Damp Soil Grassland areas may only proceed according to a schedule and plan approved by the OSD.*

1.8. Dry Soil Grassland Habitat

Description. Rabbitbrush (Biglovia) Association of Watson (1912), but upper portions that are dryer than wetland areas; Open Area habitats of Cartron et al. (2008); grassy areas (not saltgrass area) at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande on the floodplain, with dry clay, silty to sandy soils. The Dry Soil Grassland would be flood irrigated on a schedule to best support the greatest number of grassland plant species listed in Table 6.11. Typical plant species would include grasses, several forb species, and several shrub and tree species. This Dry Soil Grassland will represent a range of early seral (all herbs) to a late seral (shrubs) dry soil grassland, and the vegetation structure that is open, dominated by herbs, with scattered individual and clumps of shrubs. Plant species recommended for planting in the Dry Soil Grassland Habitat are presented in Table 6.11.

Table 6.11. Plant species recommended for planting in the Dry Soil Grassland Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
Navajo tea	*Thelesperma megapotamicum*	Asteraceae	Forb	Annual
curlycup gumweed	*Grindelia squarrosa*	Asteraceaee	Forb	Annual
spectacle pod	*Dimorphocarpa wislizennii*	Brassicaceae	Forb	Annual
Rocky Mountain beeplant	*Cleome serrulata*	Capparaceae	Forb	Annual
Clammyweed	*Polanisia dodecandra trachysperma*	Capparaceae	Forb	Annual
sandbells	*Nama hispidum*	Hydrophyllaceae	Forb	Annual
velvetweed	*Gaura parviflora*	Onagraceae	Forb	Annual
blue trumpets	*Ipomopsis longiflora*	Polemoniaceae	Forb	Annual
warty caltrop	*Kallstroemia parviflora*	Zygophyllaceae	Forb	Annual
oak-leaf thorn-apple	*Datura quercifolia*	Solanaceae	Forb	Annual/Biennial
horsetail milkweed	*Asclepias subverticillata*	Asclepiadaceae	Forb	Perennial
hairy golden-aster	*Heterotheca villosa*	Asteraceae	Forb	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
wooly paperflower	*Psilostrophe tagetina*	Asteraceae	Forb	Perennial
green Mexican-hat	*Ratibida tagetes*	Asteraceae	Forb	Perennial
threadleaf groundsel	*Senecio flaccidus*	Asteraceae	Forb	Perennial
Riddell's groundsel	*Senecio riddellii*	Asteraceae	Forb	Perennial
white-heath aster	*Symphotrichum ericoides*	Asteraceae	Forb	Perennial
lacy sleep-daisy	*Xanthisma spinolusum*	Asteraceae	Forb	Perennial
freckled milkvetch	*Astragalus lentiginosus*	Fabaceae	Forb	Perennial
Albuquerque prairie clover	*Dalea scariosa*	Fabaceae	Forb	Perennial
prairie flax	*Linum lewissi*	Linaceae	Forb	Perennial
adonis blazingstar	*Metzelia multiflora*	Loasaceae	Forb	Perennial
copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	Forb	Perennial
scarlet beeblossom	*Gaura coccinea*	Onagraceae	Forb	Perennial
Hooker's evening primrose	*Oenothera elata hirsutissima*	Onagraceae	Forb	Perennial
pale evening primrose	*Oenothera pallida*	Onagraceae	Forb	Perennial
fleabane	*Erigeron divergens, E. flagellaris*	Poaceae	Forb	Perennial
sacred thorn-apple	*Datura wrightii*	Solanaceae	Forb	Perennial
blue grama	*Bouteloua gracilis*	Poaceae	Grass	Perennial
sand dropseed	*Sporobolus cryptandrus*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
Indian ricegrass	*Achnatherum hymenoides*	Poaceae	Grass	Perennial
silver bluestem	*Bothriochloa laguroides*	Poaceae	Grass	Perennial
side-oats grama	*Bouteloua curtipendula*	Poaceae	Grass	Perennial
burro grass	*Scleropogon brevifolius*	Poaceae	Grass	Perennial
Western wheatgrass	*Pascopyrum smithii*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
spike dropseed	*Sporobolus contractus*	Poaceae	Grass	Perennial
rabbitbrush	*Ericameria nauseosua*	Asteraceae	Shrub	Perennial
broom snakeweed	*Gutierrezia sarothrae*	Asteraceaee	Shrub	Perennial
winterfat	*Krascheninnikovia lanata*	Chenopodiaceae	Shrub	Perennial
broom dalea	*Psorothamnus scoparius*	Fabaceae	Shrub	Perennial
Plains yucca	*Yucca glauca*	Asparagaceae	Succulent	Perennial
Plains prickly pear	*Opuntia phaeacantha*	Cactaceae	Succulent	Perennial
tree cholla	*Cylindropuntia imbricata*	Cactaceae	Succulent	Perennial
starvation prickly pear	*Opuntia polyacantha*	Cactaceae	Succulent	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Dry Soil Grasslands were once common on the former floodplain near the Rio Grande. Such grasslands are now rare, and there is much need to restore/create more grassland habitats to support greater species diversities and abundances of native wildlife in the Albuquerque region. The Dry Soil Grassland will provide habitats for grassland associated animal species, including; many arthropods, reptiles, birds and mammals. Without grasslands, these species will not occur in the area. Grasslands additionally provide important habitat for generalist species, where a great abundance of other more habitat-specific (grassland) species also occur.

Design. The Dry Soil Grassland would be constructed in the crop fields immediately to the east of the existing RGNC ponds and Candelaria Wetland ponds, and adjacent to the Damp Soil Wetland. The soils of this area range from clay to sandy loam (see Chapter 3). The Damp Soil Wetland would take approximately 10 years for plantings to spread and for perennial woody species to become mature. All stages of natural ecological succession for a MRG floodplain dry grassland would be planted and maintained, from open grassy areas, to perennial herb patches, and woody shrub patches.

Implementation. A planting design will be produced, and select plant species from Table 6.11 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the surface soils are damp for several days at a time during the early and late summer, but dry at the surface between irrigation events.

Maintenance. The primary maintenance needs will be the periodic flood irrigating of the Dry Soil Grassland, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan.

Dry Soil Grassland Protocols.

- *The roads around the Dry Soil Grassland shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Dry Soil Grassland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the Dry Soil Grassland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the*

Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.

- *The Dry Soil Grassland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the Dry Soil Grassland areas will be approved by OSD.*
- *Monitoring activities at the Dry Soil Grassland areas may only proceed according to a schedule and plan approved by the OSD.*

1.9. Salt Shrubland Habitat

Description Rabbitbrush (Biglovia) Association of Watson (1912); Open Area habitats of Cartron et al. (2008); shrubland (four-wing saltbush) areas at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande on the floodplain, with dry clay, silty to sandy soils. The Salt Shrubland would be flood irrigated on a schedule to best support the greatest number of shrubland plant species listed in Table 6.12. Typical plant species would include grasses, several forb species, and several shrub species. This Salt Shrubland will represent a range of mid to a late seral (shrubs) Salt Shrubland, and the vegetation structure that is open, dominated by low woody shrubs, with scattered grasses and herbs. Plant species recommended for planting in the Salt Shrubland Habitat are presented in Table 6.12.

Table 6.12. Plant species recommended for planting in the Salt Shrubland Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
oak-leaf thorn-apple	*Datura quercifolia*	Solanaceae	Forb	Annual/Biennial
blueweed	*Helianthus ciliaris*	Asteraceaee	Forb	Perennial
freckled milkvetch	*Astragalus lentiginosus*	Fabaceae	Forb	Perennial
prairie flax	*Linum lewissi*	Linaceae	Forb	Perennial
copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	Forb	Perennial
sacred thorn-apple	*Datura wrightii*	Solanaceae	Forb	Perennial
bearded sprangletop	*Leptochloa fusca fascicularis*	Poaceae	Grass	Annual
Inland saltgrass	*Distichlis spicata stricta*	Poaceae	Grass	Perennial
alkali sacaton	*Sporobolus airoides*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
giant sacaton	*Sporobolus wrightii*	Poaceae	Grass	Perennial
burro grass	*Scleropogon brevifolius*	Poaceae	Grass	Perennial
goldenweed	*Isocoma pluriflora*	Asteraceae	Shrub	Perennial
rabbitbrush	*Ericameria nauseosua*	Asteraceae	Shrub	Perennial
greasewood	*Sarcobatus vermiculatus*	Chenopodiaceae	Shrub	Perennial
Four-wing saltbush	*Atriplex canescens*	Chenopodiaceae	Shrub	Perennial
false indigo bush	*Amorpha fruticosa*	Fabaceae	Shrub	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
golden current	*Ribes aureum*	Grossulariaceae	Shrub	Perennial
New Mexico desert olive	*Forestiera pubescens*	Oleaceae	Shrub	Perennial
pale wolfberry	*Lycium pallidum*	Solanaceae	Shrub	Perennial
Torrey's wolfberry	*Lycium torreyi*	Solanaceae	Shrub	Perennial
Plains prickly pear	*Opuntia phaeacantha*	Cactaceae	Succulent	Perennial
screw-bean mesquite	*Prosopis pubescens*	Fabaceae	Tree	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Salt Shrublands were once common on the former floodplain near the Rio Grande. Such shrublands are now less common, and there is much need to restore/create more shrubland habitats to support greater species diversities and abundances of native wildlife in the Albuquerque region. The Salt Shrubland will provide habitats for shrubland associated animal species, including; many arthropods, reptiles, birds and mammals (Table 6.12). Without shrublands, these species will not occur in the area. Shrublands additionally provide important habitat for generalist species, where a great abundance of other more habitat-specific (shrubland) species also occur.

Design. The Salt Shrubland would be planted in the crop fields immediately to the east of the existing RGNC ponds and Candelaria Wetland ponds, and adjacent to the Damp Soil Wetland. The soils of this area range from clay to sandy loam (see Chapter 3). The Salt Shrubland would take approximately 10 years for perennial woody species to become mature. All stages of natural ecological succession for a MRG floodplain dry shrubland would be planted and maintained, from open grassy areas, to perennial herb patches, and woody shrub patches.

Implementation. A planting design will be produced, and select plant species from Table 6.12 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation and/or individual plant spot watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the surface soils are damp for several days at a time during the early and late summer, but dry at the surface between irrigation events.

Maintenance. The primary maintenance needs will be the periodic flood irrigating and/or individual plant spot watering of the Salt Shrubland, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan.

Salt Shrubland Protocols.

- *The roads around the Salt Shrubland shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Salt Shrubland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the Salt Shrubland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The Salt Shrubland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the Salt Shrubland areas will be approved by OSD.*
- *Monitoring activities at the Salt Shrubland areas may only proceed according to a schedule and plan approved by the OSD.*

1.10. Arroyo Margin Shrubland Habitat

Description. Rabbitbrush (Biglovia) Association, lower arroyo margins, of Watson (1912); largely replaced by non-native saltcedar and Russian olive habitats of Cartron et al. (2008); shrubland (mixed species) areas at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande floodplain, where large arroyos drained into the Rio Grande, silty to sandy soils. The Arroyo Margin Shrubland would be flood irrigated on a schedule to best support the greatest number of shrubland plant species listed in Table 6.13. Typical plant species would include grasses, several forb species, and several shrub species. This Arroyo Margin Shrubland will represent a range of mid to a late seral (shrubs) Arroyo Margin Shrubland, and the vegetation structure that is open, dominated tall woody shrubs, with scattered grasses and herbs and trees. Plant species recommended for planting in the Arroyo Margin Habitat are presented in Table X.

Table 6.13. Plant species recommended for planting in the Arroyo Margin Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
oak-leaf thorn-apple	*Datura quercifolia*	Solanaceae	Forb	Annual/Biennial
hairy golden-aster	*Heterotheca villosa*	Asteraceae	Forb	Perennial
copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	Forb	Perennial
fleabane	*Erigeron divergens, E. flagellaris*	Poaceae	Forb	Perennial
sacred thorn-apple	*Datura wrightii*	Solanaceae	Forb	Perennial
giant sacaton	*Sporobolus wrightii*	Poaceae	Grass	Perennial
blue grama	*Bouteloua gracilis*	Poaceae	Grass	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
side-oats grama	*Bouteloua curtipendula*	Poaceae	Grass	Perennial
scratchgrass	*Muhlenbergia asperifolia*	Poaceae	Grass	Perennial
Western wheatgrass	*Pascopyrum smithii*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
Indian grass	*Sorghastrum nutans*	Poaceae	Grass	Perennial
spike dropseed	*Sporobolus contractus*	Poaceae	Grass	Perennial
sand dropseed	*Sporobolus cryptandrus*	Poaceae	Grass	Perennial
alkali sacaton	*Sporobolus airoides*	Poaceae	Grass	Perennial
little-leaf sumac	*Rhus microphylla*	Anacardiaceae	Shrub	Perennial
skunkbush sumac	*Rhus trilobata*	Anacardiaceae	Shrub	Perennial
rabbitbrush	*Ericameria nauseosua*	Asteraceae	Shrub	Perennial
willow baccharis	*Baccharis salicifolia*	Asteracea	Shrub	Perennial
Four-wing saltbush	*Atriplex canescens*	Chenopodiaceae	Shrub	Perennial
golden current	*Ribes aureum*	Grossulariaceae	Shrub	Perennial
New Mexico desert olive	*Forestiera pubescens*	Oleaceae	Shrub	Perennial
Apache plume	*Fallugia paradoxa*	Rosaceae	Shrub	Perennial
pale wolfberry	*Lycium pallidum*	Solanaceae	Shrub	Perennial
Torrey's wolfberry	*Lycium torreyi*	Solanaceae	Shrub	Perennial
desert willow	*Chilopsis linearis*	Bignoniaceae	Tree	Perennial
net-leaf hackberry	*Celtis reticulata*	Cannabaceae	Tree	Perennial
black locust	*Robinia pseudoacacia*	Fabaceae	Tree	Perennial
screw-bean mesquite	*Prosopis pubescens*	Fabaceae	Tree	Perennial
peachleaf willow	*Salix amygdaloides*	Salicaceae	Tree	Perennial
coyote willow	*Salix exigua*	Salicaceae	Tree	Perennial
thicket creeper	*Parthenocissus vitacea*	Vitaceae	Vine	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Arroyo Margin Shrublands were once common on the former floodplain near the Rio Grande. Such shrublands are now largely replaced by stands of non-native saltcedar, Russian olive, and Siberian elm. Those exotic tree species provide poor habitat for native wildlife, relative to a diversity of native shrubs and trees with their associated flowers, fruit, seeds, and insects. There is much need to restore/create more shrubland habitats to support greater species diversities and abundances of native wildlife in the Albuquerque region. The Arroyo Margin

Shrubland will provide habitats for shrubland associated animal species, including; many arthropods, reptiles, birds and mammals. Without shrublands, these species will not occur in the area. Shrublands additionally provide important habitat for generalist species, where a great abundance of other more habitat-specific (shrubland) species also occur.

Design. The Arroyo Margin Shrubland would be planted in the crop fields immediately to the east of the existing RGNC ponds and Candelaria Wetland ponds, and adjacent to the Damp Soil Wetland. The soils of this area range from clay to sandy loam (see Chapter 3). The Arroyo Margin Shrubland would take approximately 20 years for perennial woody species to become mature. All stages of natural ecological succession for a MRG floodplain Arroyo Margin Shrubland would be planted and maintained, from grass and herb patches, to a dominance of woody shrub/tree patches.

Implementation. A planting design will be produced, and select plant species from Table 6.13 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation and/or individual plant spot watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the surface soils are damp for several days at a time during the early and late summer, but dry at the surface between irrigation events.

Maintenance. The primary maintenance needs will be the periodic flood irrigating and/or individual plant spot watering of the Arroyo Margin Shrubland, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan.

Arroyo Margin Shrubland Protocols.

- *The roads around the Arroyo Margin Shrubland shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Arroyo Margin Shrubland areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the Arroyo Margin Shrubland shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The Arroyo Margin Shrubland areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the Arroyo Margin Shrubland areas will be approved by OSD.*

- *Monitoring activities at the Arroyo Margin Shrubland areas may only proceed according to a schedule and plan approved by the OSD.*

1.11. Sandbar (Remnant, Dry) Habitat

Description Rabbitbrush (Biglovia) Association, open sandy areas of former riverine sand bars, of Watson (1912); Open Area habitats of Cartron et al. (2008); sandy, grassy areas at Whitfield Wildlife Conservation Area (2019).

This habitat was represented along the Rio Grande on the floodplain as remnant river channel sandbars, with dry, silty to sandy soils. These are meant to represent historic dry remnant sandbars now disconnected from the river, not active, wet sandbars in the river channel. The Sandbar Habitat would be flood irrigated on a schedule to best support the greatest number of grassland plant species listed in Table 6.14. Typical plant species would include grasses, several forb species, and several shrub and tree species. This Sandbar Habitat will represent a range of early seral (all herbs) to a late seral (shrubs) Sandbar Habitat, and the vegetation structure that is open, dominated by herbs, with scattered individual and clumps of shrubs. Plant species recommended for planting in the Sandbar Habitat are presented in Table X.

Table 6.14. Plant species recommended for planting in the Sandbar Habitat.

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	**Scientific Name[2]**	**Plant Family[3]**	**Growth Form[4]**	**Life History[5]**
Indian blanket	*Gaillarida pulchella*	Asteraceae	Forb	Annual
Navajo tea	*Thelesperma megapotamicum*	Asteraceae	Forb	Annual
desert marigold	*Bailea multiradiata*	Asteraceaee	Forb	Annual
annual sunflower	*Helianthus annuus*	Asteraceaee	Forb	Annual
spectacle pod	*Dimorphocarpa wislizennii*	Brassicaceae	Forb	Annual
Western tansymustard	*Descurainia pinata*	Brassicaceae	Forb	Annual
Rocky Mountain beeplant	*Cleome serrulata*	Capparaceae	Forb	Annual
Clammyweed	*Polanisia dodecandra trachysperma*	Capparaceae	Forb	Annual
sandbells	*Nama hispidum*	Hydrophyllaceae	Forb	Annual
velvetweed	*Gaura parviflora*	Onagraceae	Forb	Annual
blue trumpets	*Ipomopsis longiflora*	Polemoniaceae	Forb	Annual
warty caltrop	*Kallstroemia parviflora*	Zygophyllaceae	Forb	Annual
oak-leaf thorn-apple	*Datura quercifolia*	Solanaceae	Forb	Annual/Biennial
hairy golden-aster	*Heterotheca villosa*	Asteraceae	Forb	Perennial
wooly paperflower	*Psilostrophe tagetina*	Asteraceae	Forb	Perennial
green Mexican-hat	*Ratibida tagetes*	Asteraceae	Forb	Perennial
threadleaf groundsel	*Senecio flaccidus*	Asteraceae	Forb	Perennial
Riddell's groundsel	*Senecio riddellii*	Asteraceae	Forb	Perennial
tall goldenrod	*Solidago altissima gilovcanescens*	Asteraceae	Forb	Perennial

Plant Species[1,2]: Dominants are Bold; Pollinator Plants are Pink	Scientific Name[2]	Plant Family[3]	Growth Form[4]	Life History[5]
white-heath aster	*Symphotrichum ericoides*	Asteraceae	Forb	Perennial
lacy sleep-daisy	*Xanthisma spinolusum*	Asteraceae	Forb	Perennial
buffalo gourd	*Cucurbita foetidissima*	Cucurbitaceae	Forb	Perennial
freckled milkvetch	*Astragalus lentiginosus*	Fabaceae	Forb	Perennial
Albuquerque prairie clover	*Dalea scariosa*	Fabaceae	Forb	Perennial
adonis blazingstar	*Metzelia multiflora*	Loasaceae	Forb	Perennial
copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	Forb	Perennial
scarlet beeblossom	*Gaura coccinea*	Onagraceae	Forb	Perennial
Hooker's evening primrose	*Oenothera elata hirsutissima*	Onagraceae	Forb	Perennial
pale evening primrose	*Oenothera pallida*	Onagraceae	Forb	Perennial
fleabane	*Erigeron divergens, E. flagellaris*	Asteraceae	Forb	Perennial
sacred thorn-apple	*Datura wrightii*	Solanaceae	Forb	Perennial
Indian ricegrass	*Achnatherum hymenoides*	Poaceae	Grass	Perennial
sand dropseed	*Sporobolus cryptandrus*	Poaceae	Grass	Perennial
giant dropseed	*Sporobolus giganteus*	Poaceae	Grass	Perennial
side-oats grama	*Bouteloua curtipendula*	Poaceae	Grass	Perennial
blue grama	*Bouteloua gracilis*	Poaceae	Grass	Perennial
sliver bluestem	*Bothriochloa laguroides*	Poaceae	Grass	Perennial
Galleta	*Pleuraphis jamesii*	Poaceae	Grass	Perennial
spike dropseed	*Sporobolus contractus*	Poaceae	Grass	Perennial
rabbitbrush	*Ericameria nauseosua*	Asteraceae	Shrub	Perennial
sand sagebrush	*Artemisia fillifolia*	Asteraceae	Shrub	Perennial
broom snakeweed	*Gutierrezia sarothrae*	Asteraceaee	Shrub	Perennial
Four-wing saltbush	*Atriplex canescens*	Chenopodiaceae	Shrub	Perennial
winterfat	*Krascheninnikovia lanata*	Chenopodiaceae	Shrub	Perennial
broom dalea	*Psorothamnus scoparius*	Fabaceae	Shrub	Perennial
Plains yucca	*Yucca glauca*	Asparagaceae	Succulent	Perennial
Plains prickly pear	*Opuntia phaeacantha*	Cactaceae	Succulent	Perennial
starvation prickly pear	*Opuntia polyacantha*	Cactaceae	Succulent	Perennial

[1] Historic and/or current native plant species. Names follow Cartron et al. (2008).

