Saint Mary's University of Minnesota
GeoSpatial Services

New Mexico Environment Department
Surface Water Quality Bureau
Wetlands Program

Mapping and Classification of Wetlands in the Middle Rio Grande Region of Western New Mexico

ON THE COVER
Rio Puerco in New Mexico’s MRG study area, April 2018.
SMUMN GSS Photo.

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This report was prepared for New Mexico Environment Department Professional Services Contract No. 18-667-2060-0018 by Saint Mary's University of Minnesota through their GeoSpatial Services program (SMUMN GSS).

September 23, 2021

Please cite this publication as:

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

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Acronyms and Abbreviations

AIH – Aquatic Invertebrate Habitat

BSS – Bank and Shoreline Stabilization

CIR – Color Infrared

CAR – Carbon Sequestration

DEM – Digital Elevation Model

DOQQ - Digital Orthophoto Quarter Quadrangle

DRG – Digital Raster Graphic

EPA – United States Environmental Protection Agency

Esri – Environmental Systems Research Institute

FH – Fish Habitat

FGDC – Federal Geographic Data Committee

GIS – Geographic Information Systems

GPS – Global Positioning System

GR – Groundwater Recharge

HGM – Hydrogeomorphic

MRG – Middle Rio Grande

NAD – North American Datum

NAIP – National Agricultural Imagery Program

NMED – New Mexico Environment Department

NMRAM – New Mexico Rapid Assessment Method

NHD – National Hydrography Dataset

NRCS – Natural Resources Conservation Service

NT – Nutrient Transformation

NWI – National Wetlands Inventory

Acronyms and Abbreviations (continued)

OWH – Other Wildlife Habitat

PQAPP - Project Quality Assurance Project Plan

RGB - Red, Green and Blue (true color)

SM – Streamflow Maintenance

SMUMN GSS – Saint Mary's University of Minnesota, GeoSpatial Services

SQL – Structured Query Language

SR – Sediment and Other Particulate Retention

SSURGO – Soil Survey Geographic Database

SWD – Surface Water Detention

SWQB – Surface Water Quality Bureau of New Mexico Environment Department

USDA – United States Department of Agriculture

USFS - United States Forest Service

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

UWPC – Unique, Uncommon, or Highly Diverse Wetland Plan Communities

WBIRD – Waterfowl and Water Bird Habitat

Acknowledgements

Thank you to Maryann McGraw, Wetlands Program Coordinator, Emile Sawyer, Environmental Scientist, and Karen Menetrey, Environmental Scientist from the NMED SWQB New Mexico Wetlands Program, who provided insight, guidance and review for all aspects of this project. The authors are also grateful for the coordination, collaboration, advocacy, wetland expertise and project support received from other staff in NMED SWQB including Zack Stauber. Thanks, as well, to Gary Hunt from the U.S. Fish and Wildlife Service, National Wetlands Inventory Program who greatly contributed to the scientific expertise and local and regional ecological knowledge available for this report. To all those who reviewed and commented on this report, thank you. Your contributions increased its professional value for the wetlands of New Mexico.

A palustrine wetland within the Middle Rio Grande study area (SMUMN GSS photo, April 2019).

Executive Summary

This project is part of a larger effort being undertaken by the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) Wetlands Program to protect and restore New Mexico's remaining wetlands and to increase self-sustaining, naturally functioning wetlands and riparian areas for the benefit of the state into the future. Funding for the project was provided by the U.S. Environmental Protection Agency (EPA) Region 6 through a Clean Water Act Section 104(b)(3) Wetlands Program Development Grant to NMED.

The project, entitled "Mapping and Classification of Wetlands in New Mexico: Middle Rio Grande Subproject" used geospatial techniques and image interpretation processes to remotely map and classify wetlands (includes deepwater habitats) and riparian areas in western New Mexico. Wetlands for the project area were mapped and classified using on-screen digitizing methods in a Geographical Information System (GIS). This process was supported by development of a selective image interpretation key that resulted from field verification of image signatures and wetland classifications. Wetland image interpretation employed a variety of input image and collateral data sources, as well as field verification techniques. All mapping was completed at an on-screen scale of 1:12,000 or larger in compliance with national wetland mapping standards (FGDC 2009).

Wetlands were mapped in compliance with the Federal Geographic Data Committee (FGDC) Wetlands Mapping Standard (FGDC 2009) which uses the National Wetlands Inventory (NWI) classification system developed by Cowardin et al. (1979). Simultaneously, wetland features were assigned codes from the Landscape Position, Landform, Water Flow Path, and Waterbody Type (LLWW) classification system developed by Tiner (2011). To add richness to the wetland data, wetlands were also characterized by hydrogeomorphic (HGM) descriptors developed by Brinson (1993), and then correlated to a variety of potential wetland functions. Lastly, riparian areas were mapped, often adjacent to floodplain wetlands, using A System for Mapping Riparian Areas in the Western United States developed by Dick et al. (USFWS 2009).

The project area was just over 7 million acres in size. Based on the final wetland mapping, 6,886,141 acres (~97.9%) of the study area is upland habitat and 146,550 acres (~2.1%) is a combination of wetland, deepwater habitat, and riparian area habitat. Riverine system wetlands make up ~73% of the wetland area, palustrine 32%, and lacustrine <0.1%.

Classification of wetlands using the FGDC Wetlands Mapping Standard, combined with the addition of LLWW descriptors and the development of a wetland functional correlation table for New Mexico, provided the opportunity to assign functional attributes to all wetland habitats in the project area. The functional assessment schema was developed through a 'best professional judgment' exercise utilizing a consensus of local, regional and national wetland biologists and natural resource professionals plus local stakeholders who were familiar with wetland habitats in the project area. The first step in this process was to develop group agreement on which wetland functions were important to assess for the project area. The group was then asked to document the wetland characteristics that were representative of specific functions and to correlate them to both NWI and LLWW codes. Finally, wetlands were categorized as either high or moderate for the performance of specific functions relative to other wetlands in the project area.

Wetland functions that were assessed within this project study area included:

1. Surface Water Detention;
2. Streamflow Maintenance;
3. Groundwater Recharge;
4. Carbon Sequestration;
5. Nutrient Transformation;
6. Sediment and Other Particulate Retention;
7. Bank and Shoreline Stabilization;
8. Fish Habitat;
9. Aquatic Invertebrate Habitat;
10. Waterfowl and Water Bird Habitat;
11. Other Wildlife Habitat; and,
12. Unique, Uncommon, or Highly Diverse Wetland Plant Communities.

Results from the wetland functional assessment indicated that Other Wildlife Habitat (OWH) and Groundwater Recharge (GR) were the most common wetland functions performed at a high level in the project area, at 93.6% and 78.9% of wetland acreage, respectively. Performance of Surface Water Detention (SWD) and Carbon Sequestration (CAR) at a moderate level were also common, representing 18.6% and 14.5% of wetland acreage. The least common functions performed include Streamflow Maintenance (SM); Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC); and Fish Habitat (FH). These functional assessments are summarized and displayed in map form in the results section of this report (beginning with Figure 35 on p. 70) to provide a better understanding of the processes occurring in the watersheds across the project area.

The data and information developed through this mapping project supports several conclusions. Most importantly, there are a considerable number of wetlands and riparian areas across this portion of western New Mexico (over 38,000) and they are providing a wide range of important ecological functions. Secondly, when attempting to adapt mapping methodologies based on regional and local conditions, it is essential to involve local, regional, and national experts plus local stakeholders in the mapping and assessment processes.

It is important to incorporate both field evaluations (qualitative and quantitative) and collateral spatial data sources in order to support decisions related to wetland delineation, classification, and function. This is especially true in a semi-arid environment such as central and western New Mexico, which experienced severe to extreme drought conditions during 2018 (NDMC 2019).

Finally, this is a landscape-level mapping project and the resulting data should be used to support decision making at that scale. It is appropriate to use these data as a guide for further field data collection and investigation but not for site-specific compliance, restoration or mitigation activities.

Introduction

In 2017, the NMED SWQB identified a need to update and improve existing wetland information and to remotely map and classify wetlands and riparian areas of the Middle Rio Grande (MRG) region of West-central New Mexico. Before the issuance of this request, this geographic region of New Mexico had no accurate or up-to-date wetland data. In response, the Middle Rio Grande wetland mapping and classification project was initiated. As with previous New Mexico mapping projects (e.g., Jemez Mountains, Sacramento Mountains), the goal was to gather wetland information about watersheds in the MRG region utilizing a GIS-based approach in preparation for future planning, management, and protection efforts.

Given that wetland mapping in the project area was lacking, completion of this landscape level inventory process was important so that SWQB could continue the work of preserving and restoring the wetlands and riparian areas. This project was completed using modern aerial imagery, up-to-date geospatial technology, and in compliance with the Wetland Mapping Standards outlined by the FDGC (2009).

Work on this project, entitled "Mapping and Classification of Wetlands in New Mexico: Middle Rio Grande Subproject," was contracted by the NMED SWQB Wetlands Program to Saint Mary's University of Minnesota's Geospatial Services (SMUMN GSS) project center. The mapping began in 2018 and was initially completed in 2019. The decision was then made to update the mapping to NWI 2.0 (USFWS 2020), which was completed in 2021.

GeoSpatial Services operates as a Saint Mary's University of Minnesota project center and provides consulting and data development services focused on wetland mapping and classification, natural resource management and GIS technology. SMUMN GSS is a key partner with the U.S. Fish and Wildlife Service (USFWS) and other federal and state agencies working to provide comprehensive digital NWI for the conterminous United States and Alaska. SMUMN GSS was uniquely qualified to complete the project, having experience mapping wetlands in arid and semi-arid regions of the country. The project also relied on the collaborative input of local, regional and national wetland experts.

Project accomplishments include the completion of the NWI using the Wetlands Deepwater Habitats Classification (Cowardin et al. 1979) for all wetlands in the approximately 7-million-acre project area. Other tasks completed included the development and application of the LLWW classification tailored for arid region wetlands (Tiner 2011), riparian area classification (Dick et al. 2009), assignment of 12 potential functional attributes to appropriate wetlands, and the preliminary assignment of HGM wetland subclasses (after Brinson 1993). Each of these tasks satisfies wetland mapping standards established by the FGDC (FGDC 2009).

The utilization of geospatial concepts, map composition, metadata, aerial imagery, chart creation and geo-processing enhanced the completed project's products. This project provides the NMED SWQB Wetlands Program with new and improved tools to protect and restore New Mexico's remaining wetlands and riparian areas and to increase self-sustaining, naturally functioning wetlands and riparian areas for the benefit of water management in New Mexico. The information provided by this project also contributes to general watershed data for the State of New Mexico and to the development of mapping techniques for future wetland updates. This project can be used for more comprehensive water resource management and planning efforts or similar work that might be undertaken across New Mexico to improve knowledge of existing wetland areas and their functions. The project findings also provide significant support for other habitat and water quality initiatives across southern New Mexico's watersheds.

A riverine wetland within the MRG project study area (SMUMN GSS photo, April 2019).

Background

The purpose of this project was to map and classify wetlands (including deepwater habitats) and riparian areas of the MRG region in west-central New Mexico. The project area spans approximately 7 million acres, creating an irregular-shaped rectangle comprised of around 180 USGS 1:24,000 quadrangle equivalents (quads), excluding Native American tribal lands. The project area stretches from the Albuquerque area in the North to Elephant Butte Reservoir in the south, east just past Interstate 25 and west to the Zuni Mountains including portions of Torrance, Bernalillo, Valencia, Socorro, Catron, Cibola, McKinley, and Sandoval counties. It includes the Rio Grande from the town of Bernalillo to Elephant Butte Lake State Park.