[2] Common and scientific names and taxonomic classification follows Cartron et al. (2008). There have been many name changes over time, especially since Watson (1912).

[3] Native pollinators tend to specialize on different plant families and flowering periods

[4] Grass, Forb, Shrub, Tree. Note that trees and shrubs are based on species potential maximum size, not size at all life stages.

[5] Annual/Biennial, Perennial. Note some biennial species may be annual or perennial, depending on annual growing conditions.

Purpose. Sandbar Habitats were once common on the former floodplain near the Rio Grande. Such grasslands are now less common, and dominated by non-native invasive wees such as

prickly Russian thistle, kochia (Bassia), puncture vine and others. There is much need to restore/create sandbar habitats with a dominance of native plant species to support greater animal species diversities and abundances of native wildlife in the Albuquerque region. The Sandbar Habitat will provide habitats for grassland associated animal species, including; many arthropods, reptiles, birds and mammals. Without sandbar habitats, many of these native species will not occur in the area.

Design. The Sandbar Habitat would be constructed in the crop fields immediately to the east of the existing RGNC ponds and Candelaria Wetland ponds, and adjacent to the Damp Soil Wetland. The soils of this area range from clay to sandy loam (see Chapter 3). The Damp Soil Wetland would take approximately 10 years for plantings to spread and for perennial woody species to become mature. All stages of natural ecological succession for a MRG floodplain dry grassland would be planted and maintained, from open grassy areas, to perennial herb patches, and woody shrub patches.

Implementation. A planting design will be produced, and select plant species from Table 6.14 would be planted according to the spatial design, that would include phases over the next 20 years. A flood irrigation watering plan will need to be produced, based on the species planted and their water needs. The watering plan will need to be such that the surface soils are damp for several days at a time during the early and late summer, but dry at the surface between irrigation events.

Maintenance. The primary maintenance needs will be the periodic flood irrigating of the Sandbar Habitat, based on the watering plan (see above). Additionally, the control of non-native invasive weeds will need to be conducted by the development of a non-native invasive weed control plan, and implementation of that plan on a periodic basis. Monitoring will be necessary to provide data on the effectiveness of both the watering plan and the non-native invasive weed control plan.

Sandbar (Remnant, Dry) Protocols.

- *The roads around the Sandbar Habitat shall serve as access routes to the wetland for vehicle and foot traffic. With the exception of restoration and maintenance activities, and low-impact guided educational programs, the Sandbar Habitat areas shall be off-limits to farm operations, vehicular and foot traffic.*
- *The OSD or other approved parties may access the wetland areas for the purpose of routine or emergency maintenance, planting irrigating and mowing at any time, year round, although activities are to be minimized from November through May, to avoid disturbing nesting bird populations.*
- *Guided educational programs in the Sandbar Habitat shall avoid disturbing the plant and animal life, especially during the bird wintering and nesting seasons, from November through May. OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland.*
- *The Sandbar Habitat areas shall be irrigated from adjacent ditches, as needed during the irrigation season.*
- *Species planted in and around the Sandbar Habitat areas will be approved by OSD.*

- *Monitoring activities at the Sandbar Habitat areas may only proceed according to a schedule and plan approved by the OSD.*

2. Operate a Sustainable Farm for Wildlife

For the purposes of this Resource Management Plan sustainable farming uses methods and practices that are environmentally sound, protect public and wildlife health and are economically viable. Additionally, sustainable practices avoid agrichemical fertilizers and manage pests without pesticides and herbicides when feasible. Public input to date has reinforced the consensus that if farming is necessary, farming should operate sustainably in support of wildlife habitat.

This plan assumes that in the short term, the City will employ a contract farmer operational model to maintain the property and may transition to either hiring a farming full time or hiring personnel that can operate the farm. Farming operations must be monitored on a quarterly or yearly basis to evaluate methods and practices, revenues/expenses, and correlate wildlife habitat research with cropping plans and farming techniques. Successful sustainable farming practices take long-term commitment from oversight agencies and stakeholders.

2.1. Soil Management

.Healthy soil contributes to the overall health of an ecosystem by providing fungi and bacterial growth for bugs and grubs that are food sources for larger vertebrate animals. The best sustainable method to increase soil health is to keep the roots of perennial crops in the ground, practice conservation tillage and fertilize with only organic, soil-building materials. Conservation tillage, in contrast to conventional tillage methods that upturn the soil, involves limiting disturbance to the soil surface and allowing agricultural residue to compost in place. There are numerous conservation tillage techniques that vary per region, scale of the land to be cultivated, and the availability of equipment.

Benefits of conservation tillage include:

- Water erosion reduction through improved water infiltration – also reduces nitrate runoff from fertilized fields.
- Wind erosion reduction through stabilized soil surface.
- Soil nutrient retention.
- Reduction is soil emissions of greenhouse gases that occur when soil is disturbed, speeding up the microbial breakdown of organic material.
- Carbon sequestration.
- Lowered equipment/fuel costs.

Conservation tillage weaknesses:

- Specialized equipment required for large scale implementation of conservation tillage techniques.
- Development of clay lenses and/or soil compaction that limits oxygen and inhibits water permeability.

- Weeds and other pests are not impacted by traditional tillage techniques and could proliferate.
- While CO2 emissions are reduced, other non-CO2 greenhouse gases such as N20 and CH4 can still be emitted.
- Conservation tillage is a growing soil management technique with few experienced practitioners; thus, requiring a more administrative time to hire farmers capable of practicing and successfully implementing new agronomy methods.

2.2. Cover Crops and Crop Rotation

Cover crops include a variety of species planted to reduce need for fertilizer, reduce use of herbicides and pesticides, increase yields from healthier soil, reduce erosion, and to retain soil moisture. Cover crops such as clover and other leguminous plants help fix atmospheric nitrogen into the soil where it becomes available to other crops. Some cover crops are used to mechanically aerate the soil such as with daikon radish and some fibrous root grains. Cover cropping will also benefit native species and wildlife while building the soil.

Crop rotation in the context of growing annual crops such as corn for migratory waterfowl involves replenishing soil nitrogen that is depleted by an annual planting strategy. Alternating plots of corn with nitrogen fixing species (such as clover) allows for sustainable production over time.

2.3. Integrated Pest Management

Integrated Pest Management (IPM) is a systems approach for management of pests. A pest in IPM can be an insect, insect-like creature, weed, plant disease, or vertebrate whose presence or population density interferes with the land management goals for a given area. IPM is a system for the planning and implementation of an interdisciplinary program for containment or control of pests. IPM uses all available methods including education, prevention, physical or mechanical methods, biological control methods, chemical methods, cultural methods, and general land management practices. Pests and pest control measures are evaluated for their present or potential impacts to ecological, economic, and social systems. Based on this evaluation, management goals are developed, implemented, and monitored. Use of chemical pesticides will be largely eliminated.

There are several components of an IPM approach:

1. ***Prevention*** of pest infestations is the most effective means of control. Preventative measures include early detection and eradication of pests, limiting introduction of contaminated materials to management areas, and use of farming practices that are known to promote resistance to pests.

2. ***Education*** of land managers and visitors in identification of pests and in preventative measures will promote early detection of pest problems.

3. ***Identification and inventory*** of pests may be done by the farmer with assistance from agency or industry experts. Weed identification and inventory may also be done by school groups or by volunteer groups.

4. ***Establishment of management goals*** is done through an evaluation of the present and potential impact of the pest and pest control measures to crops and/or wildlife habitat, and/or non-native species, and the economics of per acre pest control costs. Integrated pest management goals may range from suppression of the pest, to maintenance of the pest population at an acceptable level, to complete eradication of the pest.

5. ***Evaluation of benefits and risks of management strategies*** is accomplished using similar criteria to establish control goals. Present or potential impacts of the pest should be weighed against the ecological and social risks and economic costs of per acre pest control. Many farming techniques that are effective as potential preventative measures are also effective control measures for new or established pest populations. This evaluation then leads to the ***selection of an appropriate management strategy*** for the implementation of IPM goals.

6. ***Monitoring*** is a critical component of the IPM plan. An ongoing evaluation of management effectiveness and impacts will provide information for required adjustments to management goals and strategies.

At the CNP, contract farmers and OSD personnel should use an IPM approach and emphasize the use of natural pest control measures, such as farming practices, biological diversity, competition, plant succession, and biological agents. Although a complete inventory of pests at CNP has not been completed, pests that are known to exist at CNP include:

Field bindweed (*Convolvulus arvensis*)

Field bindweed is a creeping perennial introduced to this country from Europe in contaminated seed. It was originally identified in Virginia as early as 1739. Since then it has become recognized as a serious weed problem in most of the United States, especially in farmlands, where it can reduce crop production up to 60%. Several fields at CNP are infested with this species. Field bindweed responds negatively to competition from alfalfa. It can be managed culturally by improved crop cover. Biological control of field bindweed includes the bindweed gall mite (*Aceria malherbae*) and the bindweed moth (*Tyta luctuosa*).

Johnsongrass (*Sorghum halepense*)

Johnsongrass is a perennial grass introduced to this country as a forage crop that spreads by seed and by creeping fleshy rhizomes. It is present along the ditches at CNP, where seed is easily transported with irrigation water to fields or to wetland/wildlife habitat areas. Biological controls are not currently available for Johnsongrass. Creeping perennials are commonly the most difficult group of weeds to manage. Plowing and tilling tend to spread them. Repeated cultivation, mowing and persistent herbicide applications are commonly used for control. In all areas where weed species have been removed, re-seeding should be carried out immediately following treatment. Appropriately selected species (i.e.: native perennials, crops, or nurse crops) will enhance the treatment success by increasing plant community resistance to weed re-establishment. Management decisions about season of treatment should consider optimal times for re-planting treated areas and for minimizing off-site impacts to non-native species.

Alfalfa Weevil (*Hypera postica*)

Alfalfa weevils are annual pests in areas with abundant alfalfa. Adults are grey and about 0.20 inches long. They overwinter secluded in thick plant stands, weeds and farm debris, emerging in late winter or early spring, when females lay eggs into alfalfa stems. When larvae hatch in late spring, they feed on the terminal buds and upper leaves first, and then the lower leaves. Adults also feed on alfalfa. Sufficient feeding can lead to extensive loss of leaves in spring and early summer, substantially reducing the farmer's first cut of alfalfa, and associated profit. Mowing or grazing alfalfa in the fall deprives weevil populations of over-wintering habitat and should be encouraged. Mowing or grazing alfalfa in the spring and cutting and bailing it as soon as the plants are at bud stage may decrease crop damage, but these springtime activities may discourage bird nesting.

Integrated Pest Management Protocols.

- *To the extent possible, the Open Space Division and Contract Farmers shall use Integrated Pest Management practices to monitor and treat pest and weed infestations, adjust farm operations to address pest management issues and maintain the long-term productivity of the farm, without harming wildlife and water quality. Pest management shall be performed by use of mechanical methods, such as pulling or mowing weeds. Chemical pesticides will not be used unless absolutely required in special situations, and such use of pesticides will require approval of OSD.*
- *Until crops are phased out, OSD and the Contract Farmers will not use chemical pesticides to control crop pests, since crops are not being grown for commercial profit. The primary method of weed control shall be through well-timed crop management, and/or physical treatments such as pulling and mowing of weeds. Mowing of weed patches separate from crops or other desirable plants is highly effective just prior to flowering of weed species.*

2.4. Wildlife Crops

Wildlife Cropping will require experimentation with a diversity of crops that provide significant food stuffs for the species of significance in the different habitat areas. Below is a partial list of potential crops that provide native wildlife with food, contribute to soil health, and provide habitat for insects and pollinators.

2.4.1. Crop Types and Varieties

A. Leguminous nitrogen fixing cover/habitat crops
   - Field peas
   - Sweet Clover
   - Sunflower
   - American vetch
   - Astragalus

B. Grains
   - Corn
   - Millet
   - Wheat

- Kernza - Perennial wheat
- Oats
- Barley
- Rye
- Triticale - A hybrid of wheat and rye
- Sorghum - Perennial sorghum preferred
- Milo
- Amaranth

Irrigation

Irrigation efficiency has been significantly improved since the change of contract farmers from Rasband Dairy to JT Robert. The contract farmer currently uses 2.3 acre-feet or less per year per acre to irrigate the farmland surface crops and has received an MRGCD award for irrigation efficiency. This effort was led by the City and the farmer which has resulted in the irrigation laterals being lined with concrete, and the fields being laser leveled for more efficient flood irrigation.

Critical to the operation of the CNP is the use of surface irrigation water rights to irrigate the property. The Resource Management Plan alternatives and preferred alternatives intend to perpetuate the use of flood irrigation to sustain the CNP for outdoor recreational purposes and the OSD goals.

Irrigation Protocols:

- *The Contract Farmers are responsible for managing irrigation activities and coordinating with the MRGCD to schedule delivery of irrigation water.*
- *In developing the Operating Agreement, the OSD may negotiate payment of the MRGCD water delivery fees with Contract Farmers.*
- *OSD is responsible for making major repairs to ditches resulting from regular use, and installing alternative irrigation technologies, as funds become available; OSD may cost-share irrigation improvements with the Contract Farmers or amortize their value over the term of the Operating Agreement. The Contract Farmers are also encouraged to make minor improvements to the irrigation system, in consultation with the OSD. OSD and the Contract Farmers shall pursue efficiency improvements in the irrigation system whenever possible.*
- *The Contract Farmers are responsible for conducting regular ditch maintenance, including mowing vegetation and removing weeds and other debris in preparation for irrigating, cutting elm trees, patching cracks and fixing gates and turnouts, unless the OSD specifically agrees to aid with these activities. The OSD may assist with these activities as resources become available. The Contract Farmers are responsible for any damages to ditches or other irrigation technologies resulting from misuse or neglect by the Contract Farmers.*
- *The Contract Farmers are responsible for burning weeds growing in ditches but may only do so with the prior approval of the OSD. Prior to burning the contract farmers must obtain the burning permits required by the City and/or County, notify the local fire department, and notify the RGNCSP.*

Farm Equipment Storage

Sustaining farm operations requires adequate storage space for equipment and supplies. The dm grove west of Field 2A is designated as an equipment storage area for use by the OSD and Contract Farmers and OSD staff. The OSD also uses this area to temporarily store soil amendments and other related material, as well as dead and down fuel wood removed from the Bosque, before distributing it to the receiving parties.

Farm Equipment Storage Protocols:

- *The OSD and Contract Farmer may store farm equipment in the Equipment Area, and assume all risk of damage or loss in doing so.*
- *In order to store smaller farm equipment with more security, the Contract Farmers may add temporary storage containers or sheds to this area, with the prior permission from the OSD.*
- *The OSD and Contract Farmers shall keep the Equipment Area reasonably clean, tidy, safe and operable. No hazardous materials shall be kept at the farm.*

Gates, Fences, Signage and Farm Roads

The signs, gates and fences around the property control access to the farm, and the farm roads allow for the circulation of farm equipment and guided programs for visitors (see Figure 6). In general, the OSD maintains these facilities.

Gates, Fences, Signage and Farm Roads Protocols:

- *The OSD shall maintain the gates, fences and signs around the property, and the farm roads within the property; The Contract Farmers will be responsible for repairing any damages to gates, fences, signs and farm roads resulting from misuse by the Contract Farmers.*
- *Gates into the property shall remain closed and locked, opened only by the OSD, the Contract Farmers, the MRGCD, the RGNCSP or the Friends of the RGNSCP, their agents and employees, to enter or exit the farm to perform authorized work.*
- *The OSD shall maintain the farm roads in their natural condition for use by the contract farmers in farm operations, and for visitors during guided interpretive programs.*
- *Vehicles and farm equipment must drive slowly on farm roads, so as to maintain public safety and avoid creating dust.*

3. Education and Outdoor Recreation

This plan identifies appropriate outdoor recreation activities for the CNP, develop guidelines for reasonable public access consistent with the wildlife preserve objective, and outline a process and schedule for transitioning the current, non-compliant land uses to wildlife-preserve-related outdoor recreation.

LWCF program supports the protection of public lands and water, secures public access, improves recreational activities and preserves ecosystem benefits for local communities. The OSD needs to ensure that the Candelaria Nature Preserve complies with LWCF regulations in the following ways:

1. Appropriate and allowable outdoor recreation activities consistent with the wildlife preserve objective must be outlined and management practices developed to as to provide reasonable public access to the property for all residents and visitors. This applies to the entire property, including the Candelaria Farms, the South Candelaria tract, and the Rio Grande Nature Center State Park.
2. The CNP is to be managed as a nature study area and wildlife preserve providing access to outdoor recreational opportunities for all residents and visitors, as required by the LWCF Act.

Additionally, the Albuquerque/Bernalillo County Comprehensive Plan states for following goals and polices specific to public access:

Goal 10.1 Facilities and Access: Provide parks, Open Space, and recreation facilities that meet the needs of all residents and use natural resources responsibly.

Goal 10.3 Open Space: Protect the integrity and quality of the region's natural features and environmental assets and provide opportunities for outdoor recreation and education.

3.1. Educational Programs, Citizen Science and Stewardship Activities

A major goal of this plan is to provide a framework for how to provide outdoor recreation opportunities to ALL members of the community. This includes resource-based recreation that is in harmony with the wildlife habitat and preservation goals on the property. It is also important to engage community groups who will help the OSD manage and steward the property into the future. Engaging youth is of importance, as well as diverse sectors of the community that represent the city's demographics.

Guided programs may be led year-round by OSD staff, RGNCSP and community partners. During wintering bird and nesting seasons from November through May, staff will pay special attention to minimize disturbance to wildlife. Hands-on activities will be offered that use scientific techniques to engage to the public and assist with monitoring plants and wildlife at the property. Interpretive themes for the guided programs may include natural and human history of the Rio Grande, water monitoring, acequia systems and culture, habitat types, local and migratory wildlife, native plants and interconnections.

In the past, programs have been scheduled for school groups as well as the general public. Boy scouts and other volunteer groups have also taken part in service-learning projects at the preserve, such as planting hedgerows. These activities will continue and be further supported and enhanced. School programs should be based on the STEAM Ready Standards and evaluated.

Programs and service-learning projects may be expanded to include senior citizen centers, community centers, service clubs, and other social and service groups; and the preserve may be an ideal site for demonstration fields days highlighting irrigation improvements, native plant propagation and other activities that align with the management of the CNP and wildlife.

Limited availability of staff and the lack of funds to pay for group transport to the site will continue to restrict the number of scheduled activities at the preserve. It is important that the

OSD engage community groups to help support the management of the CNP and to assist in delivering programs to the public and school groups.

Education Program Protocols:

- *The maximum number of program participants allowed at one time is generally limited to 35 people, although exceptions may be made if there is sufficient staffing available to divide into small groups and ensure a quality educational experience.*
- *Guided programs shall be managed so as to minimize disturbance to wildlife, especially during the bird wintering and nesting seasons, from November through May.*
- *No unguided or unreserved groups are allowed. However, groups or individuals who have a Special Use or other agreement with the OSD may access the CNP unguided under established protocols. This may include access for wildlife monitoring, service-learning activities, or assisting with management of the property.*
- *Parking and access to the CNP is still to be determined. Ideas include guided programs entering from the Tree Farm and possibly the RGNCSP. ADA parking may be at the Woodward House for guided programs.*
- *Access through the preserve for guided programs shall generally be restricted to the farm roads, the wetland trail and trails through the bosque area on the northwest comer of the farm. A limited number of educational activities may take place in the wetland, the farm fields and the bosque area, taking care to minimize environmental disturbance.*
- *OSD will inform those doing regular wetland monitoring (currently the Friends of the RGNCSP) prior to scheduling guided educational programs around the wetland; OSD will inform the Contract Farmer prior to scheduling guided programs in any farm fields.*
- *The OSD shall comply with Title II of the Americans with Disability Act and other applicable Federal and State accessibility standards in making reasonable accommodations, whenever possible and when adequate notice is given, to provide access for people with disabilities to enroll and participate in guided programs at the CNP. Staff may need to adjust programs as necessary to accommodate disabled participants. And to the extent possible, a fully accessible route shall be created between the Woodward House and RGNCSP, thereby enabling equal access by disabled visitors and the public at large.*

3.1.1. Access Opportunities and Restrictions

Defining public access for CNP requires a balance in the levels of public access and habitat and wildlife protection. There have been two types of access discussed during the development of this plan- physical and visual. Physical access provides a hands-on, immediate experience that can provide lasting educational value, and may disturb wildlife. Visual access is less experiential, will not intrude into the preserve. Visual access is the primary way visitors will experience the preserve. The CNP educational program will emphasize limited access throughout the CNP property to lessen wildlife disturbance, with higher levels of human activity in designated areas. Access will be provided by guided tours of the preserve, from the perimeter via bird blinds/overlooks, and by providing hands-on educational, stewardship activities and citizen science opportunities. All educational activities will be overseen by staff and/or informed volunteers, so to minimize wildlife disturbance.

Public Access Protocols:

- *Vehicular access will be limited to OSD and other "authorized" vehicles, emergency vehicles and, farm machinery. The majority of vehicles are expected to stay on the existing farm roads and access the site via the existing vehicular gates. Pedestrian access is limited to guided tours, education programs, citizen science monitoring activities, and rehabilitation/renovation projects.*
- *Specific areas around the perimeter of the CNP require fencing, and careful thought should be applied its type and function. Because of the light density of homes and continuous agricultural land along the northern perimeter, the landscape/habitat of the preserve is extended by adjacent private land. Fencing along this perimeter should be wildlife friendly. However, the denser residential development along the southern boundary at Veranda and the South Candelaria parcel may warrant a stronger fencing option that limits dogs and unwanted pedestrian entry.*
- *The western border adjacent to the riverside drain is another area that offers extended habitat into the bosque, however its proximity to the Paseo del Bosque Trail is problematic in that the public can intrude into the preserve without being observed. The southern edge of the preserve are the areas that are suited to visual access, overlooks and blinds.*
-
- *Visual access includes overlooks and blinds. They may be installed at the western border north of RGNCSP; eastern boundary along Duranes Lateral; southern boundary along Veranda; and northern boundary of the tract south of the RGNC south of the bosque trail access path.*

3.2. The Woodward House

The Woodward House is an approximately 800 square feet adobe house in the northeast corner of CNP. The house has been estimated to be around 70 years old, but it is currently not eligible for listing under the general guidelines of state or national preservation standards.

The Woodward House may be established as an educational facility, where visitors can see interpretive displays, gather in classrooms for formal programs and monitor the environment from a central location. Current partners in the development of educational programing include Tree New Mexico, who currently have a relationship with OSD to grow native plant material for planting efforts city-wide and have an educational outreach program to teach children planting techniques. This programming may be expanded to include partners such as Vista Volunteers and visiting student groups who would meet at the Woodward House to learn about the CNP. Partnering groups such as Tree New Mexico will benefit from a workstation in Woodward House with a desk, wi-fi access, storage, and office equipment. Alternatively, there is a small amount of space for parking near the house, so some groups may arrive directly for scheduled programs via Arbor Road.

The educational focus of the Woodward House is to provide educational and demonstration opportunities to explore wildlife habitat. The house is presently in fairly good condition, with sound foundations. The roof is a pitched gable style with asphalt shingles. Every effort should be made to retain the house's original architectural ranch style. However, while part of the purpose

of the Woodward House is to display interpretive signs, the intention is to create a practical, functional, and educational space. In addition, the Woodward House may be a good location to office citizen environmental monitoring and education efforts.

Visitors may also participate in planting, cultivating, harvesting native plants that support wildlife. In the past, Native Seed SEARCH has planted native and heirloom varieties of plants in Field 2A (see Figure 1), for the purpose of preserving these seed varieties. This field can be integrated into interpretive programs to complement other activities focusing on wildlife habitat. Some of these activities may take place at the Tree Farm Nursery rather than the Woodward House based on public input.

Funding, as always, is a major concern in planning and managing the programming of a public facility. Funding for educational and interpretive activities may be found through such programs as the Youth Conservation Corps, the Albuquerque Community Foundation, conservation organizations, legislative requests, and corporate donors.

Woodward House Protocols:

- *Any additional restoration of the Woodward House shall seek to maintain the current style of the structure, improve the educational space as described above, and provide the highest level of accessibility possible, in accordance with Title II of the Americans with Disability Act and other Federal and State policies and standards.*
- *The Woodward House may be open to education programs, with the same general limitation of 35 people at one time.*
- *The fields around the Woodward House may be improved for habitat and interpretive purposes, as described above.*
- *The Woodward House can also*
- *The Woodward House can also be a convenient location for occasional Open Space Division staff meetings.*

3.3. Conservation Buffers at Candelaria Nature Preserve

3.3.1. Conservation Buffers and Hedgerows

Conservation buffers (sometimes referred to as hedgerows) are usually linear strips of vegetation that provide multiple benefits to wildlife habitat, soils, management of stormwater quantity and quality, and protect visual and recreation assets. Buffers serve multiple functions even if they are designed primarily for one function. In an urban setting the conservation buffers provide edges and boundary designations to control human intrusions.

As would be expected existing vegetation buffers at CNP follow existing irrigation lateral routes where water is available, are generally configured in a grid fashion, or located at the property lines where vegetation control responsibilities are overlooked. These areas are neither disturbed enough nor disturbed sufficiently to dissuade nuisance vegetation from taking root. The result is that Siberian elm and other weeds occupy the edges in greater numbers than native species. Nonetheless, the weeds provide a degree of habitat and wildlife cover for many desirable insects, birds and animals.

Vegetation buffers serve the secondary environmental functions:

- Increase water quality by slowing water to infiltrate, trap pollutants, and stabilizing soils,
- Increases biodiversity by increasing habitat areas, protecting sensitive habitats, restoring connectivity, increasing access to resources and shades water,
- Reduces soil erosion by reducing stormwater and wind intensity, stabilizes and improves soils and removes pollutants,
- Protects property by reducing wind energy, modifying microclimate, enhances habitat, reduces flood water levels,
- Enhances views and aesthetic quality by screening undesirable and enhancing desirable views and noise, filter pollutants and odors and separates human activities. (Conservation Buffers Technical Report, SRS-109, 2008).

Site design challenges are inherent in a site that is surrounded by residential properties. The CNP's vegetative buffers are one component in the designer's toolbox to address the challenges of this urban/wildland interface. Conservation buffers create:

- an edge to control domesticated animal access,
- a barrier that limits the extent of dog waste (which can limit wildlife movement),
- buffers to odors and wind-borne dust resulting from agricultural activity,
- viewing areas or vegetation gaps that limits or expands visual access
- limits for physical access to sensitive habitat spaces
- a linking of an off-site vegetative buffer can extend the habitat spaces into adjacent parcels.

During the planning process the ecological and urban functions of conservation buffers were discussed for each of the alternatives and the preferred alternative.

3.3.2. The Function of Conservation Buffers

Generally, buffers to the east along the Duranes Lateral provide a strip of vegetation to slow stormwater for infiltration and trap animal waste pollutants, creates access to the lateral and water resources for wildlife, reduces wind velocity and wind-borne dust and modifies the microclimate for visitors walking along the ditch. From an urban edge standpoint, the buffer impedes domestic animal access, creates and screens views, and buffers odors and dust.

Buffers to the west impede stormwater for increased infiltration and serve to reduce pollutants that may be a result of agricultural activity. The west side buffers and the Rio Grande serve to buffer the CNP from wind erosion and, with fencing modifications, can provide extended habitat from CNP to the Bosque. Limited, and controlled visitor access to the west side conservation buffer can significantly increase biodiversity and increase opportunity to visually experience the habitats and wildlife of CNP. Importantly, a bird blind on the west side provides an opportunity to educate and teach future stewards of the CNP.

Internal conservation buffers serve many purposes including wildlife corridors, provision of food resources and cover for wildlife. Additional buffers/hedgerows will provide wind protection,

stormwater infiltration, offer pollutant removal opportunities, and improve soils. Important design considerations include the planting design to be cognizant of the thickness and visibility through the hedgerows for surrounding residents to maintain the pastoral landscape views.

3.3.3. Conservation Buffer Development

The process of removing nuisance plant material, widening existing buffers and planting native plant material has started on several fronts:

- TAG Chairman, Brian Hanson, has begun a revegetation effort of buffers by removing invasive plant material and planting native species, and;
- The Open Space Division has planted native and non-invasive short shrubs along some of the preserve's farm field roads in the past several years in coordination with school groups.
- Conversations have begun between OSD/TAG with MRGCD regarding the treatment of vegetation adjacent to the laterals.

However, the realization of rehabilitating existing and constructing new conservation buffers may take a significant amount of time if improvements continue at the current pace. The plan suggests a phased effort to plant, maintain and establish conservation buffers/hedgerows that contribute to the immediate health of habitat and biodiversity.

4. Conceptual Plan for Candelaria Nature Preserve Site Design

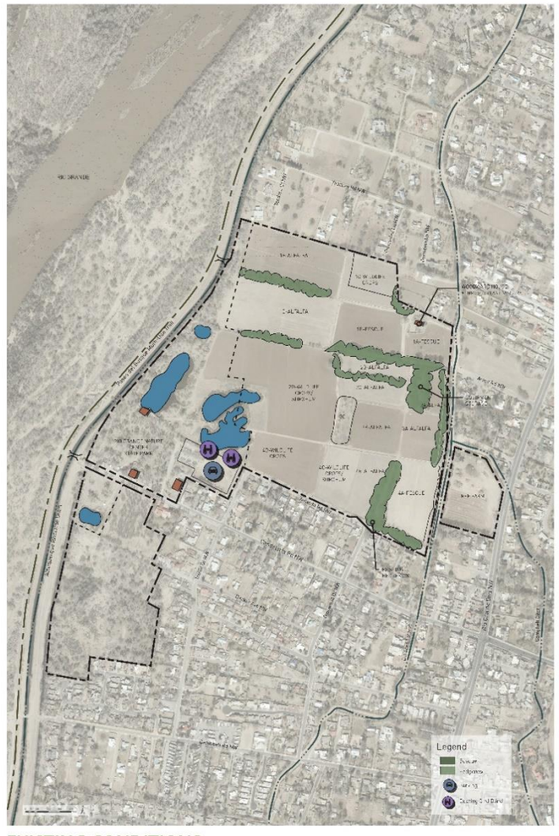
Conceptual planning has been developed based on extensive meetings with the OSD, the TAG. Additional concepts were integrated into the plan based on public input from public meeting, web-based comments, and discovery walks. Other designs and components may be added to the final preferred plan after further public input. The conceptual plan within this draft RMP represents different management and operational models by scaling the following land use factors:

1. Habitat creation, vegetation management, and farming for wildlife forage
2. Public access

Please refer to the maps below (Figure E.1-E.2) and in Appendix D for Habitat (existing Habitat Conditions, Transitional Habitat Plan, and 20-Year Habitat Plan) and Public Access and Outdoor Recreation (Existing Conditions, Limited Outdoor Recreation Access and Activity, and Increased Outdoor Recreation Access and Activity). Also, refer to restored wildlife habitats section in Chapter E for a description of each habitat type. This plan is estimated to cover a 20-year time span and to be implemented in phases.

CANDELARIA NATURE PRESERVE

Habitat Plan



EXISTING CONDITIONS

TRANSITION HABITAT PLAN

20 YEAR HABITAT PLAN

6.22.19

Parks & Recreation

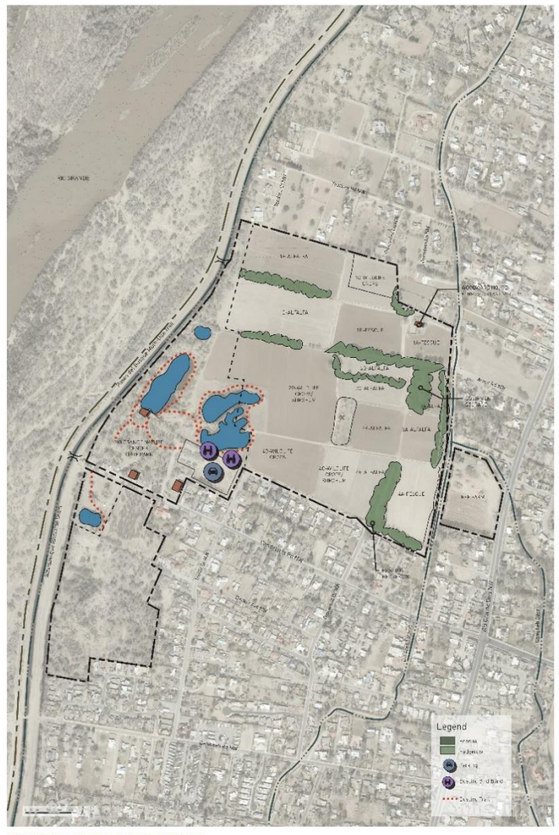
SWCA ENVIRONMENTAL CONSULTANTS

DEKKER PERICH SABATINI

Figure E.1. Conceptual Plan Maps for Habitat.

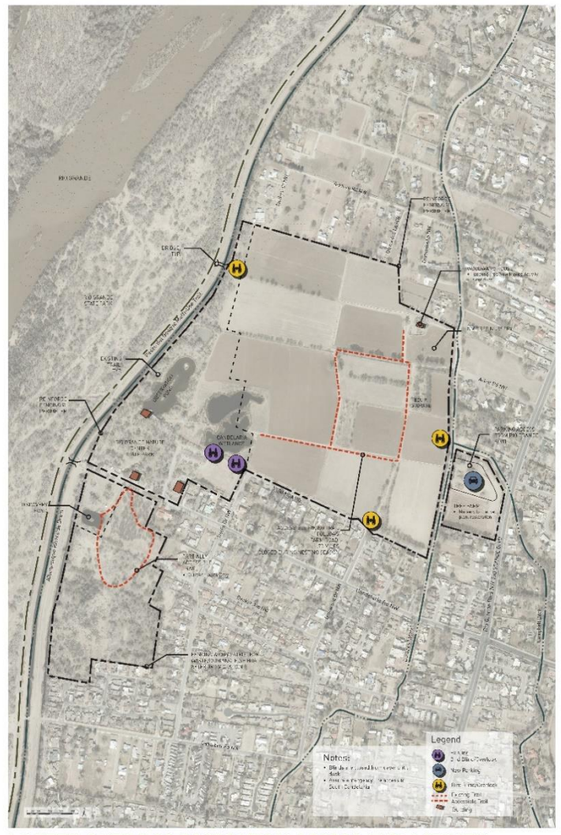
CANDELARIA NATURE PRESERVE

Public Access and Outdoor Recreation



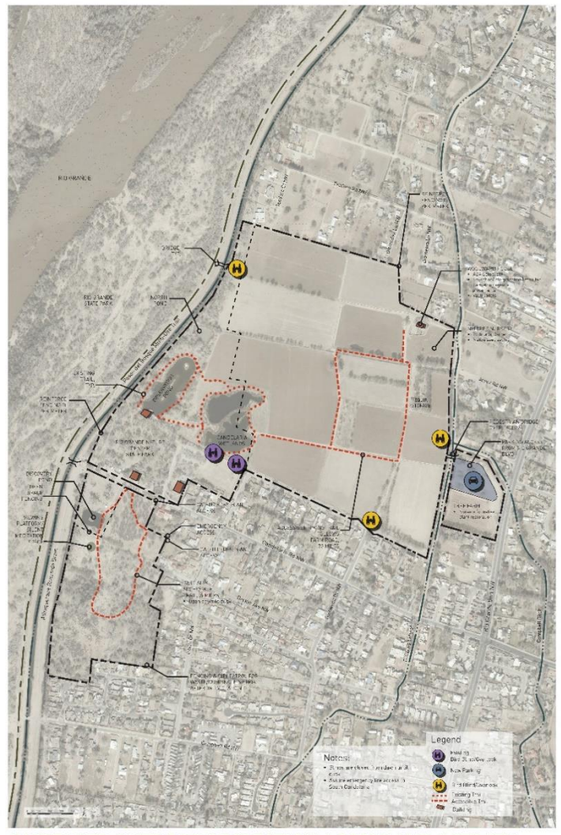
EXISTING CONDITIONS

- No open access
- Tours
- Youth Crews
- Bird blind at Rio Grande Nature Center



LIMITED OUTDOOR RECREATION ACCESS AND ACTIVITY

- Prohibited items include dogs (except service dogs), hunting, running/jogging, kite flying, drones, biking, motorized vehicles (except maintenance), rentals and use for private events and film making
- Limited trails
- Guided tours
- Bird blinds
- Interpretive signage at Woodward House



INCREASED OUTDOOR RECREATION ACCESS AND ACTIVITY

- Same features as limited access plan with the following additions:
- Candelaria South open to public and includes longer trail
- Viewing platform and silent meditation area
- Additional wildlife compatible activities by Woodward House and adjacent field

6.22.19

SWCA ENVIRONMENTAL CONSULTANTS

DEKKER PERICH SABATINI

Figure E.2. Conceptual Plan Maps for Public Access and Outdoor Recreation.

F. ADAPTIVE MANAGEMENT AND MONITORING

Adaptive management is a structured decision-making approach to natural resources management that is becoming standard across natural resource management agencies and programs. The development and implementation of resource management plans and actions requires a decision-making process to determine the best management practices based on knowledge about the effectiveness of current management practices relative to management goals and objectives. Management plans should state explicit objectives, along with a process to determine whether those management objectives are being met. Monitoring of management activities provides information to evaluate the success of management decisions and approaches, and managers can learn from the success or failure of those planned and implemented management approaches. Ideally, this learning process will lead to new and improved management decisions and better management practices over time. This learning by doing process, with adaptive change, is part of the adaptive management process.

Other aspects of adaptive management include participation of stakeholders with interests in the resources being managed and uncertainty associated with the system being managed, along with uncertainty about the existing management practices. Adaptive management is not simply a trial and error approach to resource management decisions, but rather a designed learning process where stakeholders make resource management decisions and plans based on the best knowledge available at the time, clear objectives, and explicit assumptions about the expected outcomes of management. However, adaptive management also recognizes uncertainty about how managed ecological systems function, and through implementation and monitoring adaptive management is designed to improve knowledge of how the system works and adapt or change plans accordingly to improve management over time.

This CNP RMP adopts the definition of adaptive management first stated by the National Research Council and adopted by the U.S. Department of the Interior (Williams et al. 2001):

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a “trial and error” process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

An objective of the CNP habitat restoration and wildlife crop selections, is to provide a framework for adaptive natural resource management for the CNP through developing habitat restoration success criteria, monitoring, evaluating success, and adapting management as more is learned about the entire system. Adaptive management is not possible without effective monitoring, which is the focus of this plan. An adaptive management working group is essential for implementing adaptive management for the CNP. At this time, OSD and the TAG are the key stakeholders and the equivalent to a CNP adaptive management working group.

A CNP adaptive management process should be initiated to use information from, and to guide the evolution of habitat restoration effectiveness monitoring. The adaptive management approaches to habitat restoration effectiveness monitoring for the CNP are presented below, including the proposed evaluation criteria that will be used to determine habitat restoration effectiveness relative to each of the environmental attributes (physical habitats, biota) for which the restoration was intended.

1. Monitoring and Habitat Restoration Evaluation Criteria

The RGNCSP developed a monitoring program within CNP and RGNCSP shared property to document changes over time in the diversity and abundance or birds, mammals, reptiles, amphibians and aquatic invertebrates. Water quality and soils are also part of this monitoring program. The monitoring program works in collaboration with the Friends of the RGNCSP, RGNCSP staff, and OSD. These monitoring activities will be incorporated into the CNP monitoring program and will work collaboratively with the monitoring program at RGNCSP.

In order to practice adaptive management, an effective habitat restoration program or project must have specific goals and objectives relative to the outcomes of restoration, and those goals and objectives must be developed in advance of the implementation of restoration treatments. Restoration goals and objectives that are developed during the pre-treatment planning process should then serve to guide the development and implementation of restoration treatments to achieve the original restoration goals. Conditions or attributes of specific parameters that provide target goals and objectives for habitat restoration should be quantifiable by metrics, which also should be defined during the pre-treatment planning process. Likewise, in order to assess the effectiveness of habitat restoration once treatments have been implemented, monitoring of those specific habitat parameters used to define restoration goals also must be conducted in order to evaluate whether the restoration treatments have achieved the desired outcomes relative to those original restoration goals (Block et al. 2001; Downes et al. 2002; Elzinga et al. 2001; Roni et al. 2005). The specific evaluation criteria for all habitat restoration treatments and recommended wildlife crops proposed for the CNP are presented in this plan, along with sound monitoring approaches by which to collect and evaluate data representing those criteria.

The evaluation of habitat restoration effectiveness is generally conducted by determining whether the goals and objectives of particular projects and treatments have been achieved. Evaluation criteria are defined as those desired environmental or species demographic attributes or conditions that are represented by measurable parameters or variables that define what restoration is attempting to achieve. Parameters representing evaluation criteria are monitored before and following restoration treatments, and restoration is considered successful if those environmental and/or population parameters change in ways that trend toward the desired goals and objectives of the restoration program, project, or treatments. Additionally, if specific quantified goal values for parameters are known in advance, those quantified values of parameters may be considered as the target conditions or goal values for which restoration is meant to achieve. Once target goal values have been achieved, restoration may be considered successful. However, both ecological systems and management goals change over time, so once target conditions have been achieved, monitoring should continue to determine how those conditions change over time for as long as the resources of interest are being managed.

In order to determine cause and effect of habitat restoration treatments, an experimental scientific or research monitoring and evaluation approach should be used, including baseline data, replicate sites, treatments and controls, and reference conditions (Elzinga et al. 2001; Roni et al. 2005). Non-experimental (also called non-research) monitoring and evaluation approaches may be used to document post-restoration changes in environmental and population parameters over time, but cannot be used to evaluate the cause and effect of restoration treatments on conditions of those parameters (Elzinga et al. 2001; Roni et al. 2005). Non-experimental observation monitoring may provide a useful tool for evaluating habitat restoration treatment effectiveness, but such observational monitoring approaches must be carefully designed to standardize how the conditions of parameters are recorded and minimize subjectivity and biases among different observers. Rigorous experimental research approaches provide robust and objective data for the generation and evaluation of new information to guide the adaptive management process in order to make positive changes in management approaches. Ultimately, the effectiveness monitoring and evaluation process will allow management to evolve and improve over time. New information learned from initial restoration efforts and subsequent monitoring and evaluation will lead to a better understanding of the CNP ecosystem and biotic species, inform managers, and improve upon management strategies for that system.