Over 38,500 polygons representing wetlands greater than one-quarter acre in size (FDGC 2009) were mapped and classified, totaling 103,821 acres (162 sq mi). The polygonal wetland features and deepwater habitat features include marshes, floodplains, cienagas, lakes and ponds, playas, and rivers. Lastly, riparian polygon features are transition zones between rivers or lakes and upland; 3,697 features equaling approximately 42,730 acres (67 sq. mi) of riparian areas were captured. Figure 1 displays the wetland polygons and riparian areas in the MRG study area.

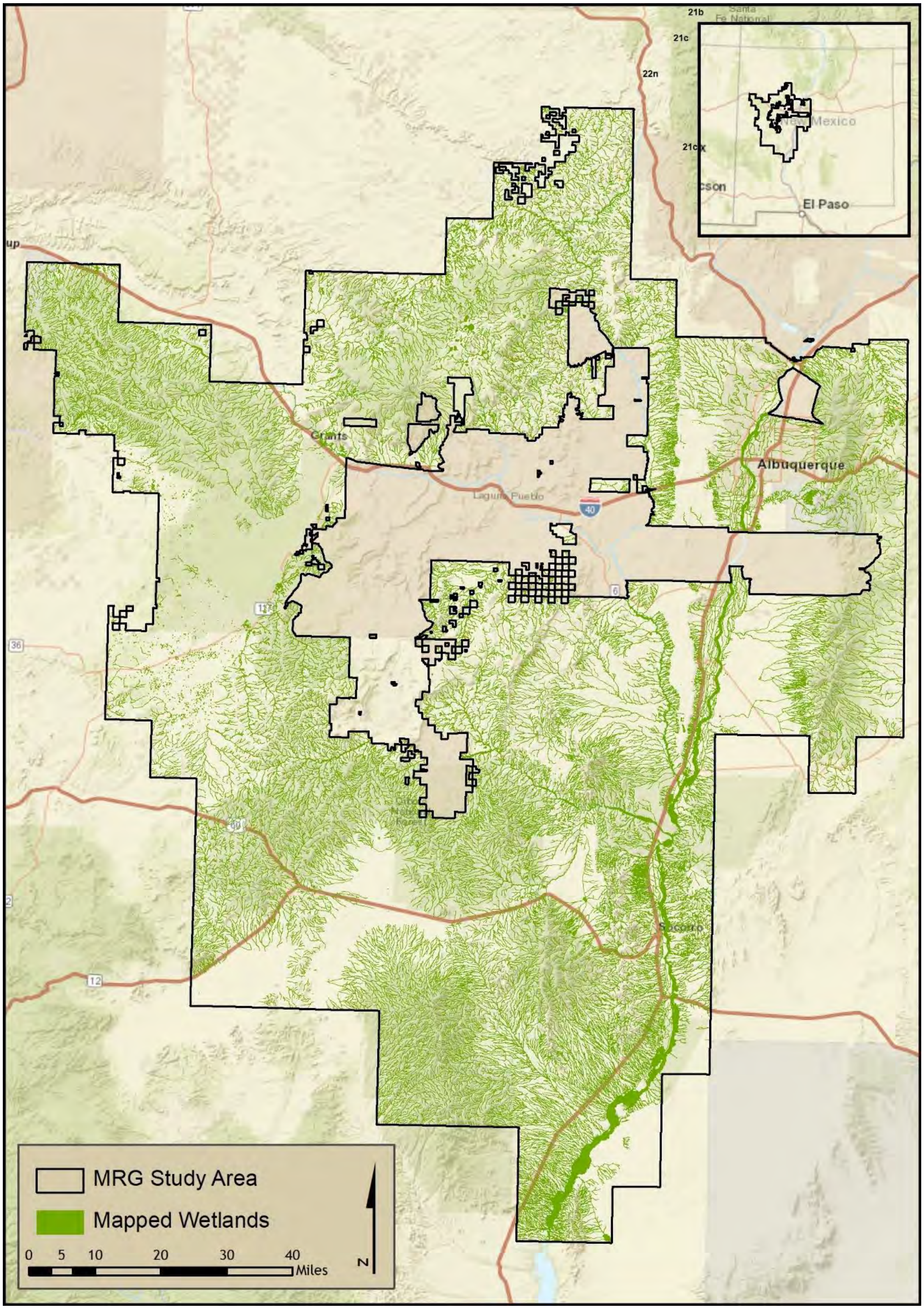

Figure 1. MRG study area with recently updated wetland features and riparian areas.

Geography

The topography of the project area ranges from the Manzano Mountains and the Rio Grande in the east, to the Zuni Mountains in the west, and the San Mateo Mountains in the south. It includes portions of three different physiographic provinces: the Colorado Plateau, Rio Grande Rift, and Mogollon Datil Volcanic Field (Figure 2; NMBGMR 2019). The Colorado Plateau covers the northwest portion of the state and of the MRG project area. It is characterized by relatively flat, colorful sedimentary rocks that have been shaped into mesas, buttes, and other erosive features by water over time. The Mogollon Datil Volcanic Field lies south of the Colorado Plateau consists of lavas and tuffs that erupted from volcanoes and calderas between 24 and 40 million years ago. The Rio Grande Rift is a north-to-south zone in the middle of the state that has formed as the Colorado Plateau "pulls away" from the High Plains province to the east, causing the earth's crust to stretch and thin (NMBGMR 2019). Large amounts of rift sediment have settled in the province's basins, forming critical aquifers for several large cities.

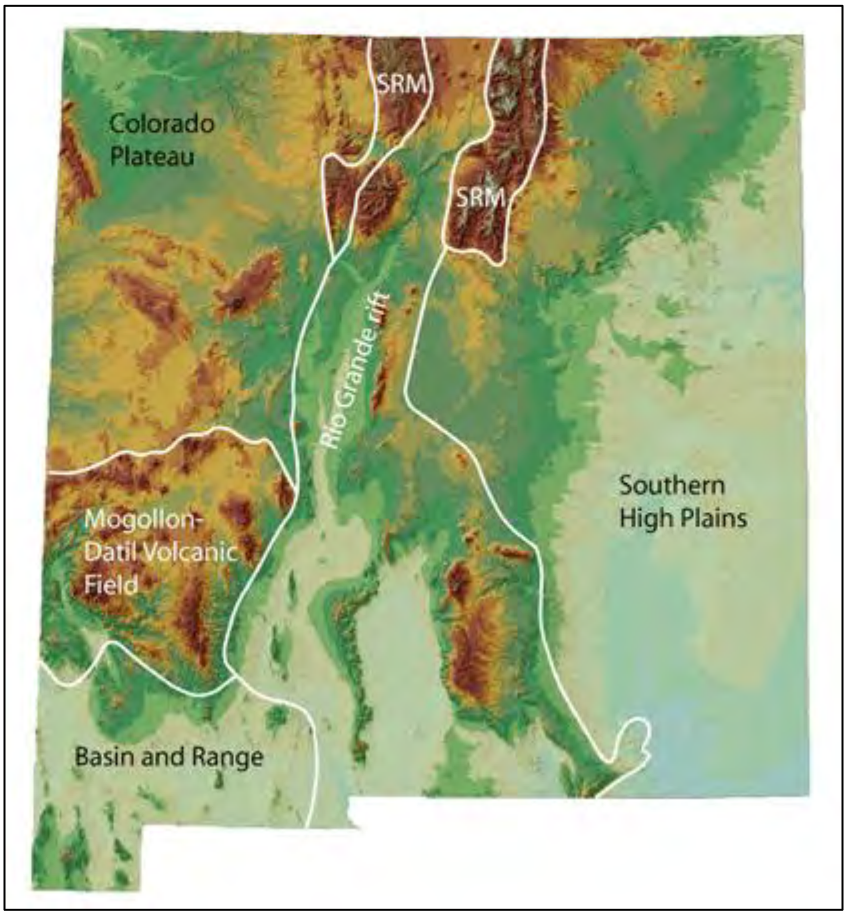

Figure 2. The physiographic provinces of New Mexico (NMBGMR 2019). SRM = Southern Rocky Mountains.

Watersheds (Subbasins)

The majority of the project area lies within the Rio Grande-Elephant Butte Basin (6-digit hydrologic unit code [HUC]), and is represented by 15 subbasins (8-digit HUCs): Arroyo Chico, Rio Puerco, Upper Puerco, Jemez, Rio San Jose, Zuni, Rio Grande-Albuquerque, Rio Grande-

Santa Fe, North Plains, Western Estancia, Carrizo Wash, Rio Salado, Plains of San Agustin, Elephant Butte Reservoir, and Jornada Del Muerto (Figure 3).

The Rio Grande-Elephant Butte Basin covers roughly 13 million acres in New Mexico. It includes the Rio Grande from the Los Alamos area to Elephant Butte Reservoir, near Truth or Consequences, New Mexico. The Rio Grande originates in southern Colorado and meanders south through New Mexico before entering Texas near El Paso.

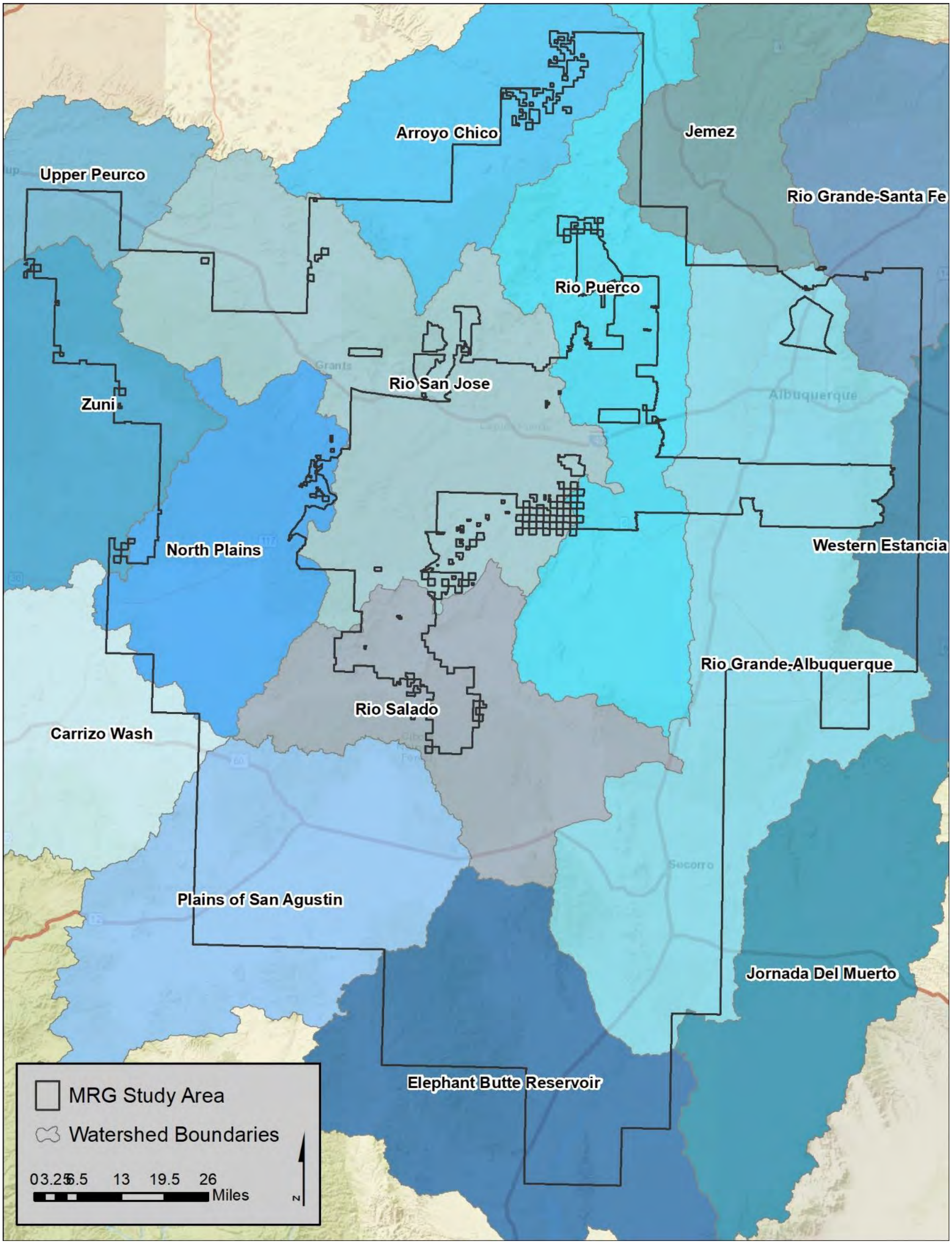

Figure 3. Watersheds (8-digit HUCs) in the MRG Study Area.