Figure 7.1 provides a proposed general conceptual model for the overall approach and context for a habitat restoration evaluation and monitoring process for CNP habitat restoration projects as overseen by the OSD and the TAG. The important aspect of this model is that OSD resource management goals determine habitat restoration projects and the selection of wildlife crops. Monitoring and evaluation of restoration project success then determine if those management goals have been met. If the evaluation process determines that management goals have been met, then that information provides positive feedback for the continuation of current management strategies with slight modifications based on new information. If the evaluation process determines that management goals have not been met, then adaptive management strategies are employed to change and improve management practices, and those new practices are implemented and evaluated through the same process as above. A salient feature of this model is that management structure and process may remain relatively stable over time, but management goals and methods are allowed to evolve and improve as more is learned about the system. Additionally, management structure and subsequent goals and objectives are subject to change from influences both outside and within the CNP, and this conceptual model is meant to allow flexibility for those changes as well.

Each habitat restoration project and/or treatment has a particular set of goals and objectives aimed at modifying the environment to provide improved conditions for each species and ultimately improved population structure parameters and viability. The particular desired states or parameters of environmental conditions may then be used both as objectives for specific restoration treatments and as specific criteria to evaluate habitat restoration effectiveness monitoring following restoration treatments.

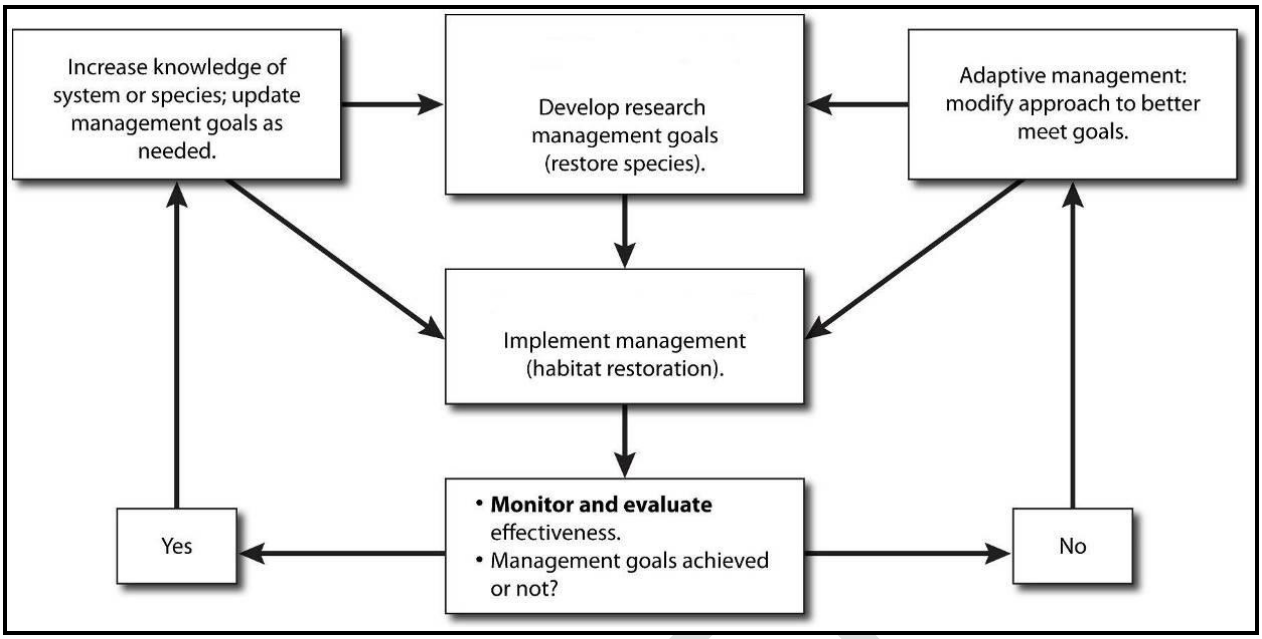


Figure 7.1. Conceptual model for habitat restoration management goal development, habitat restoration projects, and treatment evaluation.

Specific restoration treatments may enhance environmental conditions for some particular life stage or biological process that will enhance the species, while other treatments may enhance other environmental conditions for the same or different life stages or processes of the species. Together, several different restoration treatments may be used in a particular restoration project to enhance the overall ecological status for a species and meet the goals of that restoration project. In order to determine whether the goals of a restoration project and the specific objectives of restoration treatments have been met, monitoring or standardized repeated observations and measurements of parameters must be taken over time and compared to the predetermined evaluation criteria in order to evaluate restoration success. Such effectiveness monitoring spans a range of sampling designs and intensities from simple post-restoration treatment monitoring aimed at simply observing and recording environmental conditions over time relative to desired restoration goals or evaluation criteria to more complex and more useful experimental or research monitoring designs that can actually test the effectiveness of restoration treatments with pre-treatment baseline data and experimental control sites (see Habitat Restoration Monitoring below). However, non-experimental monitoring and evaluation approaches cannot be used to evaluate the cause and effect of restoration treatments on conditions of those parameters.

Habitat restoration goals and evaluation criteria for a given location or region are best determined by:

1. Understanding and evaluating the local environmental needs of a species by conducting background research on the ecology and population dynamics of the species and determining which parameters (variables) are important habitat components for the species;

2. Identifying reference sites or locations that provide habitats where those particular favorable environmental conditions and parameters support viable or ecologically successful subpopulations of the species; and
3. Using the information representing those environmental conditions and parameters from literature or data directly measured from reference sites to provide knowledge about the attributes of environmental and species population structure parameters. This information then provides target parameter conditions for both restoration goals and habitat restoration evaluation criteria.

Since local environments tend to differ from the environments of distant locations (climate, geology, soils, water chemistry, physical morphology, biota, disturbances, etc.), environmental comparisons to locations within the region of planned habitat restoration should be preferred to reference site data from outside the region or area. Similarly, comparisons to historical environmental conditions may also be problematic given that the exact historical conditions may not be known and/or the local environment has been altered so much that restoration to pre-existing environmental conditions may not be practical or possible. If current favorable local environments for the species do occur within the region, then those locations serve as the best reference sites for each species and its habitats within that particular region at that current time. The environmental characteristics of those reference locations should provide the best available measures for conditions of environmental parameters to serve as restoration goals and evaluation criteria for habitat restoration of other less suitable environments that are being restored elsewhere in the region.

For example, the endangered Southwestern willow flycatcher is not known to nest in the Albuquerque Subreach of the MRG, so a goal of CNP habitat restoration might be to create suitable nesting habitat for the endangered Southwestern willow flycatcher within the CNP. Researchers have observed and measured some of the environmental habitat attributes or parameters of successful nesting sites within the San Marcial Reach of the MRG (Moore 2007) and along the Lower Colorado River (McLeod et al. 2008). The known qualitative conditions and/or quantitative values or ranges of those habitat parameters then provide both objectives for specific habitat restoration treatments, evaluation criteria, and target goal values for post-restoration monitoring within the CNP. Priority should be given for parameter conditions obtained from successful nesting sites within the regional San Marcial Reach over those from the distant Lower Colorado River; however, a greater number of successful nesting site habitat parameters have been measured along the Lower Colorado River. Therefore, one would prioritize habitat parameter data from the local San Marcial Reach, such as tree species composition and tree foliage height, and supplement other parameters that were not measured from the local San Marcial Reach with data from other parameters that were measured from the more distant Lower Colorado River sites.

Evaluation criteria would include both qualitative conditions for parameters, such as saturated soil under successful nests observed in the San Marcial Reach, and quantitative soil moisture target goal values, such as mean soil moisture (mV) values of 751.9 +/- 15.5 or qualitative Hink and Ohmart (1984) vegetation structural types (type 3 was observed at the San Marcial Reach), along with target goal values for mean tree canopy height of 6.1 m (20 feet) +/- 0.1 m and percent basal area of native trees of 41.4% +/- 2.2%, among others also measured from the San Marcial Reach. All of these qualitative and quantitative environmental parameter values may

then be used as objectives for specific restoration treatments and as evaluation criteria for effectiveness monitoring of flycatcher habitat restoration treatments within the CNP. Changes in those conditions or values may then serve as the evaluation criteria to assess restoration success.

Quantitative data for the specific range of values for some habitat parameters may not be available, but instead qualitative information and known qualitative or categorical values of key habitat parameters from reference sites may also be used as evaluation criteria; however, target goal values are lacking. For example, a key habitat feature of successful flycatcher nesting sites is saturated soil or standing water below nesting trees. If precise quantitative data for soil moisture are not available, then restoration treatment objectives and effectiveness monitoring criteria could simply state that the soil needs to be saturated with water or that standing water is present during the nesting season, rather than some quantified range of measured target goal values for soil moisture from a reference site as presented above. Trends in soil moisture over appropriate time intervals such as years, may also be used as success criteria. Such qualitative or categorical parameters may be used for habitat restoration objectives and evaluation criteria when actual quantitative measurements for such key habitat parameters are not available, or when the acquisition of quantitative measurements are too costly. However, lack of target goal values may lead to problems of objectively determining when desired conditions have actually been achieved.

Simple qualitative trend evaluation criteria in the above example would simply be used to determine whether particular restoration treatment or project post-restoration increases in the density, cover, and heights of native willow trees as improving habitat for the flycatcher. The restoration treatments may be considered successful depending on whether native willows significantly increased following restoration treatments, but the degree of success would not necessarily be quantifiable. Target goal values do consist of actual known target qualitative and/or quantitative categories or values for particular habitat parameters from reference sites or hypothetical reference conditions. Restoration success would be achieved when the post-restoration categories or values of parameters fall within the range of known target goal values obtained from reference sites. Evaluation criteria could then be used to determine if the restoration had successfully altered the habitat toward conditions favorable to the species, but may not be able to determine if the restoration had modified the habitat to be within the range of environmental conditions required by the species. Target goal values would provide an assessment of whether restoration had in fact created environmental conditions suitable for the species based on known reference conditions. Restoration goals and objectives vary and include those that target the silvery minnow, those that target the flycatcher, and those that target both species and/or others. Again, the objectives of individual restoration treatments and goals for restoration projects define the parameters and criteria that will be used to evaluate restoration success.

Table 7.1. Proposed Criteria for Qualitative Trends in Soil, Vegetation and Wildlife Condition Data Obtained from Monitoring the Effectiveness of New Wildlife Crops and Newly Restored Wildlife Habitats of the Candelaria Nature Preserve over the next 15 years.

Treatment Type		Soils (nitrogen, phosphorus, carbon content)				Vegetation (native or crop canopy cover and number of native species [opposite for exotic species])				Wildlife (numbers of individuals and species, number of individuals of key species)			
		Before[1]	5 Years	10 Years	15 Years	Before[1]	5 Years	10 Years	15 Years	Before[1]	5 Years	10 Years	15 Years
Wildlife Crops	Corn	BL1	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Sunflowers	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Triticale	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
Restored Wildlife Habitat	Wetland	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Ephemeral Wetland	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Damp Grassland	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Dry Grassland	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Sand Bar	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Salt Shrubland	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10

Treatment Type		Soils (nitrogen, phosphorus, carbon content)				Vegetation (native or crop canopy cover and number of native species [opposite for exotic species])				Wildlife (numbers of individuals and species, number of individuals of key species)			
		Before[1]	5 Years	10 Years	15 Years	Before[1]	5 Years	10 Years	15 Years	Before[1]	5 Years	10 Years	15 Years
	Arroyo Shrubland	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Hedgerows	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10
	Bosque	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10	BL	> BL	> or = Year 5	> or = Year 10

1: BL = Baseline conditions prior to treatments.

Evaluation criteria are best assessed by the use of statistical experimental design approaches to habitat restoration monitoring. Statistical tests of metric values for parameters are used to determine whether there are significant changes in parameter attributes following restoration treatments. Assessment of target goals should be accomplished by simply noting when the post-restoration values of parameters (e.g., means and associated variances) fall within the known ranges of those parameters from reference sites. Identifying habitat restoration evaluation criteria is a complex process that must address multiple species, parameters, spatial and temporal scales, and management components. In that respect, a simple one-dimensional list of evaluation criteria is not sufficient; instead multi-dimensional matrices or tables of evaluation criteria must be developed to meet the complexities of MRG habitat restoration goals.

2. Wildlife Habitat Restoration Effectiveness Monitoring for the Candelaria Nature Preserve

Monitoring is simply the repeated observation or measurement of some particular entity or set of entities within given spatial and temporal domains over some period of time, in order to evaluate change in those entities over time. The purpose of monitoring may vary from simply observing and noting change over time to critically evaluating change over time relative to desired or anticipated target goals or objectives. The purpose for monitoring habitat restoration effectiveness relative to this plan is to scientifically determine whether restoration treatments have effectively achieved the initial restoration goals, based on the evaluation criteria. In this sense, monitoring is needed to evaluate the effectiveness of management goals and objectives. Elzinga et al. (2001) define such monitoring as "the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective." This definition is appropriate for the habitat restoration monitoring proposed here.

Terminology for habitat restoration effectiveness monitoring has been variable and somewhat confusing. Ecological monitoring relative to stream water quality was partitioned into several different categories by McDonald et al. (1991) to address different needs for assessing changes in water quality over time relative to forestry management impacts, then modified by Roni et al. (2005) relative to watershed and stream habitat restoration. These categories include 1) baseline monitoring to characterize existing, pre-impact conditions; 2) status monitoring to characterize population structure or other biological attributes of species over a broad geographic area; 3) trend monitoring to determine change in environmental conditions or biota over time; 4) implementation or compliance monitoring to determine if a project has been implemented as planned; 5) effectiveness monitoring to determine if actions or impacts have had desired effects on the system as planned (often restricted to abiotic parameters); and 6) validation monitoring to evaluate whether the planned impact or treatment has had the desired cause and effect on the system as planned (often focusing on biota and their broader habitat parameters). Baseline, implementation, effectiveness, and validation monitoring apply to habitat restoration effectiveness monitoring and have been adopted for stream and watershed restoration activities (Roni et al. 2005).

The interpretation and word usage of effectiveness and validation monitoring have been variable and confusing, as the two terms have been used both exclusively and interchangeably (Roni et al. 2005). The term effectiveness monitoring has historically referred to either 1) an evaluation of

specific restoration treatment goals and objectives only relative to those specific abiotic conditions that restoration was directly intended to change and/or 2) this same previous definition, but also including an evaluation of the effectiveness of treatments on general habitat conditions indirectly affected by restoration conditions and effects of restoration on the native species responses to those changes, also sometimes called system monitoring. The term validation monitoring has historically been used only in reference to number 2 above (Roni et al. 2005) and also relative to assessing the cause and effect relationships between restoration treatments and habitat and species responses, often at a broader spatial and temporal scale than effectiveness monitoring.

For the purposes of this monitoring plan, we propose to simplify habitat restoration monitoring terminology to 1) "implementation assessment," which represents the outcome of implementation monitoring as defined by Roni et al. (2005), and often call "construction monitoring" relative to physical constructed restoration features, and 2) "effectiveness monitoring," which is equivalent to the second defined usage of the term effectiveness monitoring as stated above and includes validation monitoring as defined by Roni et al. (2005). Evaluations of implementation success are often one-time assessments and usually do not involve multiple repeated measurements or assessments over time as effectiveness monitoring does. Implementation assessments for constructed features include "As Built" reports from contractors that provide information on the final configurations for constructed geomorphic features. Implementation or construction monitoring may be conducted to evaluate progress for restoration treatments, and the outcome of such monitoring will be the "As Built" report or the implementation assessment.

Effectiveness monitoring may address multiple spatial, temporal, and management scales; involve repeated measurements over time; and may include both abiotic and biotic parameters, native species, and cause and effect research, so as to preclude the need for a separate term, validation monitoring. Implementation assessments and effectiveness monitoring following the above terminology is incorporated into the proposed conceptual models for CNP habitat restoration evaluation as presented in Figure 7.1**Error! Reference source not found.** above. Effectiveness monitoring is the principal method by which metric data are collected on both environmental and species population parameters in order to evaluate habitat restoration effectiveness. As discussed above, the evaluation of habitat restoration effectiveness spans a range of management levels from the individual treatments within projects, up to overall program management. Monitoring information from the lower management levels provides cumulative information on habitat restoration for the entire program and a basis for adaptive management.

As stated above, **implementation assessment** is a one-time, or short-term, evaluation of whether habitat restoration treatments have been implemented as planned. Implementation assessment is generally observational rather than experimental in design and generally has the objective to provide quality assurance that the restoration construction was completed according to plans. Implementation assessment generally involves a simple observational and qualitative assessment of the immediate post-restoration treatment conditions relative to the planned treatment. Ideally, implementation assessments will be initiated with the collection of pre-treatment baseline information (e.g., photographs, descriptions, etc.) on environmental parameters that will be altered by the treatment, and an initial post-treatment assessment of physical environmental

conditions should then be made within a short period of time (e.g., days) following the treatment to determine whether the treatment was completed as planned. Implementation assessment is an evaluation of the restoration treatment itself, not the habitats or biota for which the treatment was designed to enhance.

Habitat restoration effectiveness monitoring, as defined here, provides data not only for evaluations of the effectiveness of the habitat restoration on both the physical environment or habitat, but also for the species or biota for which the restoration was designed, including both monitoring of the species habitat parameters and monitoring of the species population structure parameters. Effectiveness monitoring may be either qualitative and observational or quantitative and experimental. As stated above, the quantitative experimental approach is the only way to determine cause and effect of restoration treatments on habitat and species parameters and should be used over observational monitoring whenever possible. The actual parameters selected for monitoring, and the metrics used to measure those parameters, should be those identified as habitat restoration evaluation criteria. Monitoring is best designed as a quantitative experimental monitoring approach, including the use of baseline data, comparative treatment and control conditions, spatial replication of both treatments and controls, and reference conditions to provide parameter evaluation criteria for testing hypotheses of treatment effectiveness.

The effectiveness monitoring process is a process where metric data for chosen parameters is collected and evaluated relative to restoration treatment/program success or effectiveness. Habitat restoration effectiveness monitoring should proceed through a series of steps, and a proposed sequence of those steps is presented below. Note that the ideal process for monitoring and evaluation begins with the actual restoration planning, prior to implementation of any restoration treatments. If monitoring and evaluation for projects and treatments are initiated after the treatments have been initiated, the value of monitoring will be considerably reduced. The evaluation will likely be simply observational (see below) and not as informative as experimental monitoring with baseline and control site data. A stepwise approach to habitat restoration monitoring should include the following steps over time:

1. **Clearly state all goals and objectives** for monitoring particular response parameters (variables) for each particular habitat restoration project. The first and most important step to monitoring and evaluating habitat restoration projects and treatments is the development of goals and objectives for evaluation. As discussed above, the goals and objectives of evaluation are directly related to the goals and objectives of the restoration projects and treatments. Therefore, habitat restoration evaluation and monitoring should be planned at the same time as restoration projects and treatments are planned so that the goals and objectives of monitoring and evaluation are consistent with the goals and objectives of the restoration projects and treatments. Goals and objectives must be realistic and measurable.
2. **Determine parameters, metrics, and monitoring sampling designs (spatial and temporal**) that will be used to address the objectives for monitoring those response parameters (including need for control and/or reference sites). Consider appropriate parameters and combinations of parameters to monitor and the appropriate spatial and temporal resolution of monitoring.

If monitoring is to be used as a tool to evaluate changes in condition toward meeting a management objective, and the changes in condition are due to an imposed treatment or impact, then the monitoring design should be conducted in a scientific way using experimental design in order to statistically determine cause and effect relative to imposed treatments (Michener 1997). In this sense, monitoring becomes a designed field experiment, where testable hypotheses are formulated and tested to assess the cause and effect of treatments (Michener 1997; Quinn and Keough 2007). Such experimental monitoring has been called "research monitoring" (Elzinga et al. 2001; but note that validation monitoring also has been called research monitoring [Roni et al. 2005]). Research is simply inquiry in order to learn about something, so all types of monitoring are performing research, and we feel that the term "research monitoring" is inappropriate to define only some types of monitoring.

To avoid confusion, the term "experimental effectiveness monitoring," or simply experimental monitoring, will be used in this plan, rather than research monitoring, to refer to monitoring designs that are appropriate to provide unbiased statistical tests of treatment effects by use of baseline data, comparative treatment and control conditions, spatial and temporal replication of both treatments and controls, and use of reference conditions (if available) to provide target parameter evaluation criteria for testing the hypotheses of treatment effectiveness. Experimental monitoring design in this sense is similar to standard ecological experimental design used to test any kind of imposed treatment or environmental impact on a particular system defined by measurable parameters (Downes et al. 2002; Quinn and Keough 2007). Experimental monitoring generally is more costly that non-experimental monitoring, and project budgets may not always support intensive experimental sampling designs. We recommend that at least some habitat restoration effectiveness monitoring designs include experimental elements, but less expensive non-experimental monitoring approaches also may be used.

Non-experimental monitoring designs have been called "observational monitoring" (Elzinga et al. 2001), where observations and/or parameter measurements are taken, but the monitoring design may lack baseline data, control conditions, and/or spatial replication of treatments and controls. Observational monitoring can detect change over time after a treatment has been imposed, but usually without baseline and/or control conditions for comparison or replication to account for the effects of environmental factors other than the specific treatment. Observational monitoring cannot provide data for statistical tests of treatment effects, or in other words, the effects of restoration treatment effects on habitat or species population parameters. We will adopt the term "observational effectiveness monitoring," or observational monitoring, as a simple but less effective form of effectiveness monitoring than experimental effectiveness monitoring approaches. Low intensity observational monitoring may be valuable if there is sufficient replication over space and time, and if there are some experimental monitoring studies to relate the observational findings to. Because of budgetary and logistical constraints, most CNP habitat restoration effectiveness monitoring will likely be observational, along with some experimental monitoring designed to actually test for treatment effects.

Monitoring designs range from simple post-restoration treatment observational monitoring to pre- and post-restoration treatment experimental monitoring with baseline data and replicated treatment/control sites (Elzinga et al. 2001; Roni et al. 2005). The most common monitoring designs used for aquatic/riparian habitat restoration evaluation projects tend to be simple post-treatment (PT) and before/after (BA) designs, and particularly those with controls, called BA

control-impact, or BACI, monitoring designs (Downes et al. 2002; Roni et al. 2005). As discussed above, simple PT designs lack baseline data and are not suited to determine cause and effect of restoration treatments.

Since some of the CNP habitat restoration treatments have already been constructed prior to any effectiveness monitoring plans, some PT designs will need to be implemented in the CNP. PT designs are generally either intensive (IPT) sampling designs, where considerable effectiveness monitoring sampling efforts are concentrated in one or few locations, or extensive (EPT) sampling designs, where minimal sampling efforts are dispersed over a wide array of treatment locations or projects. The strength of IPT designs is in providing considerable information for one treatment or project, but at the expense of spatial replication, whereas the strength of EPT designs is in providing better spatial replication, but often at the expense of more intensive sampling and data. In general, EPT designs with considerable spatial replication and controls should be used over IPT designs with little spatial replications and/or controls (Hicks et al. 1991; Roni et al. 2005). EPT designs can provide useful evaluation data; however, useful EPT designs should employ considerable spatial replication (e.g., more than 10 sites) and paired controls in order to be useful.

The most robust monitoring designs are extensive BA designs that employ considerable spatial replication (generally 10 or more sites), as opposed to intensive designs with little or no spatial replication (Hicks et al. 1991; Roni et al. 2005). Extensive BA designs may provide even better results than intensive BACI designs with little spatial replication. BACI designs originally lacked spatial and temporal replication (Green 1979); however, such replication may be included, increasing the power of the design. Extensive BACI designs (MBACI designs of Downes et al. [2002]) provide the most powerful and useful of all monitoring designs, but also tend to be the most costly because of the need for considerable spatial and temporal replication along with control sites. Intensive BACI designs still provide better results than simple intensive BA designs for situations where spatial replication is limited. BACI-Paired Series (BACIPS) designs (Osenberg et al. 2006) provide another monitoring design approach not using standard statistical testing for treatment effects, but rather assessing correlations of time series data between treatments and controls with little or no spatial replication, in order to assess the magnitude of potential differences in parameter values. As with other time series approaches, considerable temporal sample replication is needed. Repeated measures BACI designs will provide data that can be used for standard hypothesis testing, and for BACIPS analysis if adequate time series data are available.

Downes et al. (2002) and Roni et al. (2005) discuss potential statistical problems with BACI designs, particularly relative to using appropriate control conditions and avoiding temporal autocorrelation of data. For the purpose of this plan, we recommend using extensive BA designs and/or extensive and intensive BACI designs with paired treatment and control experimental monitoring designs, with repeated measurements over time. We propose limiting the use of simple and less informative observational PT monitoring designs, but favoring EPT over IPT approaches for those projects where treatments have already been imposed, but no effectiveness monitoring commenced. An important consideration for a large program, such as the Collaborative Program, is that different monitoring designs may be used for different projects and treatments as appropriate and still provide comparable data and findings across projects, as long as the methods used to measure parameters are similar.

The financial cost of habitat restoration effectiveness monitoring is not only a function of sampling design, but also a function of the number of parameters and metrics used. Given that many habitat restoration projects will not have adequate budgets for the best case or ideal effectiveness monitoring designs (i.e., extensive BACI) and arrays of parameters, we recommend that all habitat restoration projects include at least a minimum or core set of parameters, metrics, and methods for effectiveness monitoring. Core parameters and metrics should be measured by simple but meaningful monitoring methods to provide evaluations of restoration goals and objectives. Core parameter metrics may be qualitative or quantitative, and will be largely observational but may also be used with experimental BACI designs. If all habitat restoration projects within the CNP adopt the concept of extensive monitoring of core parameters and metrics to evaluate restoration success, an array of extensive PT, BA, and BACI designs could then provide considerable spatial replication for effectiveness monitoring throughout the reach. Those core monitoring approaches constitute the extensive, or low intensity, monitoring approaches for this CNP monitoring plan, and those parameters and methods will be employed at all treatment sites to provide extensive replication of habitat restoration effectiveness monitoring data across the entire CNP.

In addition to the employment of extensive low intensity monitoring methods, some subset of projects with adequate funding and spatial size should also employ more robust intensive experimental monitoring designs and methods in order to adequately evaluate cause and effect of habitat restoration treatments on key parameters. Those projects employing more elaborate intensive experimental monitoring designs could then serve to provide valuable cross-reference data between extensively measured core parameters and metrics, and intensively measure parameters and metrics, to help validate the wider use of extensive sampling designs and metrics. An example of potentially useful core parameters and metrics is the extensive monitoring of terrestrial vegetation using modified a Hink and Ohmart (Callahan and White 2004) vegetation structure classification, with metrics that include dominant species, maps of vegetation type polygons at restoration sites, and monitoring of change in those polygons over time, as an alternative to more detailed quantitative vegetation measurement transects or plots. Other restoration projects should then provide comparable intensive sampling designs that would employ both simple vegetation mapping, in addition to more intensive quantitative vegetation measurements, and the detailed vegetation data could be used to validate the more general mapping. Cross-project planning would be necessary in order to provide a balance of simple extensive effectiveness monitoring for a subset of projects, along with more complex intensive effectiveness monitoring for other projects, along with comparable sets of parameters, goals, and objectives.

Other ways to reduce costs and increase cost-effectiveness include pulse monitoring (Roni et al. 2005), where some parameters that are intensively measured, and thus expensive to sample, are measured at less frequent intervals over time as appropriate, reducing seasonal or annual costs associated with more frequent sampling. Pulse sampling may be appropriate for parameters that change slowly over time, such as tree establishment and growth, but may not be appropriate for parameters that require seasonal or annual samples such as animal species population parameters, in order to evaluate habitat restoration effectiveness. Pulse monitoring may also be appropriate at the CNP in situations where monitoring measurements are collected only during certain years when spring runoff is particularly high or low.

Deciding whether to implement experimental, high intensity monitoring or observational, low intensity monitoring is an important part of planning the monitoring approaches and methods for a given restoration project. In order to determine the effectiveness of any given restoration treatment or technique within an area of interest, at least one experimental monitoring design must be implemented for each restoration technique. More than one is better, but experimental monitoring is expensive, so generally few projects will implement experimental monitoring designs. Low intensity, observational monitoring is inexpensive and will generally be chosen for most projects and treatments. The combined data from many low intensity monitoring efforts will provide more replication, and those weaker sampling designs will still provide useful, but not conclusive, effectiveness monitoring data.

The use of reference sites and their reference conditions for parameters of interest is a very important component of monitoring design (Elzinga et al. 2001; Downes et al. 2002; Roni et al. 2005). Reference locations or conditions represent the desired habitat characteristics and/or species population structure characteristics, or parameter conditions and values, that habitat restoration is attempting to achieve. Reference conditions are generally obtained from reference sites, ideally geographically near restoration sites. Data from parameters may be obtained from those reference sites to provide habitat restoration goals and objectives, as well as evaluation criteria. Ideally, actual reference sites should also be sampled as part of the same monitoring design, employing the same spatial and temporal scales as the treatment and control sites that they are being compared to. If physical reference sites or conditions are lacking, hypothetical models for desired evaluation goals and objectives may be used instead (Downes et al. 2002; Roni et al. 2005). In some systems such as the CNP, where few or possibly no reference conditions for habitat restoration exist today, retrospective reference conditions (Roni et al. 2005) may be obtained from historical information to provide at least an indication of desired reference conditions.

The temporal component of monitoring design and planning is as important as spatial considerations. The duration of monitoring depends on the initial research questions based on management objectives and goals and the nature of the system and parameters being monitored. If the principal objective is to determine the immediate effects of restoration on some parameters, with no regard for longer-term changes over time, then short-term monitoring of 1 to 5 years may be appropriate. If long-term change is important to document, then long-term monitoring for durations of five to 10 years or longer are needed. The longer any system is monitored, the better that system may be understood relative to temporal change. The MRG is in a region greatly affected by both short- and long-term climate variation, particularly relative to annual precipitation and spring snow melt runoff; therefore, long-term monitoring would be most useful relative to MRG habitat restoration evaluation to encompass both wet and dry years and longer-term patterns related to El Niño and La Niña climate cycles.

The timing of sampling for monitoring within each year is a function of the parameters being measured and which season or time of day is most appropriate to measure those parameters relative to the goals and objectives of restoration. For example, parameters of the silvery minnow related to reproduction and spawning must be measured during spring runoff when reproduction occurs. Daily sampling of flycatchers is best conducted at dawn when individual birds are actively displaying or foraging. Perennial vegetation is best measured at the end of the growing

season when live biomass peaks. Temporal replication of sampling also may be important to monitor habitat or population parameters across seasons or other temporal events.

Ideally, all habitat restoration monitoring and evaluation should be planned and implemented prior to initiating restoration treatments. Defining habitat restoration evaluation objectives and goals should be done at the same time that the objectives and goals for the restoration project and treatments are planned, in advance of implementing treatments. Such an approach is important to 1) provide baseline, pre-treatment, implementation, and initial post-treatment response data and 2) ensure that evaluation objectives and goals are consistent with project and treatment objectives and goals. Once habitat restoration evaluation goals and objectives have been defined and a monitoring design has been chosen, the next step is to establish sampling units for collecting monitoring data. Sampling units will be a function of monitoring design and will consist of entire restoration sites for GIS-level sampling or study plots, quadrats, or transects established within restoration sites. Replication of sampling units is important to account for natural variation in parameters, and to provide statistical power, the more sampling units the better. The evaluation criteria presented above include entire sites as sampling units for geomorphology, Hink and Ohmart (1984) vegetation type mapping (along with smaller transects and study plots for vegetation measurements), and river environment patches for silvery minnow sampling. Data collection methods need to be specific to parameters being measured and are usually adopted or adapted from existing literature reporting of standard techniques. For example, quadrat or line-intercept measurements for vegetation, observation or trapping for wildlife, are methods for collecting data.

1. **Establish monitoring sites and sampling locations** (study plots, transects, etc.). Once an effectiveness monitoring design is determined, monitoring sites will be based on the locations of restoration projects and treatments, and sampling locations will be a function of the monitoring design and where parameters are to be measured and monitored. Ideally, sampling units (e.g., plots, transects) should be randomly or systematically located to be spatially independent, avoid researcher bias, and replicated to achieve statistical power. Again, replication of independent sample units is very important. Replication of subsample units (e.g., quads within plots) is less critical, but still useful to adequately measure parameters within sample units. Data analysis approaches should be determined at the same time that sampling designs are developed, in order to ensure that sampling designs will provide data appropriate for the desired analysis. This step is very important and often overlooked.
2. **Collect pre-treatment or baseline data** (ideally collected over a period of several years prior to a treatment, but at least one year prior) using the chosen sampling design. This baseline data provides pre-treatment reference conditions to which post-treatment change may be compared.
3. **Initiate data management**, including quality assurance/quality control (QA/QC), storage, access, updates, and reporting. A critical part of the monitoring and evaluation process is the development of rigorous data management (Michener 1997). Data management includes the planning and oversight of all aspects of data collection, analysis, archiving, and reporting. Key aspects of data management include protocols for field collection, data entry, storage, and QA/QC of data. Careful planning should ensure that data will be structured in appropriate ways for analysis and presentation. Data

management provides consistency in data structure, accuracy, and analysis across all habitat restoration projects within the CNP. Such standard approaches allow for the comparison of data across treatments and projects and provide a consistency at the program level for the evaluation of the effectiveness of habitat restoration projects and treatments.

4. **Analyze and interpret year one data** for appropriate sample sizes and adequacy of sampling design. Again, as stated above, analytical approaches should have been determined at the time that sampling designs were developed to ensure appropriate data for these analyses. Data analysis provides the critical tool for evaluating the effectiveness of habitat restoration treatments, using data representing parameters, and testing hypotheses and questions relative to the effectiveness of habitat restoration based on goals and objectives. Results of data analysis such as summaries and graphics may also be archived as part of data management.

5. **Modify sampling as needed** or continue with initial design. Repeat Steps 4, 5, and 6 with year two and year three data for short-term monitoring. Continue for five to 10 years or more for long-term monitoring. Based on analysis of pre-treatment data (or year one post-treatment data), adjust sampling as needed. For example, sample units may not be the appropriate size or configuration, sample sizes (replication) may be too small for analysis, or sample sizes may be larger than necessary. This is an important step to minimize the needs for changes in monitoring design in the future.

6. **Implement habitat restoration treatments** (construction or alteration of the environment). Once baseline sampling designs, pre-treatment data analyses, evaluation of the initial monitoring and design, and changes to the monitoring design have been completed as needed, then implementation of habitat restoration treatments should commence.

7. **Initiate restoration treatment implementation assessment** to determine if restoration construction was conducted properly. If not, modify until treatments are correct. Implementation assessments should be conducted as soon as possible following treatments to determine whether the construction or other treatment activities have been completed as planned. If not, construction or other treatments must be modified as soon as possible until the treatments have been correctly implemented. If possible, treatments should be imposed at a time of year that is most appropriate relative to the sampling schedule for restoration evaluation parameters that will be measured. For example, to accommodate post-restoration measurements of perennial vegetation, treatments should be imposed during the winter, spring, or early summer, so that vegetation may be measured during the late summer when most appropriately measured following restoration treatments.

8. **Continue response variable (parameter) monitoring** using the same pre-treatment sampling design for at least three years after treatments (short-term), preferably up to 10 years following treatments (long-term). The duration of monitoring depends on the temporal dynamics of the variables being measured and management needs.

   Habitat and population evaluation parameter measurements should then commence as soon as possible, and at the appropriate time of year, following the restoration treatments and completion of the treatment implementation assessments. Parameter monitoring

should then continue using the same pre-treatment sampling design (or altered design if needed) for at least three years after treatments, preferably up to 10 years following treatments. Data management and analysis activities also should proceed with modifications as needed to improve the process. In order for habitat restoration evaluation to proceed in a meaningful way, analysis and interpretation of each year's data are essential in order to detect changes relative to restoration treatments and to identify possible problems with monitoring and sampling designs so that adjustments and improvements can be made as quickly as possible. Regularly scheduled reporting of evaluation findings also is important in order to keep managers informed and allow for upper-level programmatic feedback to the monitoring and evaluation process.

9. **Continue data management**, QA/QC, storage, access, updates, and reporting.
10. **Analyze and interpret each year's data relative to evaluation criteria** for evaluating restoration treatment effectiveness on native species habitat and population structure parameters.
11. **Modify sampling approaches, design, and analyses as needed** over time if any aspects of the monitoring are determined to need change or improvement. This step is part of the adaptive management portion of the habitat restoration monitoring, as discussed above in Chapter 2.
12. Monitoring plans for existing restoration projects and treatments will need to be implemented at Steps 1–3, skipped for Steps 4, 8, and 9, and continued with Steps 5, 6, 7, and 10–13. Critical evaluations of the success of CNP habitat restoration projects and treatments should follow the guidelines proposed above in order to ensure that restoration projects and treatments are providing the desired habitats and population structure for wildlife, according to the goals and objectives for habitat restoration presented in this plan.

3. Habitat Restoration and Crop Planting Assessments for the Candelaria Nature Preserve

3.1. Implementation or Construction Effectiveness Monitoring of Constructed or Altered Physical Habitat Features

Implementation or construction monitoring may be conducting during habitat restoration treatment or construction phases, and assessments will be conducted after all construction (e.g., simulated oxbow depression, etc.) or other planned physical alteration of the environment (e.g., including tree removal, plantings, etc.) is completed at each project treatment area. This assessment will be an evaluation of whether the habitat restoration treatment was implemented according to planned engineering design specifications (e.g., As Built report). The implementation assessments will include both observational, qualitative assessments, and in some cases quantitative measurements of the immediate post-restoration treatment conditions relative to proposed treatment planning. Ideally, pre-treatment baseline conditions for parameters intended to be altered by each treatment will be recorded or measured prior to treatments to provide a comparative data to assess change resulting from each treatment. Implementation assessments should be conducted within several days to one week following treatments. Implementation assessment is an evaluation of the restoration treatment itself, not the subsequent habitats or biota for which the treatment was designed to enhance.

4. Wildfire Management

Fuels management aimed at reducing the threats of wildfire will be included as part of the vegetation monitoring for the CNP. The primary concerns for wildfire fuels include dry grassland vegetation and woody debris resulting from the removal of non-native trees and shrubs. Restored grassland habitats will be surrounded by ditch and road or mowed grass fire breaks. Woody debris from non-native tree removal will be chipped and used for soil surface mulching to enhance soil organic matter, and some downed woody material will be left in small piles for wildlife habitat. BEMP will coordinate with OSD to guide the implementation and monitoring of wood pile habitats and wildlife use of those habitats. Bosque wildfire management will follow OSD fire management policy, and coordination with the City of Albuquerque Fire Department.

5. Proposed Restoration Effectiveness Monitoring for Vegetation, Wildlife Crops, and Restored Wildlife Habitat Vegetation Plantings

5.1. Qualitative Repeat Photo Point Monitoring for Terrestrial Riparian Vegetation

Permanent repeat photo point locations will be established at all restoration sites to photo document temporal changes in vegetation composition and habitat structure. Repeat photo points are used to provide visual documentation of environmental conditions or features at given points over time, providing a chronological set of images from the same location with the same view, to assess change over time. Photo points could be permanently marked and located, and repeat photographs will provide the same view, including the same lens magnification, similar lighting, and time of season. Permanent photo points could be marked with 1-m-long (3-foot-long) rebar driven 0.5 m (1.6 feet) vertically into the ground. Each rebar will be tagged with an aluminum tag providing a unique identification code for that point. Universal Transverse Mercator (UTM) coordinates will be recorded with a GPS unit and labeled with the same unique code, and may be used to relocated repeat photo points without any physical markers. A repeat photo point database file will be created to provide information including purpose, view descriptions, and GPS coordinates for each point. All photographs will be taken with a minimum 8 megapixel digital camera. Photo point photographs will be taken at the same times that vegetation measurements are being taken.

Photo points will be established at all monitoring sites to provide a range of views to characterize each restoration site's relative landforms and vegetation. The number of photo points will vary depending on the size and complexity of each site. Photo points also will be established at any quantitative vegetation measurement locations, if quantitative vegetation measurements are employed. Photographs will be organized and managed as part of the CNP habitat restoration effectiveness monitoring database.

A standardized rapid assessment change scoring procedure could be used to compare the scenes of photographs taken at each photo point to score change in vegetation and soil features as positive, negative, or neutral relative to visible impacts to vegetation and soil caused by construction and/or visitors over time. All initial baseline photo point photographs should be taken in the late summer, one-year prior to any new crop plantings or habitat restoration treatments, in order to provide pre-treatment, baseline views of vegetation. Time series

comparisons of repeat photos and analysis of those photographs will provide standardized information on changes in vegetation species composition, cover and structure over time.

5.2. Quantitative Vegetation Measurements

Vegetation species composition, relative foliage canopy cover by species, counts of woody shrubs and trees of different size classes, along with soil surface cover, may be measured by use of standard line-point intercept and plot sampling methods, similar to that used for long-term vegetation monitoring by the BEMP, 5 × 30–m (16 × 98–foot) plots (Eichhorst et al. 2012) (Figure 7.2). Five to Ten sampling sites should be randomly located within each crop field or restored habitat polygon to provide data to evaluate changes in vegetation species composition, relative abundances of plant species, and vegetation structure. Vegetation and should be measured in the late summer (time of maximum above-ground plant biomass) of years when vegetation measurements are scheduled.

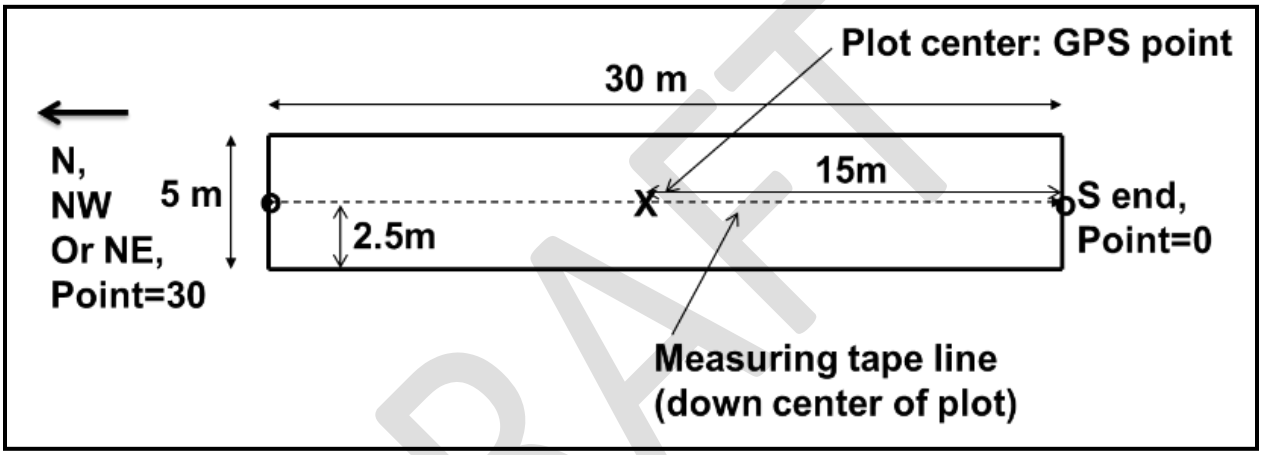


Figure 7.2. Diagram of a BEMP-style vegetation measurement plot proposed for vegetation monitoring.