Climate
The climate of New Mexico is continental and relatively mild, with seasonal temperature variation, low relative humidity, and light precipitation totals (NM Climate Center 2019). Temperatures and precipitation in western New Mexico typically vary with elevation. Areas of higher elevation, such as the many mountain ranges, can receive substantially more precipitation than lower-lying areas. This is illustrated by 30-year climate normals (1980-2010) for localities in the region (Table 1). The town of Socorro, at a lower elevation in the southeastern portion of the study area, averaged 10.3 inches of annual precipitation and a mean annual temperature around 57°F. McGaffey, in the northwestern portion at nearly double the elevation of Socorro, averaged 20.7 inches of precipitation annually with a mean temperature around 44°F. Albuquerque, at a middle elevation on the eastern side of the study area, averaged 16.3 inches of precipitation annually and a mean temperature of 56°F.

Table 1. 30-year climate normals for towns within or near the Middle Rio Grande study area (NCDC 2019).

Town	Elevation (ft)	Mean days max ≥ 90°F	Mean days min ≤ 32°F	Annual mean (°F)	Total annual precipitation (in)
Socorro	4,585	61.1	123.5	56.6	10.3
Albuquerque (foothills)	6,270	38.1	97.1	55.6	16.3
McGaffey	8,000	3.0	205.1	44.4	20.7

Soil
Soil data provides valuable information to image interpreters during the wetland mapping and classification process. Of most importance was the consideration of hydric soils located in the project area which, along with certain vegetation, become indicators for wetland delineation and classification. Soils in the MRG project area can vary greatly due to factors such as elevation, underlying geology, and climate. The most common soils at lower elevations include aridisols and entisols. Aridisols, as the name implies, occur in dry climates and often contain accumulations of salt, gypsum, or carbonates (SSSA 2020). Entisols occur in areas of recently deposited sediments such as active floodplains, where there is little soil development beyond a topsoil horizon. At slightly higher elevations, mollisols become more common. These fertile grassland soils are often found in climates with pronounced dry seasons. Their surface soil horizons are typically dark from the annual accumulation of organic matter to the soil from plant roots (SSSA 2020). Other soils found in the project area include alfisols (typically under forests), vertisols (fertile, clay-rich), and inceptisols. According to NRCS soil mapping, 37 different soil types occur within the project area (NRCS 2012). The major soil types (by percent of total area) are presented in Table 2.

Table 2. Major soil types in the MRG project area (NRCS 2012).

Soil type	% of total area
Rockland-Torriorthents-Argiustolls	9.2
Torrifluvents-Calciorthids-Torriorthents	9.1
Haplargids-Calciorthids-Torripsamments	8.8
Haplustolls-Argiustolls-Rockland	8.3
Argiustolls-Haplargids-Rockland	6.4
Argiustolls-Rockland	5.4

Soil type	% of total area
Eutrboralfs-Argiborolls	5.2
Haplargids-Torriorthents	4.5
Argiborolls-Argiustolls-Rockland	3.9
Haplargids-Torripsamments	3.7
Torriorthents-Rockland	3.0
Torrifluvents-Haplargids-Haplustolls	2.7
Haplargids-Camborthids-Torriorthents	2.6
Haplargids-Argiustolls-Rockland	2.6
Argiborolls-Cryoborolls-Usorthents	2.5
Haplargids-Torrithents-Rockland	2.4
Calciorthids-Haplargids	2.4
Haplargids	2.3
Camborthids-Torriorthents	2.2
Lava Rockland	1.8
Rockland-Haplargids	1.5
Rockland-Torriorthents-Haplargids	1.5
Torriorthents-Torrifluvents-Badland	1.5
Haplargids-Rough Broken Land	1.5
Haplargids-Haplustolls-Argiborolls	1.2

Note: 12 additional soil types comprised less than 1% of the total study area.

Ecoregions

The MRG project area contains four Level III ecoregions: the Arizona/New Mexico Plateau, the Arizona/New Mexico Mountains, the Chihuahuan Deserts, and small portions of the Southwestern Tablelands. Within those Level III ecoregions, there are 16 Level IV ecoregions (Figure 4).

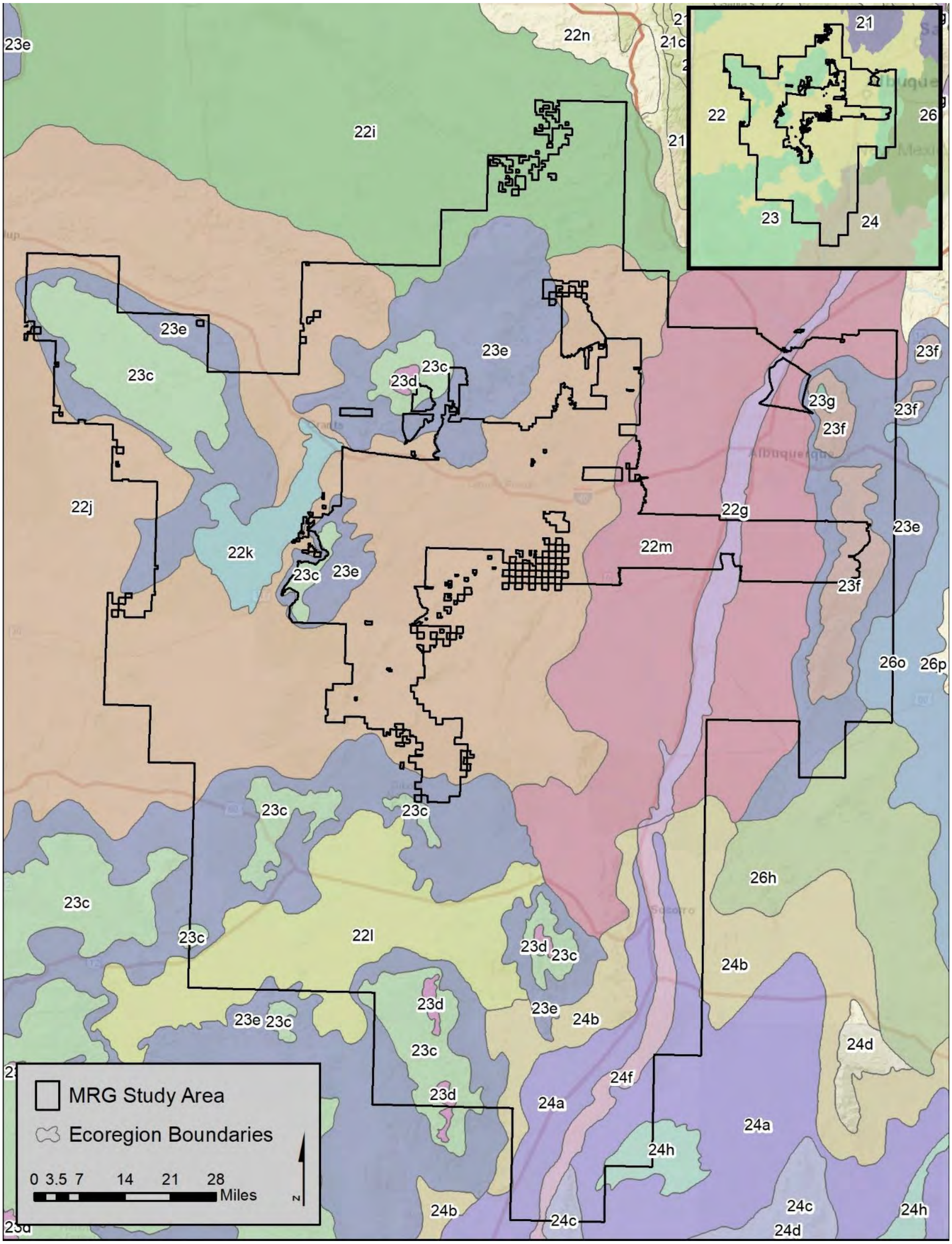

Figure 4. Level IV Ecoregions in the study area (main map) and Level III Ecoregions (small inset map). See next page for a key to ecoregion codes.

Level IV Ecoregions (*Main Map*)			
Code	Name	Code	Name
22g	Rio Grande Floodplain	24b	Chihuahuan Desert Grasslands
22i	San Juan/Chaco Tablelands & Mesas	24c	Low Mountains and Bajadas
22j	Semiarid Tablelands	24f	Rio Grande Floodplain
22k	Lava Malpais	24h	Lava Malpais
22l	Plains of San Agustin	26h	Pinyon-Juniper Woodlands & Savannas
22m	Albuquerque Basin	26o	Central New Mexico Plains
23c	Montane Conifer Forests	**Level III Ecoregions (Inset Map)**	
23d	Arizona/New Mexico Subalpine Forests	22	Arizona/New Mexico Plateau
23e	Conifer Woodlands & Savannas	23	Arizona/New Mexico Mountains
23f	Rocky Mountain Conifer Forests	24	Chihuahuan Deserts
23g	Rocky Mountain Subalpine Forests	26	Southwestern Tablelands
24a	Chihuahuan Basins and Playas		

The following descriptions of ecoregions come from Griffith et al. (2006).

<u>The Arizona/New Mexico Plateau (Ecoregion 22)</u>

The Arizona/New Mexico Plateau represents a large transitional region between the drier shrublands and wooded higher relief tablelands of the Colorado Plateaus in the north, the lower, hotter, less vegetated Mojave Basin and Range in the west, and forested mountain ecoregions that border the region on the northeast and south. Local relief in the region varies from a few feet on plains and mesa tops to well over 1,000 feet along tableland side slopes. The Continental Divide splits the region, but is not a prominent topographic feature. The region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley.

Level IV Ecoregions within the Arizona/New Mexico Plateau:

Rio Grande Floodplain (22g)

Once containing a perennially flowing, meandering, braided river, the Rio Grande Floodplain ecoregion has undergone many human alterations to its landscape and hydrology over the past 400 years. The once-shifting Rio Grande had mosaics of riparian woodlands and shrublands along with a variety of wetland meadows, ponds, and marshes. The gallery forest, or bosque, of cottonwood and willow with understories of coyote willow, New Mexico olive, false indigo, and seepwillow depended on this dynamic system. A long history of irrigation and drainage canals, levees and jetty jacks, and upstream dams have altered river flows and narrowed and straightened the stream channel. Conversion to cropland, orchards, small rural farms and ranchos, and urban and suburban uses have also altered the region. Cottonwood and willow, dependent on spring flooding, have been widely replaced by invasive saltcedar and Russian olive.

San Juan/Chaco Tablelands and Mesas (22i)

The San Juan/Chaco Tablelands and Mesas ecoregion of plateaus, valleys, and canyons contains a mix of desert scrub, semi-desert shrub-steppe, and semi-desert grasslands. Shadscale, fourwing saltbush, mormon tea, Indian ricegrass, galleta, and blue and black gramas are typical. It is more arid, has generally lower elevations, and less pinyon-juniper than the Semiarid Tablelands to the south or the Near-Rockies Valleys and Mesas to the east. It is mostly composed of gently dipping Tertiary and Cretaceous sedimentary rocks. Oil and gas production occurs mostly in the northern part of the region. It contains the upper reaches of the Rio Puerco, an area of severe erosion due to geology, topography, and human influences.