Herbaceous and woody vegetation will be measured along a 30-m (98-foot) line down the center of each soil and vegetation plot using the line-point-intercept method following the protocols of Herrick et al. (2005), at 1-m (3-foot) intervals along the line, for a total of 30 point measurements per plot. Note that BEMP uses continuous line-intercept measurements for vegetation; this is one way that we modified the BEMP sampling design. Line-point-intercept was chosen instead, because it is much more efficient, is subject to less observer bias, and is as accurate as the continuous line-intercept method (Elzinga et al. 2001). Each plant species intercepted at each of the 30 points per plot was recorded, and the condition of the soil surface at each of the 30 points per plot was recorded as bare ground, biotic soil crust, organic leaf litter, dead and downed wood (>2 cm in diameter).

Trees and large shrubs with diameters at breast height (DBH) of 2 cm or greater would be counted and tallied by species over each entire plot to provide counts of trees and shrubs by species. Note that BEMP tags and measures cottonwood (*Populus deltoides*) trees only. Trees and shrubs would be further categorized by three size classes based on DBH measurements of: 1) <10 cm, 2) 10–20 cm, and 3) >20 cm.

Repeat photo points would be established at the north and south ends of each plot, providing photographic views of each plot, with a view from each end of the plot looking into and across each plot. Repeat photo points will be used in addition to the actual measurements to evaluate changes in vegetation and soils over time (see repeat photo points below).

5.3. Wildlife Community/Assemblage Monitoring

The assemblages or communities of several different taxonomic groups of animals will be monitored to determine the effects of habitat restoration and new wildlife crops on wildlife. Different sampling and measurement methods must be used for these different animal groups (e.g., birds vs. rodents), but data and analyses should be similar Multivariate (multispecies) community assessment approaches based on similarity/dissimilarity indices are the best way to analyze characterize differences in plant and animal species assemblages (count or cover data) for spatial and temporal comparisons (McCune and Grace 2002). Such analyses are useful to examine changes in overall species composition and relative abundances over time.

5.3.1. Bird Community Monitoring

The health and species composition of entire bird communities are important, and bird communities provide useful indicators of environmental health based on the diversity of species and trophic guilds (Finch et al. 2006; Hawks Aloft 2008; Walker 2006). This CNP monitoring plan therefore includes methods for monitoring bird communities in relation to habitat restoration projects and treatments within the CNP, especially relative to exotic tree removal and native vegetation planting projects.

Two commonly used approaches to bird community monitoring are transects (Emlen 1971; Thompson et al. 1998) and point counts (Bibby et al. 1992; Thompson et al. 1998). Transects are best used in situations where large linear areas or patches of landscape are monitored, and transects tend to be several hundred meters long. Point counts tend to be used in situations where sampling areas are relatively small, from several to many hectares or acres in size. Since many of the habitat restoration projects and treatments within the CNP will represent relatively small landscape patches, bird point count sampling will be conducted for most bird community monitoring.

Bird community monitoring will be conducted primarily during the early summer to document breeding bird use of restored habitats, and also during the late summer and fall to document migratory bird use of restored habitats. Different managed bird habitats will be monitored in synchrony with the vegetation monitoring. Bird point count sampling locations will usually be stratified by vegetation structural or habitat types within restoration project or treatment sites. The placement and number of bird point count locations will be determined with GIS, such that points will be stratified within vegetation habitat polygons and situated at least 100 m (328 feet) apart and 50 m (164 feet) from the polygon boundary. The number of point count locations per site will be a function of the size and shape of each site and each vegetation habitat polygon. Bird community monitoring will all be conducted at the same intensity, which will be considered extensive sampling. Data collected will include the counts of each bird species present at each sampling location and date. Those data will be used to determine the species trophic guild diversity of each site and similarity of bird communities among sites and over time.

5.3.2. Amphibian and Reptile Community Monitoring

Amphibians and reptiles are typically monitored by use of pitfall trap buckets and drift fences (Fisher et al. 2008; Jones 1987). The herpetofauna (e.g., lizards, snakes, and toads) of the CNP will be monitored following the methods and protocols of Chung-MacCoubrey and Bateman (2006) and Bateman, Chung-MacCoubrey, and Snell (2008), Bateman, Harner et al. (2008), Bateman et al. (2009), and used elsewhere to monitor the herpetofauna along the MRG. Pitfall trap, funnel trap, and drift fence arrays will be installed at selected treatment sites for monitoring. Three arrays will be installed at each site at random distances from the edge of the each site, and at least 100 m (328 feet) apart. Each array will have three lines, 6 m (20 feet) long, 7.5 m (25 feet) from the center of each trap array, and each of the lines will be positioned at 0, 120, and 240 degrees from the center point. Each line will have a 5-gallon bucket pitfall trap at each end of the drift fence, and one funnel trap at the middle of each fence on both sides (Bateman et al. 2009). The trapping arrays will be run for a one-month period in the mid-summer (July) and checked three times each week. All individual animals will be recorded by species, and basic body dimensions measured. Data produced will include species composition and total numbers of individuals captured representing each species. Relative abundance data will be useful for assessing changes within and between populations of species over time.

5.3.3. Small Mammal Community Monitoring

Small mammals (i.e., species generally less than 300 grams body weight) are generally inventoried and monitored by use of small box traps that capture animals alive so they may be released again (Morrison et al. 2001; Thompson et al. 1998; Wilson et al. 1996). The traps have a spring plate mechanism that causes the open door to close when an animal enters the trap and releases the mechanism, and 23-cm (9-inch) H.B. Sherman live traps will be used for monitoring. The majority of small mammals at the CNP are rodents, which are typically active at night, so trapping for this project will be conducted during the nighttime hours.

The number, spatial arrangements, and temporal sampling of small mammal trap arrays vary with research scope, environment, and biology of target mammal species. The goals of this monitoring project are to compare the rodent communities (species composition and relative abundance) of treatment and control sites, or of treatment sites over time, representing relatively small areas, so grid arrays of trap lines of the same size and dimensions will be used for all comparative plots. Capture-mark-recapture studies with associated mathematical density estimator algorithms are often used in order to determine recapture rates, estimate densities, and monitor individual animals over time (Thompson et al. 1998; Wilson et al. 1996). Such approaches require rigorous sampling efforts over large or replicated areas, along with considerable repeat sampling over time in order produce data useful for density estimates. Such approaches also are subject to many mathematical and biological assumptions that often cannot be met or verified in the field (Thompson et al. 1998; Williams et al. 2001; Wilson et al. 1996). Since the sampling effort will not be spatially or temporally extensive (adequate between site replication) or intensive (adequate within site replication), and since array trapping data will not be used to verify assumptions relative to density estimation methods, rodent array trapping will simply document and monitor the species composition and relative abundances of all rodent species on the comparative trapping arrays. Such an approach will provide useful information as to whether restoration treatments have changed the small mammal communities and as to how those communities and species abundances change comparatively over time.

Small-mammal trapping will generally be conducted on 50 × 50–m (164 × 164–foot) grids located within each treatment area. Each mammal-trapping grid will consist of an array of six trap lines, each with six traps at 10-m (33-foot) intervals, by a perpendicular array of another six trap lines, each with six traps, making a six by six grid of 36 traps. Grid dimensions must be flexible for different sized and shaped treatment areas, so modifications of grid dimensions should be considered as needed. Trapping will be conducted during one night without a moon, twice each year (May, September). All animals captured will be identified to species. Data produced will include species composition and total numbers of individuals captured representing each species. Relative abundance data will be useful for assessing changes within and between populations of species over time.

5.3.4. Large Mammal Community Monitoring

Large to medium sized animals, which tend to be nocturnal and shy of humans and not easily observed, are best monitored by use of stationary, automatic wildlife cameras, also called camera traps. Large to medium wildlife include native vertebrate animal species; large birds and all medium (5-100 lbs; e.g., squirrels, raccoons, coyotes, etc.) to large (>100 lbs; e.g., mule deer, mountain lion, black bear) animals. Non-native feral domestic animals and humans also are recorded, including recreational use of the habitat patches by people, and people with dogs and horses.

Wildlife cameras are mounted on poles or trees, and left in place providing a constant view of field. The infrared sensors are triggered by movement, such as passing animals, which trigger the camera to take a photograph. Cameras may be set at different levels of sensitivity, for day and night use (all infrared, no visible light to scare animals), and for still photos at variable intervals, or for video. The cameras stamp each photograph or video with the date and time of day.

At least 10 wildlife camera traps will be installed permanently among the various crop fields and habitats to supplement casual observations and to sample nocturnal animals. The 10+ traps will be allocated among different crop types, and subjectively placed as uniformly across the preserve as possible, to provide representation of the different vegetation and water landscapes present at the preserve. Priority for camera sampling will be for the largest and most representative habitat patch types, and less so for small patch types. Some cameras should be installed at permanent locations for long-term monitoring, while others may be moved around to provide photo surveys of various locations to inventory the large animal wildlife. The camera traps will be operational 24 hours per day for one week or one month during each of the four seasons. Photographs from each camera will be viewed and all animals (and persons) observed will be recorded and summarized for each habitat patch type, within each season. All field recorded wildlife camera trap data, will be digitized into a MicroSoft Excel spreadsheet. The data will include dates, habitat patch names, wildlife species and their counts of individuals observed. Wildlife cameras often take photographs of vegetation movement from wind or other non-animal subjects, and such non-useable photographs will be discarded. All photographs of animals will be named by date, location and subject. Those useable photographs will be organized by date and location and stored in a file structure.

5.3.5. Terrestrial Macroinvertebrate Community Monitoring

Terrestrial macroinvertebrate monitoring will focus on ground-dwelling arthropods, which are reasonable to sample, and have been well studied in relation to MRG environments and restoration (Ellis et al. 1999; Cartron et al. 2003; Eichhorst et al. 2006). Pitfall traps will be used to sample ground-dwelling arthropods, similar to those used by the BEMP (Eichhorst et al. 2006). Each pitfall trap will consist of a 9-ounce plastic cup, placed within a 10-ounce steel can, both buried in the ground so that the open cup is level with the ground surface. One 25-cm-diameter (10-inch-diameter) tile will be placed approximately 2.5 cm (1 inch) over each pitfall trap, resting on four large nails. Each cup will be filled with 4 ounces of propylene glycol to serve as a trapping and preserving agent. Five subsample traps will be located within each Hink and Ohmart vegetation type polygon (identified as part of vegetation monitoring) at each treatment site. The pitfall traps will be left open and running for a one-month period in April, June, August, and October of each year. Arthropods from the traps will be collected in the field at the end of each one-month trapping period and taken to the lab for sorting and tabulation. Traps will be capped with lids during the one-month periods between trapping periods.

Arthropods collected in the pitfall trap samples will be identified to the lowest reasonable taxonomic rank, generally family, and genus and species for some. All taxa that are tabulated will be assigned to trophic group (detritivore, herbivore, predator, omnivore) based on the biological knowledge of each taxon (e.g., darkling beetles [Tenebrionidae] are known to be detritivores, etc.). Data produced from pitfall trapping will include taxa composition and total numbers of individuals captured representing each taxon. Data will be averaged over the five subsample traps per vegetation type polygon to provide an average or mean number per vegetation type per treatment site. Taxonomic composition and relative abundance data will be useful for assessing changes within and between populations of taxa over time.

5.3.6. Insect Pollinator Monitoring

Insect pollinators (the principal arthropod pollinators of the CNP region) are recognized as important components of terrestrial ecosystems primarily because of their necessary functional role in the propagation of most flowering plant species (Berenbaum et al. 2007; Droege 2015; Ward et al. 2014; Wilmer 2011). Graminoid plants such as grasses and sedges and gymnosperm plants such as conifer trees are largely wind pollinated, while most of flowering plants require animal pollinators, usually insects, to transport pollen between different individual plants for pollination and reproduction of those plants to occur. Some pollinators, such as the non-native Western or European honeybee, are generalists that visit and pollinate a wide range of flowering plants. While most native species of insect pollinators are specialists on certain plant species, or certain groups of related plant species that have similar flower morphologies, colors, and scents other species of insect pollinators are specific to only one or a few species of plants, and those plants may rely entirely on those specific pollinators for pollination and reproduction (Berenbaum et al. 2007; Holm 2014; Wilmer 2011).

Not all arthropods that visit flowers are pollinators. Many predatory arthropods, including spiders (especially crab spiders [*Thomisidae]*), assassin bugs (*Reduviidae*), ambush bugs (*Phymatinae*), and praying mantises (*Mantidae*), wait on flowers to capture and consume pollinator insects, and some insects feed on flower parts but do not transport pollen (e.g., sap-feeding aphids (*Aphidae*) and thrips [*Thysanoptera]*). Insect pollinators visit flowers primarily to

feed on the nectar that the flowers produce to attract pollinators, and bees collect pollen to feed to their young. Most insect pollinators have morphological and behavioral traits that enhance their abilities to collect nectar and pollen from the flowers they visit and to transport pollen from plant to plant. For example, the hind legs of most bee species feature specialized hairs called pollen baskets; the purpose of these hairs is to collect and hold large amounts of pollen, which the bees then transport to other flowers and to their nests. Many other types of insects such as butterflies and moths (Lepidoptera), hunting wasps (Hymenoptera*: Sphecidae, Pompilidae*), and many types of flies (Diptera*: Syrphidae, Bombyliidae, Tachinidae*) and beetles (Coleoptera*: Mordellidae, Nitidulidae, Scarabaeidae, Buprestidae, Cerambycidae, Meloidae*) visit flowers primarily for nectar, but some also feed on pollen, and all actively transport pollen from flower to flower.

Given that insect pollinators are essential to the reproduction of most flowering plants, managing vegetation resources across landscapes also requires understanding and managing the pollinator communities across those same landscapes. Environmental disturbances that affect vegetation also affect the insect pollinators of the vegetation, and vice versa. The need for pollinator surveys and conservation is becoming pronounced as the essential roles of pollinators in healthy ecosystem function are becoming recognized (Berenbaum et al. 2007; Holm 2014; Ward et al. 2014). Although the European honey bee is the key pollinator insect managed by humans primarily for agricultural crop pollination services, the need for the management and conservation of native pollinator insects for the vast array of native plant species also is becoming a natural resources management objective. To conserve and to manage native pollinators, one must first know which pollinators are present in an area of interest and then understand their relationships to host plant species as key components of their habitats. Since native bees often have specific nesting substrate requirements, knowing which species of native bees are present will allow natural resource managers to also manage landscapes for bee nesting substrates (certain soil types and compaction levels, woody vegetation, cavities, etc.).

Flying insects, including pollinators, are in decline worldwide (Berenbaum et al. 2007, Ward et al. 2014), indicating that and their roles as plant pollinators also are in decline. The decline of European honeybees is especially well known, but the population trends and ecological status of most native pollinator insects is not known or even well understood (Berenbaum et al. 2007). Most plant/pollinator relationships are based on mutual timing of life-history patterns so that the insect pollinators emerge from pupation while their host plants are flowering, and both plant and pollinator life-histories are governed by ambient temperature and rainfall patterns. Understanding which species of plants and which pollinators occur on a given landscape and which pollinators pollinate which species of plants will allow managers to make informed planning decisions to conserve both the vegetation and their associated pollinator insects. Those two groups of organisms are key elements of the overall biological diversity of any terrestrial landscape.

Pollinators of the CNP may be sampled by two different approaches:

1. A qualitative pedestrian active search, locate, and collect method that focuses on actively searching for flowering plants and collecting the pollinators found visiting those plants and is intended to maximize locating and sampling all pollinator species at sampling locations across CNP; and

2. A quantitative, repeatable sampling design at those same locations.

Both qualitative and quantitative sampling may be conducted on permanent sampling routes that incorporate multiple sampling sites that are stratified across the different habitat/crop types. Sampling methods proposed are the generally accepted methods for sampling pollinator arthropods currently in use by most scientific investigators of pollinators and are consistent with those used by the U.S. Department of Agriculture and the U.S. National Park Service (Droege 2015).

The pollinator survey sampling should be conducted during the early (May), mid (July) and late (September) summer to target pollinators of early, mid and late summer flowering plant species.). Field sampling for pollinators should focus on the mid-day hours (9 a.m.–5 p.m.), when most pollinators are active. Some qualitative sampling also should be conducted during the evening hours, when some species of pollinating moths (e.g., Sphingidae and Noctuiidae) tend to fly. Quantitative sampling should focus on mid-day hours, when most pollinators visit flowers, to standardize the quantitative sampling protocols.

The quantitative pollinator sampling survey would be based on standardized and repeatable pollinator collection methods employed at a series of predetermined permanent sampling locations, which will be sampled twice over each summer period. Five to 10 sampling points (depending on cost adjustments) would be randomly located within each of the five habitat or crop types across the CNP.

6. Quantitative Sampling

At each sampling location, the following quantitative sampling protocols would be employed:

- Each quantitative sampling point would be a sampling site that includes a circular area of 1 acre around the center point. Upon arriving at each sampling site, the sampling crew would will walk the entire 1-acre circle, searching for flowing plants and recording (photographing) all of the pollinators they find at the three most common species of plants present.
- The field crew would sample pollinators at each site for 30 minutes and will then move on to the next sampling site.
- At each site, the pollinator species of the most abundant species of flowering plants would be observed and collected for a time-limited period of 30 person/minutes by at least one person, or two persons for 15 person minutes each.
- All pollinators observed at flowers of the dominant flowering plants would be photographed or collected with light aerial insect nets for identification, and host plant species could be recorded.
- Photographs will be taken from the center point of each site during the visit, providing views in the four cardinal directions, north, south, east and west, to document the habitat and vegetation conditions, including flowering plants. Photographs of some individual pollinators also will be taken, as appropriate.
- Pollinator or bee traps, are another standard method for sampling pollinators of a given area (Berenbaum et al. 2007; Droege 2015).

- At each quantitative sampling point, the 30 bee traps consisting of colored disposable plastic bowls approximately 4 inches in diameter, are placed at 10 meters apart along a transect, alternating the colors blue, yellow, and white, for a total of 10 traps of each color. Each bowl contains water and a small amount of liquid dish soap to act as a surfactant to trap visiting insects. The traps are left in place for 24 hours, visited and the next day, and the insect samples are transferred from the traps to labeled bottles the next day. The trap contents are then strained through a fine-mesh net, and the insects are placed in vials labeled with date, location, and trap color. All sample vials are then transported to a lab or classroom, where the pollinators are identified, and their data (date, site, ecological system, plant association, and trap color) will be tabulated into a database. Ideally, the pollinator specimens would then be used to build a collection of the various pollinators to be used as reference for future pollinator identifications. Professional entomologists, such as at the University of New Mexico, Museum of Southwestern Biology, could assist with the identifications and the development of a CNP insect pollinator reference collection. The combined data from the bee traps and the standardized quantitative observational 0.5-hour pollinator observations and sampling from each quantitative sampling site will provide standardized and comparable counts across all sites.

7. Qualitative Sampling

In addition to, or instead of (depending on costs and funding) quantitatively sampling pollinators as above, the pollinator monitoring sampling could simply focus on pedestrian surveys documenting the occurrences of particularly high-quality pollinator habitat patches (i.e., high abundance and diversity of flowering plants) observed across the CNP, on any meaningful spatial and temporal sampling schedule. Such qualitative pedestrian high quality patch sampling would be conducted and data would be recorded by specific location, approximate land area, soil type, vegetation association, dominant species of flowering plants, and at least one photograph. Pollinators would be photographed and/or collected from some of those habitat patches, using the active search and collect protocols stated above. Such qualitative sampling would be far less expensive, but the resulting data also would be less useful for long-term habitat restoration effectiveness monitoring, because the data would not be standardized and represented by consistent effort each time.

8. Sampling Results

The combined results of the pedestrian pollinator collection from flowering plants, the data from the pollinator dish trap sampling, and the high-quality pollinator habitat documentation would provide OSD with comprehensive data on the representative pollinators of the CNP and their geographic distributions, along with habitat and some host plant relationships across the preserve. These proposed survey methods would provide both baseline pre-habitat restoration data and a standardized quantitative sampling design and methodology that can be repeated in the future for long-term pollinator monitoring.

G. IMPLEMENTATION AND INTERAGENCY COORDINATION

The OSD will continue to work with and solicit and obtain support when needed from the following agencies in order to implement this RMP:

1. Rio Grande Nature Center State Park and New Mexico State Parks Division
2. Friends of the Rio Grande Nature Center State Park
3. Middle Rio Grande Conservancy District
4. Natural Resource Conservation Service (formerly the Soil and conservation Service)
5. U.S. Fish and Wildlife
6. Other City of Albuquerque Departments
7. Other public agencies
8. Community and non-profit organizations

While seeking interagency cooperation, community partnership and public involvment, the OSD shall remain responsible for the overall management of the property, including:

- Developing and monitoring wildlife habitat areas.
- Overseeing farm operations and maintenance, in accordance with Farm Operating Agreements and Annual Crop Plans.
- Maintaining and improving the irrigation system in cooperation with the Contract Farmer, as appropriate.
- Conducting interpretive programs for the public at the CNP and producing interpretive materials.

In addition, OSD Law Enforcement Officers are responsible for enforcing City, County, State and Federal law on the property.

The OSD intends to complete these tasks over the 20-year time frame of the plan. Table F.1 below summarizes the possible implementation of tasks discussed in this plan.

Table 21. Candelaria Nature Preserve Implementation Draft Schedule.

The cost is still being developed.

GOAL	TASK	PHASE (each phase is ~4 years)					IMPLEMENTED BY	COST ($)
		1	2	3	4	5		
Wildlife Habitat	**Wetland:** Planning to construct wetland habitat (year 1); Widening moist soil zone in phases (small sections in the zoned area), Re-seeding native plants	X	X				FRGNCSP/OSD	
	Then regular monitoring, filling/ flushing			X	X	X	FRGNCSP/OSD	
	Grasslands: Re-level, amend soils, plant with native seed	X					FRGNCSP/OSD/Farmer	
	Irrigation, maintenance		X	X	X	X		
	Hedgerows: Maintain, additional planting	X	X	X	X	X	OSD/Volunteers	
Sustainable Farming	**Cropping:** Grow wildlife crops and maintain infrastructure	X	X	X	X	X	Farmer/ OSD Supervision	
	Pest Management: Monitor pests and treat appropriately	X	X	X	X	X	Farmer/ OSD Supervision	
	Irrigation: Line ditches and install measuring devices	X	X	X			Farmer/OSD (seeking funds)	
	Irrigate crops, maintain ditches	X	X	X	X	X	Farmer	
	Equipment Storage: Maintain	X	X	X	X	X	Farmer/OSD	
	Gates, Fences, Signs & Roads: Maintain	X	X	X	X	X	OSD	
Public Education	**Education Programs:** Provide to public education, citizen science and service-learning programs.	X	X	X	X	X	OSD/RGNCSP	
	Citizen Science Programs and Monitoring: iNaturalist, Nature's Notebook, etc..	X	X	X	X	X	OSD, Partnering Agencies, Volunteers	

GOAL	TASK	PHASE (each phase is ~4 years)					IMPLEMENTED BY	COST ($)
		1	2	3	4	5		
	Woodward House: Develop and install interpretive signs; make improvements to the WH based on partner's and public's needs			X	X	X	OSD	
Outdoor Recreation Amenities	**Bird blinds/overlooks** Design, construct and install blinds	X	X	X			OSD	
	Accessible trails Plan and develop accessible trails on identified designated paths		X	X			OSD	

Draft Budget for the Candelaria Nature Preserve RMP Implementation

This section is being developed.

H. REFERENCES

Allan, R.P., and B.J. Soden. 2008. Atmospheric warming and the amplification of precipitation extremes. *Science* 321:1481–1484.

Bateman, H.L., A. Chung-MacCoubrey, D.M. Finch, H.L. Snell, and D.L. Hawksworth. 2008. Impacts of non-native plant removal on vertebrates along the Middle Rio Grande (New Mexico). *Ecological Restoration* 26:193–195.

Bateman. H.L., A. Chung-MacCoubrey, and H.L. Snell. 2008. Impact of non-native plant removal on lizards in riparian habitats in the southwestern United States. *Restoration Ecology* 16:180–190.

Bateman, H.L., M.J. Harner, and A. Chung-MacCoubrey. 2008. Abundance and reproduction of toads (*Bufo*) along a regulated river the southwestern United States: Importance of flooding in riparian ecosystems. *Journal of Arid Environments* 72:1613–1619.

Bateman, H.L., A. Chung-MacCoubrey, H.L. Snell, and D.M. Finch. 2009. Abundance and species richness of snakes along the Middle Rio Grande riparian forest in New Mexico. *Herpetological Conservation and Biology* 4:1–8.

Berenbaum, M., et al. 2007. *Status of Pollinators in North America*. Committee on the Status of Pollinators of North America, Board of Life Sciences, Board of Agricultural and Natural Resources, Division of Earth and Life Sciences. National Research Council of the National Academies. Washington, D.C.: The National Academies Press.

Berry, K.L., and K. Lewis. 1997. *Historical Documentation of Middle Rio Grande Flood Projection Projects, Corrales to San Marcial*. Report submitted to U.S. Army Corps of Engineers. Albuquerque: Office of Contract Archeology, University of New Mexico.

Bibby, C.J., N.D. Burgess, and D.A. Hill. 1992. *Bird Census Techniques*. 2nd ed. London: Academic Press.

Block, W.M., A.B. Franklin, J.P. Ward, Jr., J.L. Ganey, and G.C. White. 2001. Design and implementation of monitoring studies to evaluate the success of ecological restoration. Restoration Ecology 9:293–303.

Brown, R.D., and P.W. Mote. 2009. The response of Northern Hemisphere snow cover to a changing climate. *Journal of Climate* 22 (8):2124–2145.

Callahan, D., and L. White. 2004. Vegetation mapping of the Rio Grande floodplain from Velarde to Elephant Butte. U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, and Technical Service Center, Ecological Planning and Assessment Branch, Denver.

Campbell, C.J., and W.A. Dick-Peddie. 1964. Comparison of phreatophyte communities on the Rio Grande in New Mexico. Ecology 45:492–502.

Cartron, J.E., D.C. Lightfoot, J.E. Mygatt, S.L. Brantley and T.K. Lowrey. 2008. A field guide to the plants and animals of the Middle Rio Grande bosque. Univeristy of New Mexico Press. Albuquerque, NM.

Cartron, J.E., M.C. Molles, Jr., J.F. Schuetz, C.S. Crawford, and C.N. Daham. 2003. Ground arthropods as potential indicators of flooding regime in the riparian forest of the middle Rio Grande, New Mexico. Environmental Entomology 32:1075–1084.

Chung-MacCoubrey, A.L., and H. L. Bateman. 2006. *Herpetological Communities of the Middle Rio Grande Bosque: What Do We Know, What Should We Know, and Why?* U.S. Department of Agriculture, Forest Service Proceedings RMRS-P-42CD:57-66.

Crawford, C.S., A.C. Cully, R. Leutheuser, M. S. Sifuentes, L. H. White, and J. P. Wilber. 1993. *Middle Rio Grande Ecosystem: Bosque Biological Management Plan*. Albuquerque, New Mexico: Biological Interagency Team, U.S. Fish and Wildlife Service.

Dick-Peddie, W.A. 1993. *New Mexico Vegetation—Past, Present and Future*. Albuquerque: University of New Mexico Press.

Downes, B.J., L.A. Barmuta, P.G. Fairweather, D.P. Faith, M.J. Keough, P.S. Lake, B.D. Mapstone, and G.P. Quinn. 2002. *Monitoring Ecological Impacts: Concepts and Practice in Flowing Water.* Cambridge, England: Cambridge University Press.

Droege, S. 2015. *The Very Handy Manual: How to Catch and Identify Bees and Manage a Collection*. Beltsville, Maryland: U.S. Geological Survey.

Eichhorst, K.D., D.C. Shaw, J.F. Schuetz, A.D. Gebauer, and C.S. Crawford. 2006. *Bosque Ecosystem Monitoring Program (BEMP): Third supplement*: *2004–2005.* Open-File Report 06-4. Prepared in cooperation with Bosque School. Albuquerque: University of New Mexico.

Eichhorst, K.D., D.C. Shaw, J.F. Schuetz, K.A. Scheerer, M. Keithley, and C.S. Crawford. 2012. *Bosque Ecosystem Monitoring Program (BEMP) Comprehensive Report: 1997–2009.* Open File Report 12-5. Albuquerque: University of New Mexico. Available at: http://www.bosqueschool.org/uploads/FileLinks/4647afda67484412b45f4c35df0ca689/BEMP_comprehensive_report_FINAL_6.29.12.pdf.

Elias, E.H., A. Rango, C.M. Steele, J.F. Mejia, and R. Smith. 2015. Assessing climate change impacts on water availability of snowmelt-dominated basins of the Upper Rio Grande basin. *Journal of Hydrology: Regional Studies* 3 (2015): 525–546.

Ellis, L.M., C.S. Crawford, and M.C. Molles, Jr. 1997. Rodent communities in native and exotic riparian vegetation in the Middle Rio Grande Valley of Central New Mexico. *Southwestern Naturalist* 42:13–19.

Ellis, L.M., M.C. Molles, and C.S. Crawford. 1997. Short-term effects of annual flooding on a population of *Peromyscus leucopus* in a Rio Grande riparian forest of central New Mexico. *The American Midland Naturalist* 138(2):260–267.

Ellis, L.M., M.C. Molles, Jr., and C.S. Crawford. 1999. Influence of experimental flooding on litter dynamics in a Rio Grande riparian forest, New Mexico. *Restoration Ecology* 7:193–204.

Ellis, L.M., M.C. Molles, Jr., C.S. Crawford, and F. Heinzelmann. 2000. Surface-active arthropod communities in native and exotic vegetation in the Middle Rio Grande Valley, New Mexico. *The Southwestern Naturalist* 45(4): 456–471.

Elzinga, C.L., D.W. Salzer, J.W. Willoughby, and J.P. Gibbs. 2001. *Monitoring Plant and Animal Populations*. Malden, Massachusetts: Blackwell Science, Inc.

Emlen, J.T. 1971. Population densities of birds derived from transect counts. *Auk* 88:323–343.

Finch, D.M., J. Galloway, and D. Hawksworth. 2006. Monitoring Bird Populations in Relation to Fuel Loads and Fuel Treatments in Riparian Woodlands with Tamarisk and Russian Olive Understories. In *Monitoring Science and Technology Symposium: Unifying Knowledge for Sustainability in the Western Hemisphere Proceedings RMRS-P-42CD,* edited by C. Aguirre-Bravo, P.J. Pellicane, D.P. Burns, and S. Draggan, pp. 113–120. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Fisher, R., D. Stokes, C. Rochester, C. Brehme, S. Hathaway, and T. Case. 2008. Herpetological Monitoring Using a Pitfall Trapping Design in Southern California. U.S. Geological Survey Techniques and Methods 2-A5.

GeoSystems Analysis, Inc. 2018. Soil sampling and piezometer installation at Candelaria Farms. Technical Memorandum. Submitted to SWCA Environmental Consultants, Albuquerque, New Mexico, September 19, 2018.

Green, R.H. 1979. *Sampling Design and Statistical Methods for Environmental Biologists*. New York, New York: Wiley and Sons, Inc.

Groisman, P.Y., and R.W. Knight. 2008: Prolonged dry episodes over the conterminous United States: New tendencies emerging during the last 40 years. *Journal of Climate* 21:1850–1862.

Gutzler, D.S. 2013. Special feature: sustainability on the U.S./Mexico border, regional climatic considerations for borderlands sustainability. *Ecosphere* 4(1)7:1–12.

Gutzler, D.S., and T.O. Robbins. 2011. Climate variability and projected change in the western United States: regional downscaling and drought statistics. *Climate Dynamics* 37:835–849.

Hall, A.W., P.H. Whitfield, and A.J. Cannon. 2006. Recent variations in temperature, precipitation, and streamflow in the Rio Grande and Pecos River Basins of New Mexico and Colorado. *Reviews in Fisheries Science* 14:51–78.

Hawks Aloft. 2008. *Raptor Monitoring in the Middle Rio Grande Bosque of Central New Mexico.* Prepared for the U.S. Army Corps of Engineers, Albuquerque, New Mexico.

Hawley, J.W. 1978. *Guidebook to the Rio Grande Rift in New Mexico and Colorado*. New Mexico Bureau of Minds and Mineral Resources, Circular 163.

Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems*. Quick Start. Design, Supplementary Methods and Interpretation, 1 and 2. U.S. Department of Agriculture Agricultural Research Service Jornada Experimental Range, Las Cruces, New Mexico. Tucson: University of Arizona Press.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedell. 1991. Responses of salmonids to habitat changes. In Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, edited by W.R. Meehan, pp. 483–518. American Fisheries Society Special Publication 19.

Hink, V.C., and R.D. Ohmart. 1984. *Middle Rio Grande Biological Survey*. Albuquerque, New Mexico: U.S. Army Corps of Engineers, Albuquerque District. Contract No. DACW47-81-C-0015. Tempe: Arizona State University.

Holm, P. 2014. Pollinators of native plants: Attract, observe and identify pollinators and beneficial insects with native plants. Pollination Press LLC, Minnetonka, MN. Printed by Hillcrest Media Group, Minneaplis, NM.

Hunt, C.B. 1983. Physiographic overview of our arid lands in the western U.S. In Origin and Evolution of Deserts, edited by S.G. Wells and D.R. Haragan, pp. 7–63. Albuquerque: University of New Mexico Press.

Hurd, B.H., and J. Coonrod. 2008. *Climate Change and its Implications for New Mexico's Water Resources and Economic Opportunities*. Technical Report 45. Las Cruces, New Mexico: New Mexico State University Agricultural Experiment Station.

iNaturalist. 2019. Interactive website available at: https://www.inaturalist.org/.

Intergovernmental Panel on Climate Change. 2007. *Climate Change 2007: I. The Physical Science Basis*. New York: Cambridge University Press.

Johnson, D.C. 1983. *Draft Rio Grande Nature Center Management Plan*. Santa Fe: New Mexico Natural Resources Department, State Park and Recreation Division.

Jones, K.B. 1987. Amphibians and reptiles. In *Inventory and Monitoring of Wildlife Habitat*, edited by A.Y. Cooperrider, R.J. Boyd, and H.R. Stuart, pp. 267–290. Denver, Colorado: Bureau of Land Management.

Lee, S., A. Klein, and T. Over. 2004. Effects of the El Niño Southern Oscillation on temperature, precipitation, water equivalent and resulting streamflow in the Upper Rio Grande River Basin. *Hydrological Process* 18:1053–1071.

Llewellyn, D., and S. Vaddey. 2013. *West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment*. Albuquerque: U.S. Department of Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Office Area.

Mann, M.E. 2019. The weather amplifier: Strange waves in the Jetstream foretell a future full of heatwaves and floods. *Scientific American* 320 (3):42–49.

McAda, D.P., and P. Barroll, 2002. *Simulation of Ground-water Flow in the Middle Rio Grande Basin between Cochiti and San Acacia, New Mexico*. U.S. Geological Survey Water-Resources Investigations Report 02-4200.

McCune, B., and J.B. Grace. 2002. *Analysis of Ecological Communities*. Gleneden Beach, Oregon: MjM Software Design.

McDonald, L.H., A.W. Smart, and R.C. Wissmar. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. Seattle: U.S. Environmental Protection Agency, Region 10, NPS Section.

McLeod, M.A., T.J. Koronkiewicz, B.T. Brown, W.J. Langeberg, and S.W. Carothers. 2008. *Southwestern Willow Flycatcher Surveys, Demography, and Ecology along the Lower Colorado River and Tributaries, 2003–2007*. Five-year summary report submitted to U.S. Bureau of Reclamation, Boulder City, Nevada. Flagstaff, Arizona: SWCA Environmental Consultants.

Melillo, J.M., T. (T.C.) Richmond, and G.W. Yohe (eds.). 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program. doi:10.7930/J0Z31WJ2.

Michener, C.D. 2000. *The Bees of the World*. Baltimore and London: John Hopkins University Press.

Michener, C.D., R.J. McGinley, and B.N. Danforth. 1994. *The Bee Genera of North and Central America (Hymenoptera: Apoidea).* Washington, D.C.: Smithsonian Institution Press.

Michener, W.K. 1997. quantitatively evaluating restoration experiments: Research design, statistical analysis, and data management considerations. *Restoration Ecology* 54:324–327.

Moore, D. 2007. Vegetation Quantification of Southwestern Willow Flycatcher Nest Sites: Rio Grande from La Joya to Elephant Butte Reservoir Delta, New Mexico 2004–2006. Denver: U.S. Bureau of Reclamation, Fisheries and Wildlife Resources.

Morrison, M.L., W.M. Block, M.D. Strickland, and W.L. Kendall. 2001. Wildlife Study Design. New York, New York: Springer-Verlag New York, Inc.

Muldavin, E., C.S. Crawford, and N. Umbreit. 2004. *The Albuquerque Overbank Project: A Model for Large River Riparian Restoration in the Southwest*. Natural Heritage New Mexico.

Osenberg, C.W., B.M. Bolker, J.S. White, C.M. St. Mary, and J.S. Shima. 2006. Statistical Issues and Study Design in Ecological Restorations: Lessons Learned from Marine Reserves. In *Foundations of Restoration Ecology*, edited by D.A. Falk, M.A. Palmer, and B. Zedler, pp. 280–302. Washington, D.C.: Island Press.

Parker, D.L., M. Renz, A. Fletcher, F. Miller, and J. Gosz. 2005. *Strategy for Long-Term Management of Exotic Trees in Riparian Areas for New Mexico's Five River Systems, 2005–2014.* U.S. Department of Agriculture, Forest Service and New Mexico Energy, Minerals and Natural Resources Department, Forestry Division Publication.

Petrie, M.D., S.L. Collins, D.S. Gutzler, and D.M. Moore. 2014. Regional trends and local variability in monsoon precipitation in the northern Chihuahuan Desert, USA. *Journal of Arid Environments* 103:63–70.

Petrie, M.D., S.L. Collins, and M.E Litvak. 2015. The ecological role of small rainfall events in a desert grassland. Ecohydrology.

Quinn, G.P., and M.J. Keough. 2007. *Experimental Design and Data Analysis of Biologists*. Cambridge, England: Cambridge University Press.

Rahmstorf, S., A. Cazenave, J.A. Church, J.E. Hansen, R.F. Keeling, D.E. Parker, and R.C.J. Somerville. 2007. Recent climate observations compared to predictions. *Science* 316:709.

Robert, L. 2005. Middle Rio Grande Ecosystem Bosque Biological Management Plan - the First Decade: A Review and Update. Middle Rio Grande Bosque Initiative and the Bosque Improvement Group, Albuquerque, NM 112-127.

Roni, P., M.C. Liermann, C. Jordan, and E.A. Steel. 2005. Steps for designing a monitoring and evaluation program for aquatic restoration. In *Monitoring Stream and Watershed Restoration*, edited by P. Roni, pp. 13–34. Bethesda, Maryland: American Fisheries Society.

Ruth, L. and R. Standiford (compilers). 1994. Conserving the California spotted owl: Impacts of interim policies and implications for the long-term. Report 33. Wildland Resources Center, University of California. Berkeley, California.

Scurlock, D. 1998. *From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin.* General Technical Report RMRS-GTR-5. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H.-P. Huang, N. Harnik, A. Leetmaa, N.-C. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. *Science* 316:1181–1184.

Seavy, N.E., T. Gardali, G.H. Golet, F.T. Griggs, C.A. Howell, R. Kelsey, S.L. Small, J.H. Viers, and J.F. Weigand. 2009. Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research. Ecological Restoration. 27(3): 330-338.

Smith, D.M., J.F. Kelly, and D.M. Finch. 2006. *Wildfire, Exotic Vegetation, and Breeding Bird Habitat in the Rio Grande Bosque*. U.S. Forest Service Proceedings RMRS-P-42CD.

S.S. Papadopulos and Associates, Inc. (SSPA). 2005. *River Flow Monitoring and Observation for Silvery Minnow Rescue*, "River Eyes," Final project Deliverable: SSPA Work Order

SSPA2-RG16. Report submitted to the New Mexico Interstate Stream Commission, Albuquerque.

———. 2006. *Riparian Groundwater Models for the Middle Rio Grande: ESA Collaborative Program FY04.* Report submitted to the New Mexico Interstate Stream Commission, Albuquerque.

Stromberg, J., K. McCluney, M. Dixon, and T. Meixner. 2012. Dryland riparian ecosystems in the American Southwest: Sensitivity and resilience to climatic extremes. *Ecosystems* 16: 411-415.

Swetnam, T.W., and J. L. Betancourt. 1999. Mesoscale disturbance and ecological response to decadal climatic variability in the American Southwest. Journal of Climate 11:3128–3147.

Tebaldi, C., K. Hayhoe, J.M. Arblaster, and G.A. Meehl. 2006. Going to the extremes. *Climatic Change* 79(3–4):185–211.

Tetra Tech. 2004. *Habitat Restoration Plan for the Middle Rio Grande*. Report to the Middle Rio Grande Endangered Species Collaborative Program, Habitat Restoration Work Group. 145 pp.

Thompson, W.L., G.C. White, and C. Gowan. 1998. *Monitoring Vertebrate Populations*. London: Academic Press.

U.S. Army Corps of Engineers (Corps), Albuquerque District, U.S. Department of Interior Bureau of Reclamation, and New Mexico Interstate Stream Commission. 2006. *Upper Rio Grande Basin Water Operations Review: Draft Environmental Impact Statement* (URGWOPS). Volumes 1 and 2. January 2006.

U.S. Environmental Protection Agency (EPA). 2015. Climate impacts in the Southwest. Available at: https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-southwest.html. Accessed October 2018.