Semiarid Tablelands (22j)
The Semiarid Tablelands consists of mesas, plateaus, valleys, and canyons formed mostly from flat to gently dipping sedimentary rocks, along with some areas of Tertiary and Quaternary volcanic fields. The region contains areas of high relief and some low relief plains. Bedrock exposures are common. Grass, shrubs, and woodland cover the tablelands. The vegetation is not as sparse as in Ecoregion 22i to the north or 22m to the east. It lacks the denser pine forests of the higher and more mountainous Ecoregion 23. Scattered junipers occur on shallow, stony soils, and are dense in some areas. Pinyon-juniper woodland is also common in some areas. Saltbush species, alkali sacaton, sand dropseed, and mixed grama grasses occur.

Lava Malpais (22k)
Part of the much larger Zuni-Bandera volcanic field, the Lava Malpais covers some of the younger Holocene volcanic flows with the least soil development. The youngest flow, called the McCartys flow, dates from about 3,000 years ago. Different types of lava flows are found here, as well as lava tubes and ice caves. Some unique flora and fauna not found in surrounding areas occur here, and some species that are more widespread have made adaptations to survive in the specialized habitats here. The lava substrate has the ability in places to trap and retain moisture, allowing for a more mesophytic vegetation, such as stunted Douglas-fir and ponderosa pine, to occur in some areas. The region is an important area for understanding recent ecological successions, as well as longer term climatic changes.

Plains of San Agustin (22l)
The Plains of San Agustin are mostly a topographically closed basin, with some alluvial fans and piedmont slopes near the surrounding mountains of Ecoregion 23. Beach and lacustrine deposits mark various stages of Pleistocene Lake San Agustin. Clay to fine-grained sand lake bed sediments, linear beach-ridge sand deposits, and some sand sheets and dune sand deposits occur. The sandy areas are mostly stabilized by grasses and low shrubs. Vegetation of alkali sacaton, fourwing saltbush, and greasewood is found in the low areas. Some western wheatgrass, vine-mesquite, areas of blue grama and sand dropseed occur. Higher elevation slopes have some pinyon-juniper savanna with an understory of blue grama, dropseeds, Indian ricegrass, and bottlebrush squirreltail grasses. Livestock grazing is the predominant land use.

Albuquerque Basin (22m)
Part of one of the deeper physiographic basins of the Rio Grande rift, the Albuquerque Basin ecoregion is lower in elevation, drier, and warmer than surrounding ecoregions to the north, east, and west. The basin is filled with thick sediments of mostly Quaternary and some Tertiary age, with a few areas of volcanic rocks and lava-capped mesas. Extending from the La Bajada Escarpment on the north to near Socorro in the south, the region contains some diverse features and transitional characteristics. Unlike most of Ecoregion 22 which has mesic soils, the Albuquerque Basin has a largely thermic soil temperature regime. There is a mix of sand scrub and desert grassland vegetation. Native vegetation includes black grama, sand dropseed, mesa dropseed, blue grama, galleta, sand sage, alkali sacaton, threeawns, and scattered yucca. Juniper occurs primarily in the north. Urban and suburban land uses are spreading. The Santa Fe Group

aquifer, the drinking water source for Albuquerque and most of the Middle Rio Grande Valley, has seen some groundwater declines in recent years, along with increases in contaminants.

The Arizona/New Mexico Mountains (Ecoregion 23)
The Arizona/New Mexico Mountains are distinguished from neighboring mountainous ecoregions by their lower elevations and associated vegetation indicative of drier, warmer environments, due in part to the region's more southerly location. Forests of spruce, fir, and Douglas-fir, common in the Southern Rockies and the Wasatch and Uinta Mountains, are only found in limited areas at the highest elevations in this region. Chaparral is common at lower elevations in some areas, pinyon-juniper and oak woodlands are found at lower and middle elevations, and the higher elevations are mostly covered with open to dense ponderosa pine forests. These mountains are the northern extent of some Mexican plant and animal species. Surrounded by deserts or grasslands, these mountains in New Mexico can be considered biogeographical islands.

Level IV Ecoregions within the Arizona/New Mexico Mountains:

Montane Conifer Forests (23c)
The Montane Conifer Forests are found west of the Rio Grande at elevations from about 7,000 to 9,500 feet. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry. Some Douglas-fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. The influence of the Sierra Madre flora is seen mostly in the southern mountains and diminishes to the north. In the far south, other oaks appear, such as silverleaf oak, netleaf oak, Arizona white oak, and Emory oak. The summer rains are especially important for herbaceous plants. The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks. Endemic Gila trout occur in some of the region's streams. Livestock grazing, logging, and recreation are the primary land uses. Wildfire is an important feature influencing the forested ecosystems in this region.

Arizona/New Mexico Subalpine Forests (23d)
The Arizona/New Mexico Subalpine Forests occur west of the Rio Grande at the higher elevations, generally above 9500 feet. The region includes parts of the Mogollon Mountains, Black Range, San Mateo Mountains, Magdalena Mountains, and Mount Taylor. The peak elevations are mostly above 10,000 feet. Although there are some vegetational differences from mountain range to mountain range within Ecoregion 23d, the major forest trees include Engelmann spruce, corkbark fir, blue spruce, white fir, and aspen. Some Douglas-fir occurs at lower elevations. Cryic soils developed on the mixed geology of mostly Tertiary volcanics and Tertiary intrusives, with only minor areas of Precambrian rocks in the Black Range.

Conifer Woodlands and Savannas (23e)
The Conifer Woodlands and Savannas ecoregion is an area of mostly pinyon-juniper woodlands, with some ponderosa pine at higher elevations. It often intermingles with grasslands and shrublands. Although elevations are higher than surrounding Ecoregion 22 areas, the boundaries tend to be transitional. The region is generally cooler, with more uniform winter and summer seasonal moisture compared to the Madrean Lower Montane Woodlands at lower elevations. It also lacks the milder winters, wetter summers, chaparral, Madrean oaks, and other species of those montane woodlands.

Rocky Mountain Conifer Forests (23f)
The Rocky Mountain Conifer Forests are found at elevations from about 7,000 to 9,600 feet in the mountains east of the Rio Grande. With similarities to Ecoregion 23c, ponderosa pine and Gambel oak are common, with mountain mahogany and a dense understory. Some Douglas-fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. In the Sandia and Manzano Mountains, white fir and Douglas-fir are more extensive than in other parts of the region. Current forests have been shaped by fire and fire suppression. It differs from Ecoregion 23c by some of the flora, fauna, and water quality characteristics that more closely resemble the Southern Rockies. The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks.

Rocky Mountain Subalpine Forests (23g)
The Rocky Mountain Subalpine Forests ecoregion occurs east of the Rio Grande at high elevations, generally above 9,500 feet. It includes parts of the Sandia Mountains, Capitan Mountains, and Sierra Blanca. The peak elevations are mostly above 10,000 feet, with Sierra Blanca Peak nearing 12,000 feet. There are some differences in flora, fauna, geology, and water quality from the subalpine ecoregion (23d) to the west. The major forest trees include Engelmann spruce, corkbark fir, blue spruce, white fir, and aspen. Some Douglas-fir occurs at lower elevations. There are a few small inclusions of montane grassland. A mix of geology occurs in the region. Sierra Blanca and the Capitan Mountains are composed of Tertiary volcanics and Tertiary intrusives, while the Sandia Mountains to the north have a core of Precambrian rocks capped by Pennsylvanian sedimentary rocks.

<u>Chihuahuan Deserts (Ecoregion 24)</u>
This desert ecoregion extends from the Madrean Archipelago in southeast Arizona to the Edwards Plateau in south-central Texas. It is the northern portion of the southernmost desert in North America that extends more than 500 miles south into Mexico. The physiography is generally a continuation of basin and range terrain that is typical of the Mojave Basin and Range and the Central Basin and Range ecoregions to the west and north, although the pattern of alternating mountains and valleys is not as pronounced as in those Ecoregions. The mountain ranges (sky islands) are a geologic mix of Tertiary volcanic and intrusive granitic rocks, Paleozoic sedimentary layers, and some Precambrian granitic plutonic rocks. Outside the major river drainages, such as the Rio Grande and Pecos River, the landscape is largely internally drained. Vegetative cover is predominantly desert grassland and arid shrubland, except for high elevation islands of oak, juniper, and pinyon pine woodland. The extent of desert shrubland is increasing across lowlands and mountain foothills due to gradual desertification caused in part by historical grazing pressure.

Level IV Ecoregions within the Chihuahuan Deserts:

Chihuahuan Basins and Playas (24a)
The Chihuahuan Basins and Playas include alluvial fans, internally drained basins, and river valleys mostly below 4,500 feet. The major Chihuahuan basins formed during Tertiary Basin and Range tectonism when the Earth's crust stretched and fault collapse resulted in sediment-filled basins. These low elevation areas are some of the hottest and most arid habitats in the state. The playas and basin floors have saline or alkaline soils and areas of salt flats, dunes, and windblown sand. The typical desert shrubs and grasses, the dominant creosotebush, along with tarbush,

fourwing saltbush, acacias, gyp grama, and alkali sacaton, must withstand large seasonal and diurnal ranges in temperature, low available moisture, and a high evapotranspiration rate. Horse crippler and other cacti are common. Bitter Lake near Roswell is a biologically significant wetland area. It has a high diversity of dragonflies and damselflies, including the continent's largest and smallest dragonfly species.

Chihuahuan Desert Grasslands (24b)
The Chihuahuan Desert Grasslands occur in areas of fine-textured soils, such as silts and clays, that have a higher water retention capacity than coarse-textured, rocky soil. The grasslands occur in areas of somewhat higher annual precipitation (10 to 15 inches) than the Chihuahuan Basins and Playas (24a), such as elevated basins between mountain ranges, low mountain benches and plateau tops, and northfacing mountain slopes. Grasslands were once more widespread, but heavy grazing in the late 19th and early 20th centuries was unsustainable, and desert shrubs invaded where the grass cover became fragmented. In grassland areas with lower rainfall, areal coverage of grasses may be sparse, 10% or less. Some areas are now mostly shrubs as grasslands continue to decline due to erosion, drought, and climatic change. Typical grasses are black, blue, and sideoats grama, dropseeds, bush muhly, and tobosa, with scattered creosotebush, and prickly pear and cholla cacti.

Low Mountains and Bajadas (24c)
The Low Mountains and Bajadas include several disjunct hilly areas that have a mixed geology. The mountainous terrain has shallow soil, exposed bedrock, and coarse rocky substrates. Alluvial fans of rubble, sand, and gravel build at the base of the mountains and often coalesce to form bajadas. Vegetation includes mostly desert shrubs, such as sotol, lechuguilla, yucca, ocotillo, lotebush, tarbush, and pricklypear, with a sparse intervening cover of black grama and other grasses. At higher elevations, there may be scattered one-seeded juniper and pinyon pine. Strips of gray oak, velvet ash, and little walnut etch the patterns of intermittent and ephemeral drainages, and oaks may spread up north-facing slopes from the riparian zones.

Rio Grande Floodplain (24f)
The Chihuahuan Desert portion of the Rio Grande Floodplain has some similarities to Ecoregion 22g upstream. Hydrology has been altered by upstream impoundments, by Elephant Butte and Caballo reservoirs, and by channelization in this region. Annual flooding of terraces and benches has been eliminated. Riparian woodlands and shrublands have been greatly reduced and invasive salt cedar has expanded. Narrow bands of cropland, orchards, vineyards, and small farms occur in portions of this ecoregion. The southern Rio Grande valley in New Mexico is still an important wintering area for sandhill cranes, snow geese, and other migratory waterfowl. Urban land uses are spreading in the Las Cruces and El Paso areas. Drought, aquifer depletion, and agricultural irrigation create water supply concerns in Texas and Mexico.