U.S. Global Change Research Program (USGCRP). 2014. Ch. 3: Water Resources. A. Georgakakos, P. Fleming, M. Dettinger, C. Peters-Lidard, T.C. Richmond, K. Reckhow, K. White, and D. Yates. In *Climate Change Impacts in the United States: The Third National Climate Assessment*, edited by J.M. Melillo, T.C. Richmond, and G.W. Yohe, pp. 69–112.

———. 2017. *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles,D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. Washington, D.C.: U.S. Global Change Research Program. doi: 10.7930/J0J964J6.

———. 2018. *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. Washington, D.C.: U.S. Global Change Research Program.

Walker, H.A. 2006. Southwestern avian community organization in exotic Tamarisk: Current patterns and future needs. In Monitoring Science and Technology Symposium: Unifying Knowledge for Sustainability in the Western Hemisphere, edited by C. Aguirre-Bravo, P.J. Pellicane, D.P. Burns, S. Draggan. September 20–24, 2004. Denver. Proceedings RMRS-P-42CD:274-286.

Ward, K., E. Cariveau, E. May, M. Roswell, M. Vaughan, N. Willams, R. Winfree, R. Isaacs, and K. Gill. 2014. Streamlined Bee Monitoring Protocol for Assessing Pollinator Habitat. Portland, Oregon: The Xerces Society for Insect Conservation.

Williams, B.K., J.D. Nichols, and M.J. Conroy. 2001. *Analysis and Management of Animal Population*s. San Diego, California: Academic Press.

Wilmer, P. 2011. Pollination and floral ecology. Princeton, New Jersey: Princeton University Press.

Wilson, D.E., F.R. Cole, J.D. Nichols, R. Rudran, and M.S. Foster (eds.). 1996. *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals*. Washington, D.C.: Smithsonian Institution Press.

APPENDIX A.
Policy Framework and Planning Documents

Please see the accompanying CD.

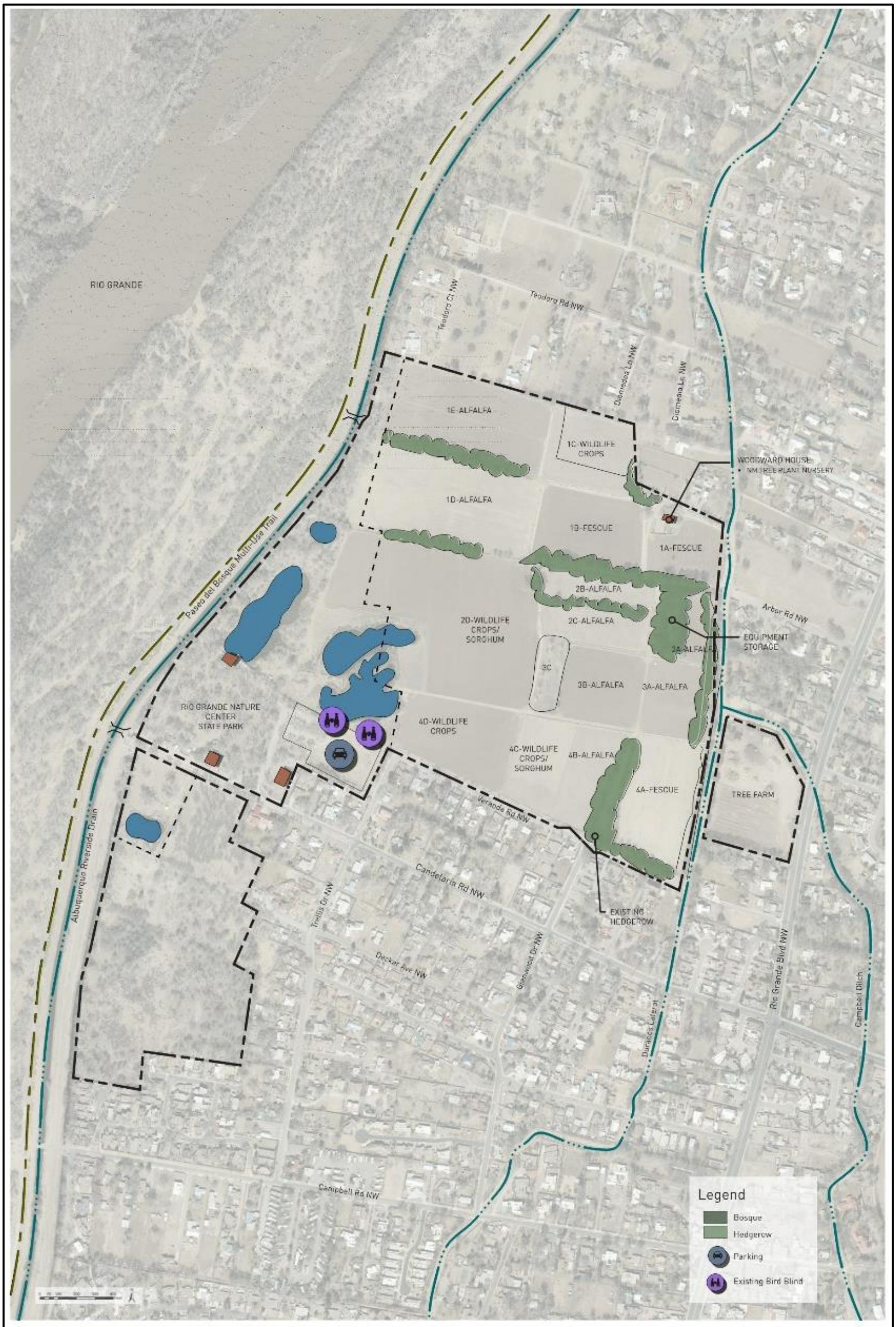
APPENDIX B.
Soil Descriptions and Characteristics

Please see the accompanying CD.

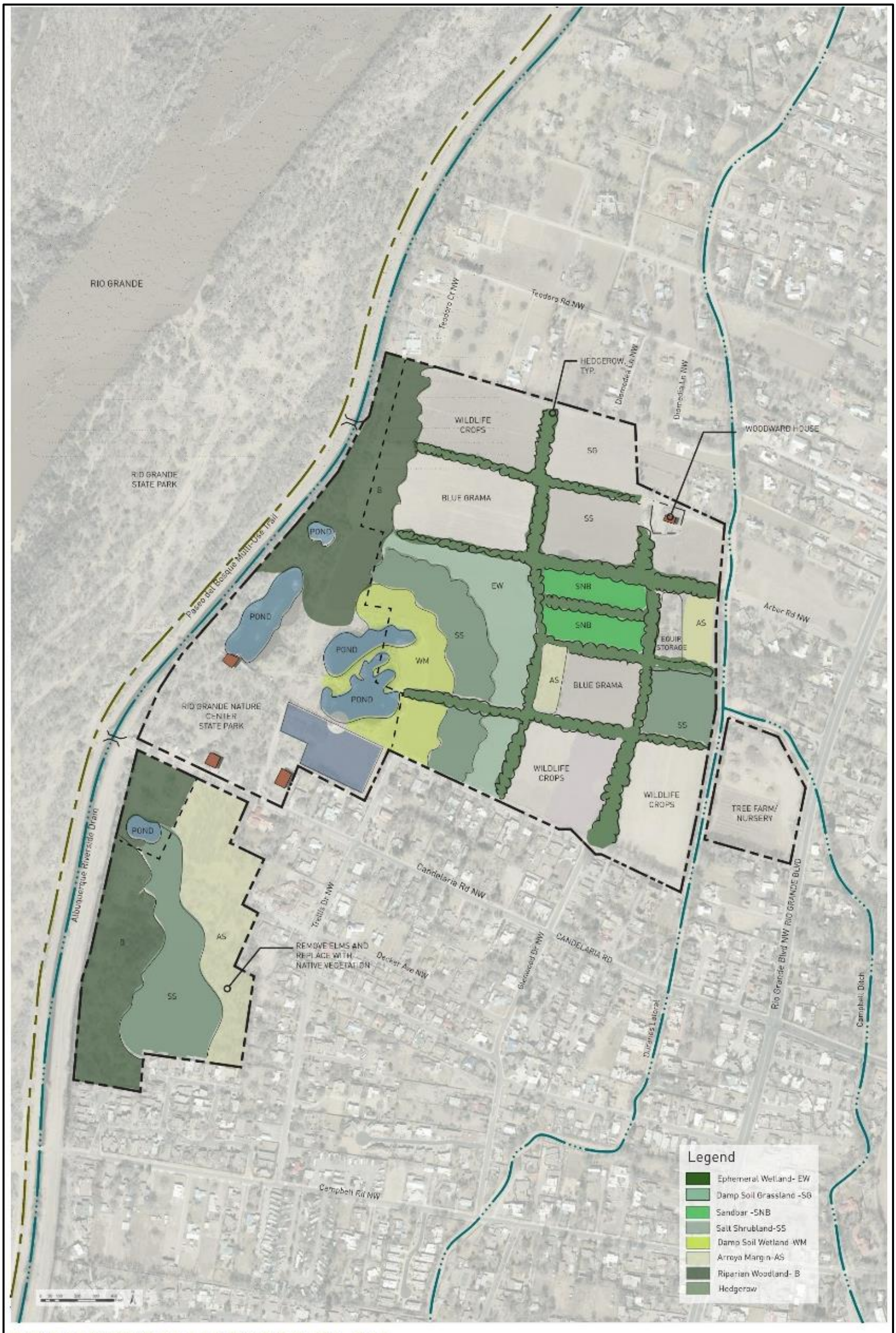
APPENDIX C.
Public Planning Process

Please see the accompanying CD.

APPENDIX D.
Conceptual Plan Maps

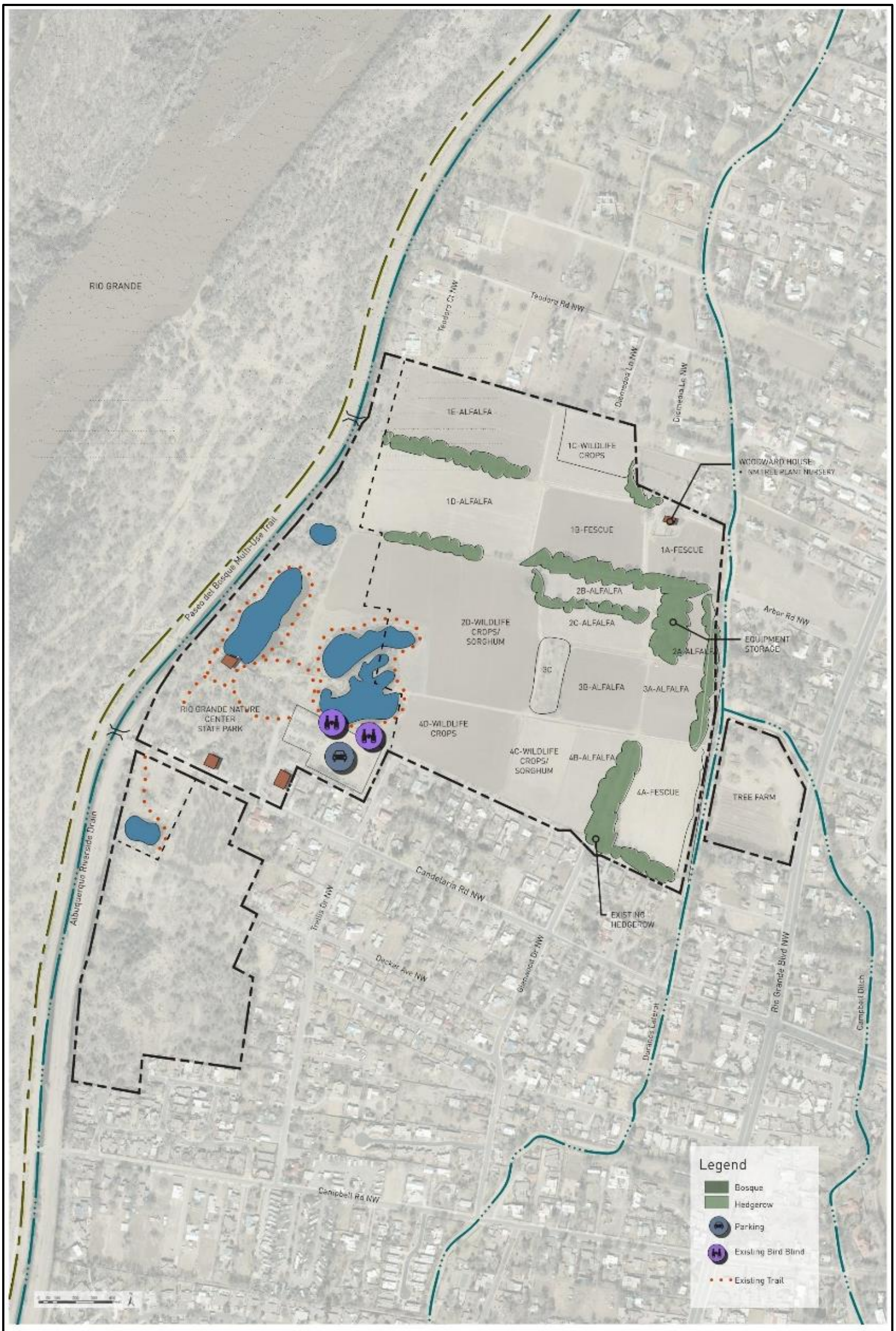


EXISTING CONDITIONS



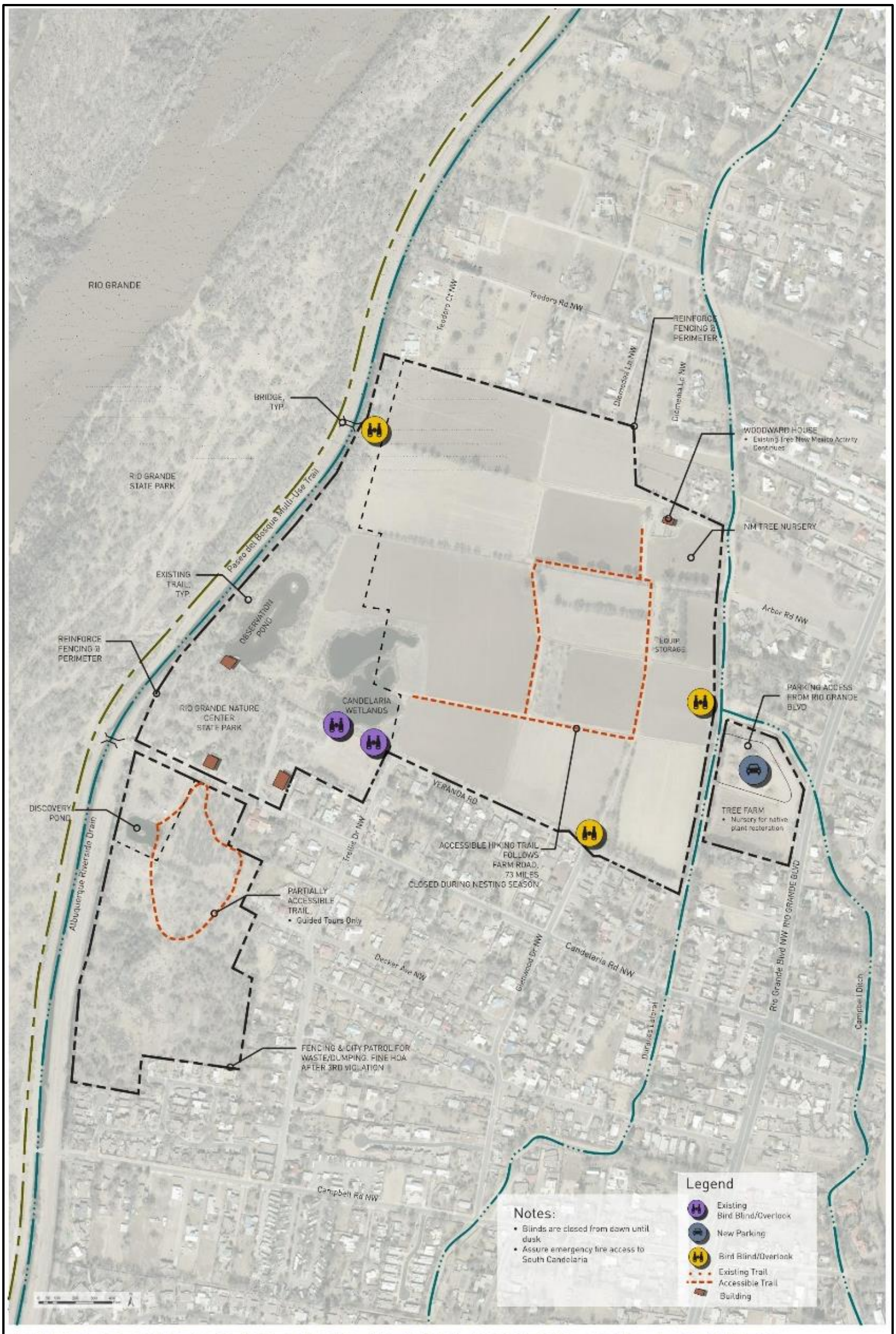
TRANSITION HABITAT PLAN

20 YEAR HABITAT PLAN



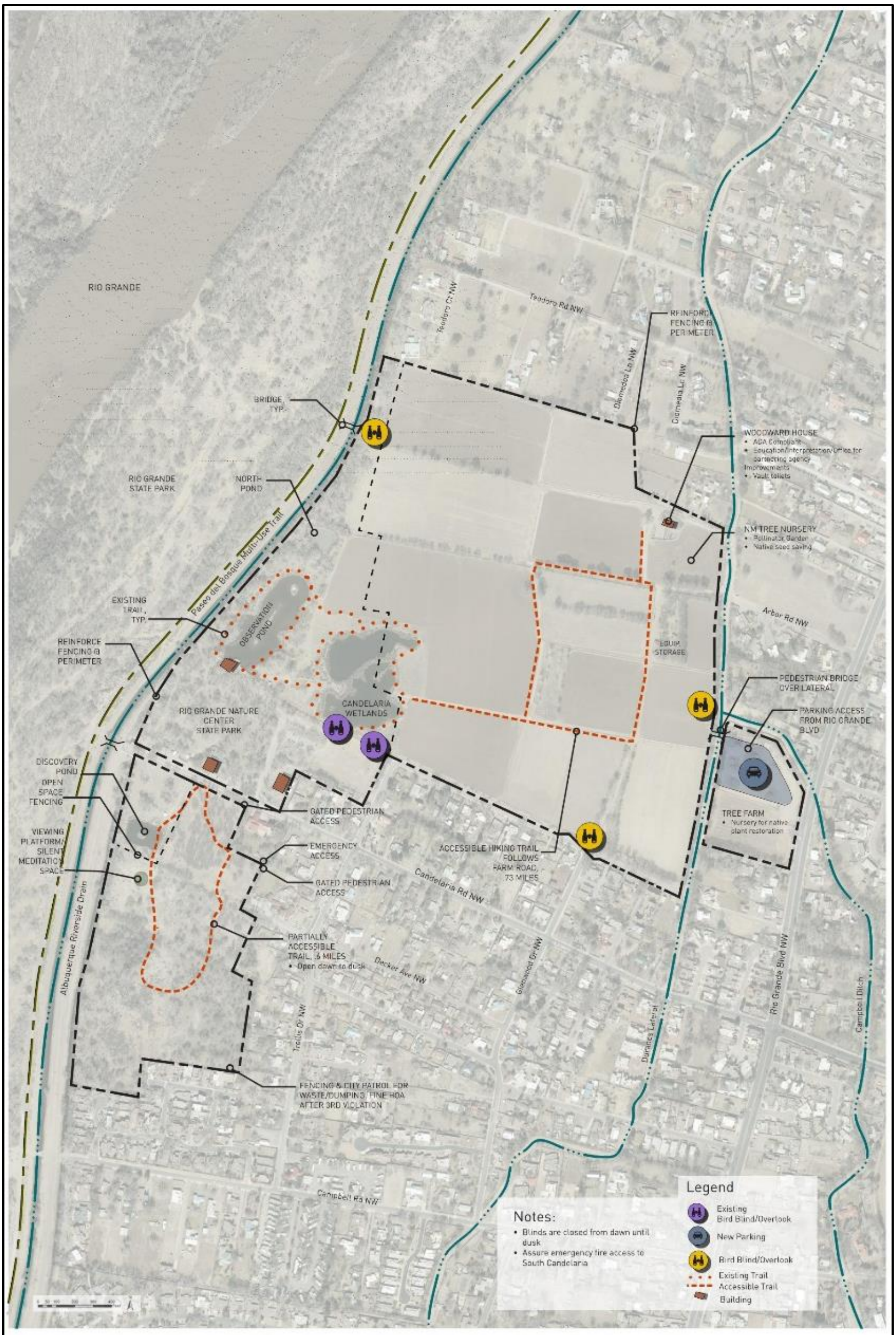
EXISTING CONDITIONS

- No open access
- Tours
- Youth Crews
- Bird blind at Rio Grande Nature Center



LIMITED OUTDOOR RECREATION ACCESS AND ACTIVITY

- Prohibited items include dogs (except service dogs), hunting, running/jogging, kite flying, drones, biking, motorized vehicles (except maintenance), rentals and use for private events and film making
- Limited trails
- Guided tours
- Bird blinds
- Interpretive signage at Woodward House



INCREASED OUTDOOR RECREATION ACCESS AND ACTIVITY

- Same features as limited access plan with the following additions:
- Candelaria South open to public and includes longer trail
- Viewing platform and silent meditation area
- Additional wildlife compatible activities by Woodward House and adjacent field