Lava Malpais (24h)
The Lava Malpais region includes three separate areas: the impressively long Carrizozo Lava flow in the northern part of the Tularosa Basin, an area of Quaternary lava in the Jornada del Muerto, and, in the south, the Aden-Afton basalt flow. The Carrizozo lava, one of the younger volcanic features in New Mexico, flowed from a small cinder cone or vent called Little Black Peak, located at the northern end. Pahoehoe lava texture, collapse pits, lava tubes, and other

volcanic features are found here. Mixed shrubs and grasses occur on the lava, taking advantage of available moisture and warmer ground temperatures created by solar absorption.

Southwestern Tablelands (Ecoregion 26)
The Southwestern Tablelands flank the High Plains (25) with red hued canyons, mesas, badlands, and dissected river breaks. Unlike most adjacent Great Plains ecological regions, little of the Southwestern Tablelands is in cropland. Much of this region is in sub-humid grassland and semiarid rangeland. The eastern boundary represents a transition from the more extensive cropland within the High Plains (25) to the generally more rugged and less arable land within the Southwestern Tablelands (26) ecoregion. The natural vegetation in this region is mostly grama-buffalograss, with some juniper-scrub oak-grass savanna on escarpment bluffs. Prairie fires were likely important in maintaining the grasslands and suppressing encroachment of shrub and woody species. Pronghorn antelope is the most common large native mammal of the region.

Level IV Ecoregions within the Southwestern Tablelands:

Pinyon-Juniper Woodlands and Savannas (26h)
Scattered, dissected areas with pinyon and juniper woodlands on the uplands characterize the Pinyon-Juniper Woodlands and Savannas ecoregion. Occurring in Colorado and New Mexico, the region is a continuation or an outlier of the pinyon-juniper woodlands found in Ecoregion 21d in the Southern Rockies (21). Soils tend to be thin, and for most of the region are formed in materials weathered from limestone, sandstone, and shale. Rock outcrops are common. In central New Mexico, much of the region is often associated with the Paleozoic Glorieta Sandstone and other limestone and shale rocks. In the north, the region includes a few hills and peaks of volcanic or mixed geology that have some small areas of montane coniferous forest. Annual precipitation in the New Mexico portion ranges from 12 to 16 inches, with the highest precipitation found in areas closest to the mountains. Land use is primarily wildlife habitat and rangeland.

Central New Mexico Plains (26o)
The Central New Mexico Plains are slightly drier than Ecoregion 26n to the east, with more shortgrass steppe and less midgrass prairie. It has generally higher elevations and more mesic soils than the somewhat lower elevations and thermic soils of 26n. The region is composed of mostly Permian rocks compared to the Triassic materials of Ecoregion 26n. Livestock grazing is the dominant land use. Pronghorn antelope are common as well as coyote and a variety of raptors.

Land Ownership and Use
The land in the MRG project area is divided between public and private (including Native American) ownership. The majority of public lands in the study area are managed by the BLM and the U.S. Forest Service (USFS) (Figure 5). The remaining public land is owned by the New Mexico state government, the National Park Service (NPS), the USFWS, and the Department of Defense (DOD). Much of the forested land in the project area lies in the Cibola National Forest, under USFS management.

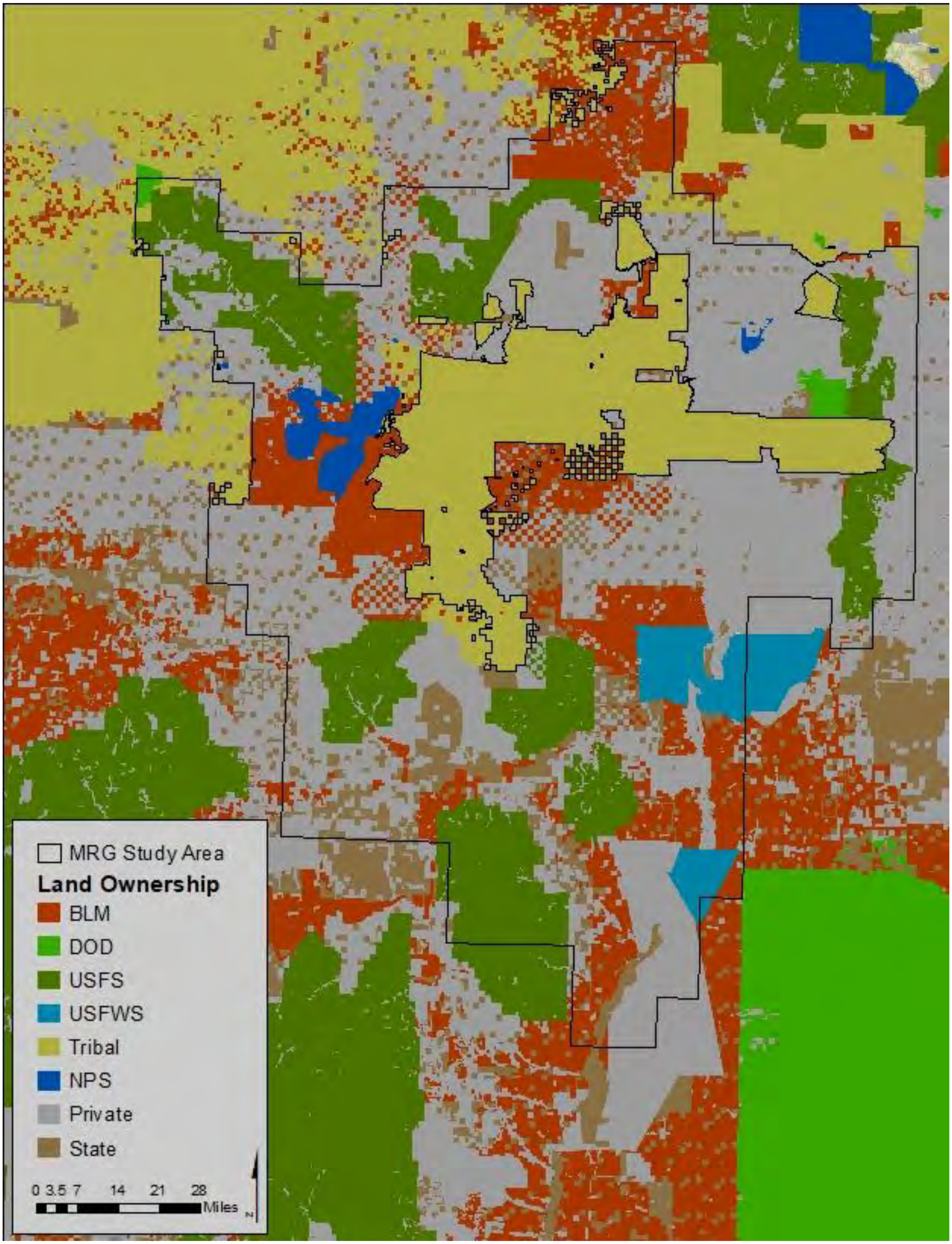

Figure 5. Land ownership in the MRG project area (BLM 2021).

As of 2016, the most common land cover types in the project area were shrub/scrub (60%) and evergreen forest (24%) (USGS 2019). Herbaceous cover accounts for nearly 11% of all lands and is more common in the southern portion of the MRG area. Developed lands cover just 3% of the MRG study area, mainly in and around Albuquerque. Agricultural uses (pasture, hay, crops) account for <1% of land cover, primarily concentrated along the Rio Grande in the eastern portion of the project area (USGS 2019). A generalized land cover/land use map of the study area is provided in Figure 6.

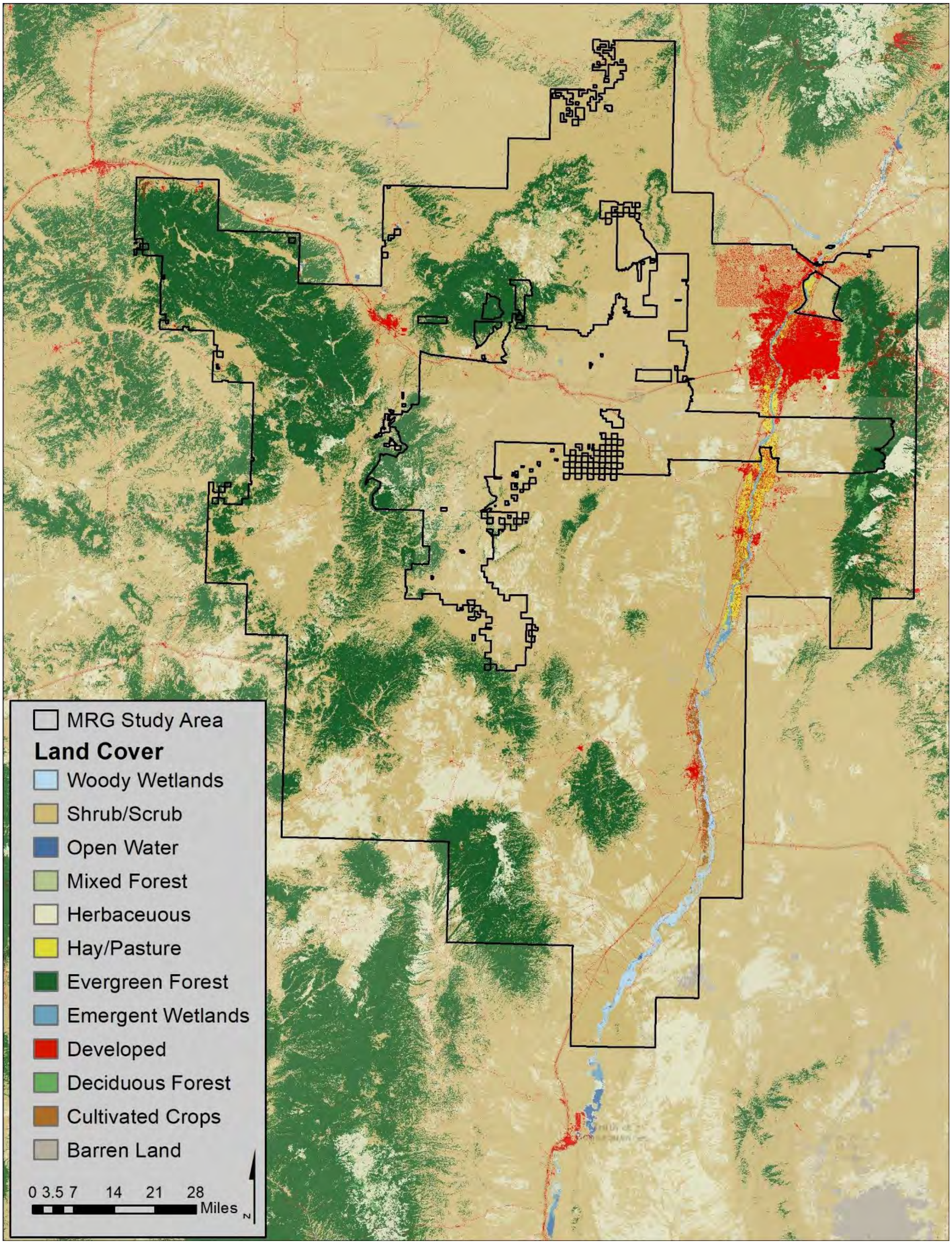

Figure 6. Land cover in the MRG project area, 2016 (USGS 2019).

Wetland Mapping and Classification Systems

Geographic Information Systems technology has allowed wetland mapping to advance from hard copy maps drawn directly on reproducible Mylar film to large, searchable geodatabases able to satisfy any number of user queries. Currently, wetlands are mapped by highly trained image interpreters using on-screen digitizing methods. Aerial imagery serves as a base map and is combined with collateral data such as soils, topographic, hydrologic, and land cover information, allowing a skilled interpreter to make informed wetland mapping and classification determinations. The use of a GIS geodatabase structure provides the advantage of being able to assign any number of attributes (and any number of classification systems) to characterize wetland features. How various wetland attributes are assigned is dependent on the particular classification system in use. In the case of the Mapping and Classification of Wetlands in the Middle Rio Grande Region, New Mexico, three classification systems are relevant (Appendix A, B): The Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979); Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Water body Type Descriptors (LLWW) (Tiner 2011), and A System for Mapping Riparian Areas in the Western United States (Dick et al. 2009).

Notation for the Reader:

> Classification codes are provided throughout the document for the purposes of review. Conventions on wetland code notations in this report are as follows: The Wetlands and Deepwater Habitats Classification System (Cowardin et al. 1979) codes are *italicized*; Dichotomous Keys and Mapping Codes for Landscape Position, Landform, Water Flow Path, and Water body Type Descriptors (LLWW) are <u>*italicized and underlined*</u>; codes for A System for Mapping Riparian Areas in the Western United States are **bolded.** The "%" character is a placeholder or 'wildcard' indicating various options might be used. The following information summarizes the wetland classification systems applied to the mapped project area in New Mexico.

National Wetlands Inventory (NWI)

The USFWS is responsible for the development and management of the NWI, an ongoing national program. The National Wetlands Classification System (Wetlands and Deepwater Habitats Classification, Cowardin et al. 1979) was adopted by the NWI program in 1996 and is used for wetland mapping across the country for conservation purposes. Any partner providing mapping services for the NWI must also adhere to the NWI Data Collection Requirements and Procedures for Mapping Wetland, Deepwater and Related Habitats for the United States implemented in 2009. This program satisfies the federal standard for wetland mapping and classification adopted by the FGDC in 2009 (FGDC 2009).

A wetland is defined by the NWI Program as land supporting hydrophytic plant communities, land with hydric soils, or land where the water table is at or near the surface for part of the year. If one or more of these conditions are met, the area can be identified as a wetland. The Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) separates wetlands into Systems, and further divides these Systems into Subsystems, Classes, Subclasses, Water Regimes and Modifiers.

Alphanumeric codes representing the classification of each wetland mapped are assigned and stored in the geodatabase. This information provides descriptions about the wetland, the water regime, plant communities, alterations by humans or wildlife, and surface hydrology.

With the use of current and high-resolution aerial photography, the presence of hydrophytic vegetation becomes a dominant factor in identifying and classifying wetlands. Collateral data is also used to aid in classification and normally consists of soils, topographic, and land cover data. Soil data, for example, provides information on the location of hydric soils while topographic data provides insight into surface hydrology. Collateral data is important especially when mapping semi-arid regions such as those found in the project area of New Mexico.

The Wetlands and Deepwater Habitats Classification used for the NWI describes wetland characteristics in a hierarchal order including:

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

The classification index first defines wetlands in the broadest sense by identifying their System with a single uppercase alphabetic (letter) code. There are five Systems: *M* (Marine), *E* (Estuarine), *L* (Lacustrine), *R* (Riverine), and *P* (Palustrine). Of these, only the latter three apply to the project study area in New Mexico (the first two refer to coastal and offshore saltwater environments).

The *R* (Riverine System) (Figure 7) includes deepwater habitats and mostly non-vegetated wetlands contained in natural or artificial channels periodically or continuously containing flowing water or which form a connecting link between the two bodies of standing water. Three out of five of the Subsystems from the *R* (Riverine) System were found in the New Mexico project area. These include *R2* (Lower Perennial), *R3* (Upper Perennial), and *R4* (Intermittent). Examples include rivers, streams, creeks, arroyos, washes, or ditches.

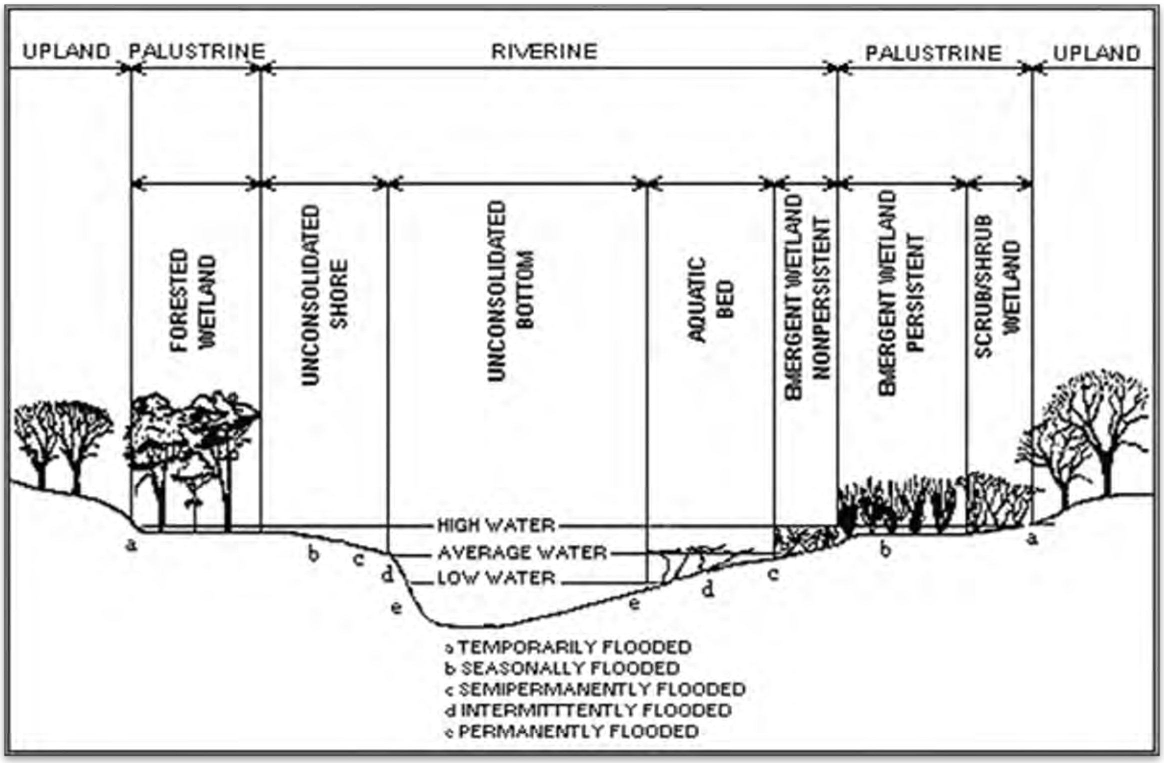

Figure 7. Diagram of a riverine system with the appropriate Cowardin et al. (1979) associations.

The *L* (Lacustrine System) (Figure 8), includes wetlands and deepwater habitats defined by all of the following characteristics: 1) deep water situated in a topographic depression or a dammed river channel, area of wetland lacking trees, shrubs, or persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; 2) wetland area exceeding 20 acres; or 3) total wetland area less than 20 acres but deeper than 6.6 meters at low water. There are two Subsystems in the Lacustrine System: *L1* (Limnetic) and *L2* (Littoral). Wetland examples include lakes, reservoirs, or intermittent lakes such as playa lakes unique to the region.

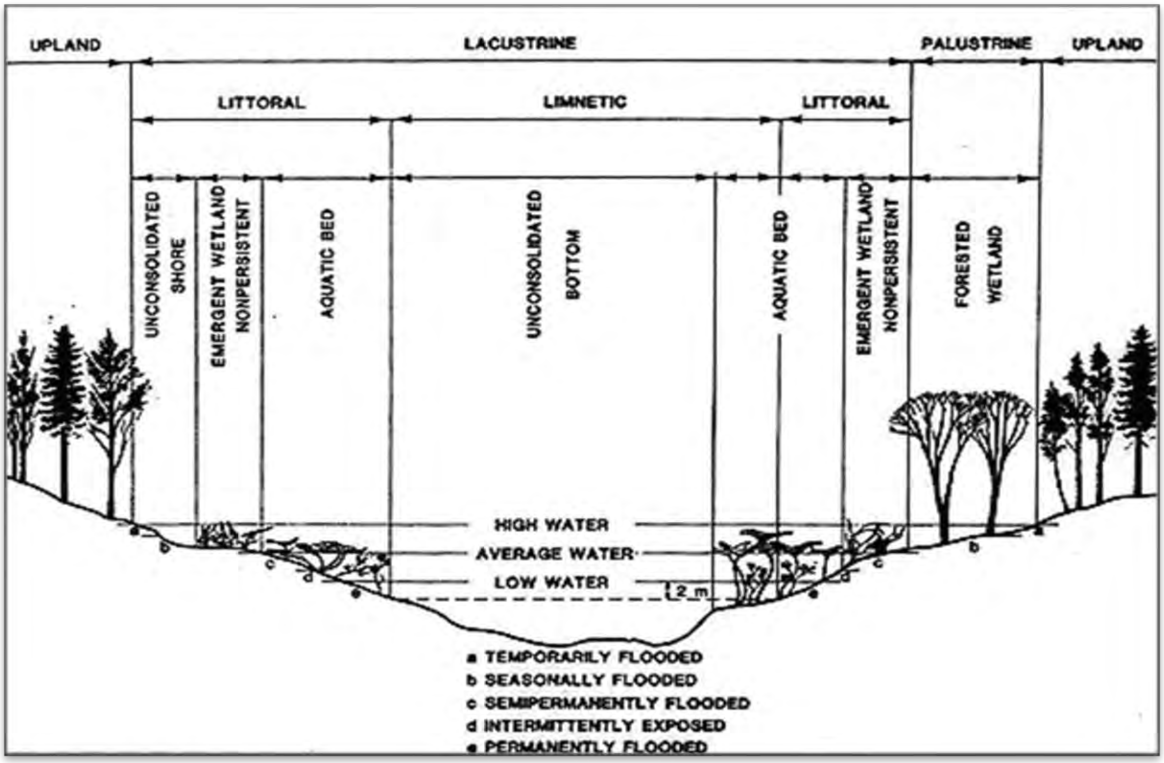

Figure 8. Diagram of a lacustrine system with the appropriate Cowardin et al. (1979) associations.

The *P* (Palustrine System) (Figure 9) includes all non-tidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all wetlands that occur in tidal areas where salinity due to ocean-derived salt is below 0.5 ppt. An estimated 95% of all wetlands in the U.S. are freshwater, palustrine wetlands, and will predominate in most wetland mapping efforts. There are no Subsystems in the Palustrine System. Examples of Palustrine wetlands found in the New Mexico project area include flooded basins, marshes, swamps, vegetated floodplains, cienegas, and ponds.

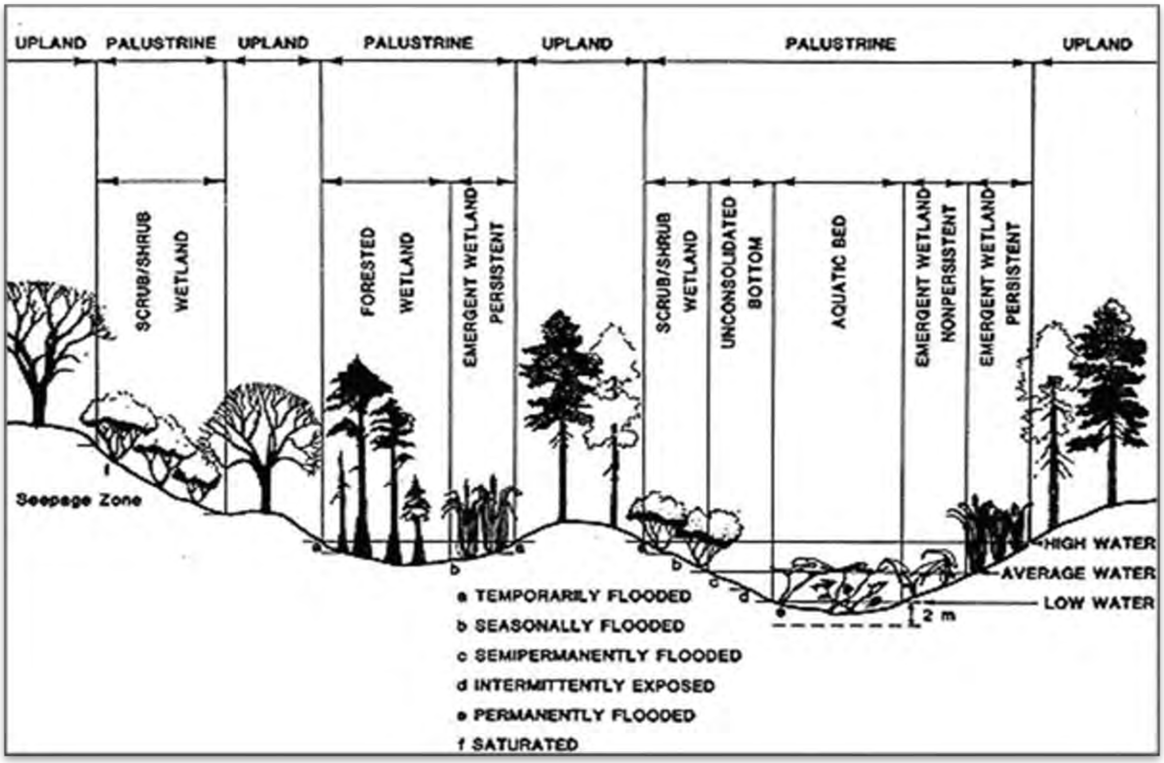

Figure 9. Diagram of a palustrine system with the appropriate Cowardin et al. (1979) associations.

After the System and Subsystem are classified, a Class is assigned, which is denoted by a two-letter uppercase letter code referring to the dominant vegetation or substrate type. Examples of Classes for the project area include *UB* (Unconsolidated Bottom), *EM* (Emergent Vegetation), and *FO* (Forested). It is possible to have dual Classes assigned; these are separated and notated in the alphanumeric code with a slash "/".

The Subclass, while similar to a Subsystem, refers to a more specific type within the wetland Class and is coded with a single number. For example, the code *FO1* refers to broad-leaved deciduous forest while *FO4* refers to needle-leaved evergreen forest.

The meaning of a Subsystem code is dependent upon the particular System to which it is being applied. Similarly, the meaning of the Subclass is dependent on the Class to which it is being applied. Often times a wetland code is not classified to the Subclass level. In this case, there is no number representing a Subclass after the Class code itself.

There are several Modifiers in the classification system that may be applied to a wetland classification at the Class (or lower level) in the hierarchy. Modifiers include Water Regime, Special Modifiers, Water Chemistry, and Soil. Within these Modifiers are additional codes which describe the wetland in more detail. The Water Regime Modifier is sometimes referred to as the "hydrologic" Modifier. It consists of a single uppercase letter and encodes hydrologic information such as flooding frequency. The Water Regime Modifier is only applied during the growing season, because flooding during the dormant season does not significantly affect the vegetation that is present. The *B* (Seasonally Saturated) Water Regime is often used to classify hydric soils. Water Regimes include, in order of ascending wetness, *A* (Temporarily Flooded), *B* (Seasonally Saturated), *C* (Seasonally Flooded), *D* (Continuously Saturated), *E* (Seasonally Flooded/Saturated), *F* (Semipermanently Flooded), *G* (Intermittently Exposed), *H* (Permanently Flooded), *J* (Intermittently Flooded), and *K* (Artificially Flooded).

The Modifiers-Special Modifiers are notated as a single lower case letter. This code characterizes very specific physical conditions within a wetland including *b* (Beaver), *d* (Partly Drained/Ditched), *f* (Farmed), *h* (Diked/Impounded), *r* (Artificial), *s* (Spoils) or *x* (Excavated). The *x* (Excavated) and *h* (Diked/Impounded) codes from the Modifiers-Special Modifiers are most commonly applied because their presence is usually interpretable from aerial imagery.

The Modifiers-Water Chemistry indicate pH modifiers for fresh water. An example of the Water Chemistry modifier applied to the project area included the (*i*) alkaline code.

The Modifiers-Soil identify the presence of either *g* (organic) or *m* (mineral) soil conditions in a wetland.

A common characteristic of NWI classification data is that not all special modifiers are regularly used and that the lack of a special modifier does not necessarily mean that a particular condition does not exist in that wetland. This is especially true of Modifiers-Water Chemistry and Modifiers-Soil codes where interpretive limitations exist. It is also possible to have more than one special modifier attached to a wetland. As aerial imagery resolution improves and the availability of digital collateral data increases, the application of Modifiers in wetland mapping projects is increasing.

To help further illustrate the coding for the Wetlands and Deepwater Habitats Classification, (Cowardin et al. 1979), the following codes for various wetlands found in the project area are provided as examples:

PEM1Cx (Palustrine, Persistent Emergent, Seasonally Flooded, Excavated): these include wetlands with herbaceous, rooted hydrophytic vegetation that is present for most of the growing season in most years. Surface water is present for extended periods, especially early in the growing season, but is absent by the end of the growing season in most years. The wetland lies within a basin that has been artificially deepened by humans.

R4SB3J (Riverine, Intermittent, Streambed, Cobble-Gravel, Intermittently Flooded): these areas are dry wash linear channels. They appear white (or lighter) in aerial photography, indicating the presence of sand, stones or bedrock.

L1UBHh (Lacustrine, Littoral, Unconsolidated Bottom, Permanently Flooded, Impounded): these are open water areas within reservoirs that were flooded at the date of the photograph acquisition. They are deeper than two meters and the total area of any of these reservoirs is greater than 20 acres.

Landscape Position, Landform, Water Flow Path & Water Body Classification (LLWW)

The applicability of NWI data for planning and decision support, especially related to wetland functional assessment, can be enhanced through the addition of hydrogeomorphic (HGM) descriptors to the wetland geodatabase. In recognition of this fact, the USFWS has developed a

HGM classification system that is complimentary to the national wetlands classification system (Wetlands and Deepwater Habitats Classification, Cowardin et al. 1979) and describes abiotic and landscape features such as Landscape Position (L), Landform (L), Water Flow Path (W) and Water body Type (W) or LLWW. This classification system is sometimes called ‘NWI Plus’ because of its relationship to the NWI; however, for clarity in this report it is referenced as “LLWW”.

LLWW is not based on vegetation as indicators, but instead classifies wetlands and water bodies with the area’s landscape position and hydrologic characteristics, which are more permanent on the earth’s surface. In a similar manner to the Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979), the LLWW system uses alphanumeric codes to describe wetland characteristics. The LLWW classification makes a distinction between wetlands and water bodies. Wetlands are vegetated, while water bodies are deep water habitats. The coding syntax can actually take two slightly different forms, depending on whether the feature is being classified as a wetland or a water body. Vegetated wetlands, such as marshes, wet meadows, and non-vegetated substrates that are periodically exposed (e.g., mud flats), are first classified using the wetland Landscape Position and Landform codes identified below. The LLWW code (noted here in italics and underlined) is expressed *Landscape Position, Landform, Water Flow Path, Modifier(s).*

In the LLWW system, *Landscape Position* is denoted as an uppercase two-letter code and describes whether the wetland is associated with a lake, a river, or is surrounded by uplands. There are also classifications for marine and coastal areas that do not apply in the case of the New Mexico study area. Wetlands associated with lakes are defined as *LE* (Lentic). Wetlands associated with flowing water are classified as *LS* (Lotic Stream) or *LR* (Lotic River), depending upon their size. Wetlands that are surrounded by upland as part of an isolated basin are classified as *TE* (Terrene). In LLWW, the Landscape Position can be more specifically classified using a hierarchal combination of lowercase letters and numbers similar to the subsystem or subclass in the NWI classification system. The modifying codes are dependent on the Landscape Position code to which they are being applied.

The second portion of the LLWW code is *Landform*. This code is made up of two uppercase letters which can be classified more specifically with the addition of codes consisting of two lower case letters. Landform refers to the geomorphic structure on or in which the wetland resides. While both coastal and inland Landforms are defined in LLWW, only inland Landforms are present in the current study area. Landform codes include *SL* (Slope), *FR* (Fringe), *FP* (Floodplain), *BA* (Basin), and *FL* (Flat). Further classification of each Landform code may occur by adding an additional lowercase two-letter code. For example, a *FR* (Fringe) wetland associated with a *pd* (Pond) would be coded as *FRpd*. Lowercase codes only apply to specific Landform types, and although there is no repetition in codes between the Landforms, the Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors (Tiner 2011) should be consulted so that valid codes are accurately applied.

There are also *Water Flow Path* and *Other Modifier* codes within the LLWW schema. Since these are the same for both wetlands and water bodies, the Waterbody Type coding schema will be addressed first.

In LLWW, the *Waterbody Type* consists of an uppercase two-letter code. There are six water body types, two coastal and four inland. All four of the inland types are present in the study area of New Mexico: *LK* (lake), *RV* (River), *PD* (Pond), and *ST* (Stream). Additional codes consisting of a number followed by a lowercase letter may be added to further specify the water body's characteristics. For example, a woodland pond surrounded by uplands might be classified as *PD1c* (Pond, natural, woodland-dryland). When a wetland feature is classified as a Waterbody Type there is no Landform code applied; the wetland is considered to be its own Landform.

The next component of the code is *Water Flow Path*, which applies to both wetlands and water bodies as defined by LLWW. Water Flow Path refers to how and if the feature is part of the surface hydrology network. Common codes for Water Flow Path include *TH* (Throughflow), *IN* (Inflow), and *OU* (Outflow). Wetlands that are not directly connected to the surface hydrology network are classified as *VR* (Vertical Flow). Most of the Water Flow Path codes are the same for both wetlands and water bodies but there are some small differences. As a result, reference materials need to be consulted to assure that appropriate codes are consistently applied. It should be emphasized that the LLWW classification can only consider surface hydrology. Subsurface hydrologic connectivity is not considered because these characteristics cannot be assessed through image interpretation.

Finally, the LLWW code includes *Other Modifiers*. These modifier codes consist of two lower case letters. Other Modifiers are used to encode very specific conditions, and more than one modifier may be used. Common examples are *br* (barren of vegetation) or the *hw* (headwater) modifier. Again, there are some differences in which modifiers can be applied to wetlands versus those applied to water bodies.

LLWW codes can vary in length from five characters up to 14 or more characters, depending on how many modifiers are applied. Examples of LLWW codes classified in the MRG study area are provided below.

Example LLWW codes for wetland features found in the project area:

- *LS2BATHsf*: this *LS2* (middle gradient lotic stream) is in a *BA* (basin) with *TH* (Throughflow). It is fed by a spring (*sf*).

- *RV2TH*: this *RV2* (middle gradient river) in New Mexico is usually connected upstream to headwater features and is downstream to a larger river network or wetland complex with *TH* (Throughflow). This stream or river has portions of riffles or rapids and is represented by such NWI (Cowardin et al. 1979) attributes as *R2RBG*.

- *ST3TIar*: this *ST3* (high gradient stream) has *TI* (Intermittent Throughflow). The wetland feature includes a wash or gulch that temporarily or seasonally fills then flows after sufficient rain. This is known as an arroyo (*ar*) and the wetland is typically attributed as *R4SB3J* in the NWI (Cowardin et al. 1979) classification system.

- *LR2FPbaTH*: a basin wetland associated with a *LR2* (middle gradient river) and a *FP* (Floodplain). The feature has *TH* (Throughflow). This means that the river floods the banks therefore enters and leaves the wetland structure. Cattail or willow marshes with river flooding access are NWI examples of this type of wetland. These might be coded as *PEM1F* or *PSS1C* in the NWI (Cowardin et al. 1979) system.

- *LS3FPflTI*: this polygon shaped wetland is alongside a LS3 (Lotic Stream, high gradient). The landscape is FP (Floodplain) with TI (Throughflow - Intermittent). *PEM1A, PFO1A*, or *PSS1A* are possible NWI attributes.

- *PD2OU*: this code refers to a small, impounded Waterbody *PD2* (Pond) with water flowing OU (Outflow) of the pond. *PUBGh* is an example NWI code related to this LLWW code.

- *TEBAVRhi*: this code refers to a *TE* (Terrene) wetland surrounded by uplands. It is in a BA (basin), and due to the wetland being disconnected from the surface hydrology network it is given the *VR* (Vertical Flow) Water Flow Path codes. The feature is an artificial structure *hi* (modified for human use, such as an excavation).

- *TESLOUdshw*: this attribute is for a *TE* (Terrene) feature that is surrounded by uplands. The Landscape Position is *SL* (Slope), causing *OU* (Outflow) into a larger terrene complex or possibly *ds* (discharges into a stream via seepage from the saturated wetland). An *hw* (headwater) wetland is one that provides a continual, perennial source of water for all other wetlands downstream. Headwaters are also known as first or second order streams, or may be wetlands adjacent to first and second order streams. These streams connect to a larger river network or complex downstream. *PEM1D* is a common NWI attribution for this type of wetland.

- *TEFLIN*: this code refers to a *TE* (Terrene) wetland surrounded by uplands. They are located in a *FL* (Flat) landscape with *IN* (Inflow) of water. Examples of NWI codes for this wetland type are *PEM1Ai* or *PEM1Ji*.

- *TEBAplVR*: this code refers to a *TE* (Terrene) wetland that is *BA* (basin-shaped). This complex is a *pl* (playa) wetland and it has *VR* (Vertical Flow). Examples of NWI codes for this wetland type are *PUS3C* or *PUS2A.*

Wetland Functional Assessment

Natural chemical, biological, and physical processes occur in wetland environments, providing specific functions that contribute to broader ecosystem health. These wetland functions provide specific goods and services, depending on the conditions and processes that are present. An objective for this project was to extend traditional wetland mapping by developing wetland classes and subclasses according to HGM characteristics and then to correlate LLWW descriptors and metrics to established wetland functions. The development of functional metrics for wetlands in the project area was completed in collaboration with state and federal wetland experts using their collective best professional judgment. The result was a correlation table of mapped wetland characteristics and their functional metrics for the project area (Appendix C).

Unique to New Mexico's geographic region, wetland functions established for the project area included Surface Water Detention; Streamflow Maintenance; Groundwater Recharge; Nutrient Transformation; Carbon Sequestration; Sediment and Other Particulate Retention; Bank and

Shoreline Stabilization; Fish Habitat; Aquatic Invertebrate Habitat; Waterfowl and Waterbird Habitat; Other Wildlife Habitat; and Unique, Uncommon, or Highly Diverse Wetland Plant Communities Function.

Some wetland types in the project area were found to perform more than one function while others provided only a single, particular function. Upon analysis, and in consensus with the project team, certain wetlands were also classified as either highly or moderately performing a given function(s) relative to other wetlands in the project area. The correlation table developed by the project team established specific codes and conditions that allowed for extensive geospatial analysis of wetland functions for the project area. The criteria, codes, and conditions were summarized for each wetland function that was identified for the project area.

The completion of the mapping and classification of the project area, including the wetland functional assessment, will serve as a link to other wetland assessments, such as a Level 2 Rapid Wetlands Assessment Method or Level 3 Intensive Site Assessment, as desired in the future. All of the reviewed wetland classification codes combined within current GIS technology will allow stakeholders to query large spatial data sets and to determine the functionality of wetlands on a landscape scale.

A System for Mapping Riparian Areas in the Western United States

One of the requirements for the project was to delineate and classify riparian wetlands in the project area using technical procedures outlined by the USFWS for mapping riparian areas in the western United States. The NWI program recognized that in certain regions of the country, where evaporation exceeds precipitation, riparian habitats are as critical for wildlife as wetlands are in more humid regions.

Riparian areas are typically transitional lands between wetland and upland that contain plant communities contiguous to and affected by surface and subsurface hydrologic features of adjacent perennial or intermittent lotic and lentic water bodies such as rivers, streams, lakes, or drainage ways. As much as 80% of wildlife species in semi-arid western regions depend on riparian habitats for breeding or foraging. Riparian areas are important as they connect critical migration corridors. The condition of these riparian habitats is also important for maintaining healthy aquatic systems.

Given these well-documented values, the NWI program recognized a need to include these habitats in their inventory of areas west of the Mississippi River. To standardize this type of mapping, the USFWS developed a riparian classification system (Figure 10), as well as unique mapping conventions and standards for these types of wetlands (USFWS 2009). This classification system may be used alone or may supplement other wetland mapping efforts (such as the Wetlands and Deepwater Habitats Classification, or the LLWW system) to produce mapping products in arid or semi-arid regions of the country.

As with other wetland mapping, aerial imagery is the primary data source for riparian mapping and classification. Collateral data sets often used to complete this task include digital topographic maps, soils datasets, and local wildlife and plant community surveys or inventories.

Riparian areas have one or both of the following characteristics:

- Distinctly different vegetative species than adjacent areas, and
- Contain species that are similar to species in adjacent areas but exhibit more vigorous or robust growth forms.

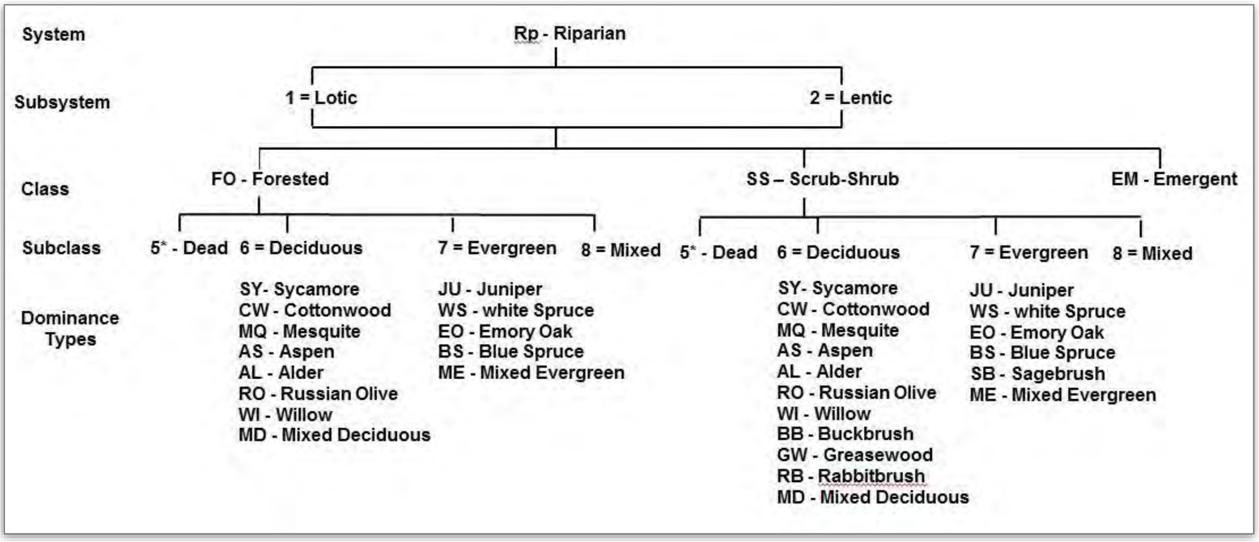

Figure 10. Riparian classification schema.

The riparian mapping system for areas in the western United States includes a hierarchical and open-ended coding system including System, Subsystem, Class, Subclass and Dominance Types:

- System is a single unit category - Rp (Riparian Vegetation);
- Subsystem defines two categories reflecting the water source for the riparian area, **1** (Lotic) or **2** (Lentic);
- Class describes the dominant life form of riparian vegetation. For these conventions, classes are **FO** (Forested) woody vegetation usually greater than 6 m in height, **SS** (Scrub/Shrub) woody vegetation usually less than 6 m in height, or **EM** (Emergent) erect, rooted vegetation with herbaceous stems;
- Subclass further describes the Class as **5** (Dead), **6** (Deciduous), **7** (Evergreen), or **8** (Mixed deciduous/evergreen);
- Dominance Type refers to vegetative species dominance within the mapping unit such as **CW** (Cottonwood), or **AL** (Alder). Dominance types vary throughout the western U.S.

Hydrogeomorphic (HGM) Classification

Another requirement of this project was to assign wetlands within the project study area to one of several regional HGM wetland subclasses (Brinson 1993). As part of this process, the project team worked jointly to develop a method of querying combinations of NWI and LLWW coded wetlands and other spatial layers (e.g., elevation bands representing alpine, montane and lowland ecoregions and confined and unconfined riverine valleys) to assign wetlands to a New Mexico HGM Regional Subclasses. These subclasses are listed in **Table 3**.

Table 3. HGM regional subclasses for New Mexico.

Riverine	Depressional	Slope	Flats
Subalpine Riverine	Artificial Depressional	Spring-fed Slope	Mineral Flats
Alluvial Fan Riverine	Natural Depressional	Headwater Slope	Organic Flats
Episodic Riverine	Playa Depressional	Irrigated Slope	
Lowland Confined Riverine		Other Slope	
Lowland Unconfined Riverine	**Fringe**		
Montane Confined Riverine	Lake Fringe		
Montane Unconfined Riverine			

Given that there was not a direct correlation between NWI and LLWW codes and regional subclasses, multiple data sources were often required to make interpretations. In addition, certain HGM regional subclasses were challenging to interpret (e.g., Episodic Riverine) because there was insufficient information in the current wetland data and available collateral sources to make a definitive assignment to an HGM subclass.

Quality Assurance Considerations

The use of remotely sensed imagery to map and classify wetlands requires quality data, technology and skilled personnel. Accuracy in wetland mapping is a measurement of both errors of omission and/or commission. Errors of omission occur due to factors including scale and quality of the imagery, the map scale, environmental conditions when the imagery was taken, type of imagery, or even the quality of collateral datasets available. Errors of commission occur when wetlands are not classified correctly.

Project accuracy and potential limitations of this wetland mapping and classification were addressed by the application of an in-depth project quality assurance plan. This plan was developed in collaboration with the project team using the Wetlands Classification Standards established by the FGDC for the NWI. It was also developed according to EPA guidance (EPA 2003).

Mapping standards included thresholds for the identification of the target mapping unit (smallest wetland consistently mapped and classified at a particular scale), producer accuracy (percentage of features correctly identified and classified), feature accuracy (identification of wetland versus non wetland), and spatial accuracy of the final map product measured including the horizontal positional accuracy in relation to the imagery. Data verification was completed as required and included checks for logical consistency, edge matching and attribute validity. Wetland data was re-projected to Albers Equal-Area and the datum to the North American Datum 1983 (NAD83) prior to submission. Metadata conformed to FGDC Content Standard for Digital Geospatial Metadata (CSDGM).

Methods

Overview

This project used geospatial techniques and image interpretation processes to remotely map and classify wetlands and riparian areas of the MRG project area. The intention of this effort was to complete wetland mapping and classification of wetlands in the project area for inclusion into the USFWS NWI. Other goals were to complete the LLWW classification (developed by Tiner 2003) by determining wetland classes and subclasses according to HGM characteristics, and to correlate LLWW metrics to wetland functions identified for the MRG project area.

The completion of the project will serve as a link to future wetland assessments including the New Mexico Rapid Assessment Method (NMRAM). The requirement to complete mapping at a 1:12,000 resolution and to comply with the National Wetlands Mapping Standard of the FGDC was achieved. Results from this project are important for wetland protection in New Mexico and will improve the knowledge of existing wetland areas and their functions. The results of this project will also provide a strong base for future wetland mapping updates for New Mexico.

The project was collaborative and dynamic in nature, with input from multiple individuals and agencies at every stage. SMUMN GSS provided project management and technical expertise in wetland delineation from aerial imagery, as well as the knowledge of wetland biology and HGM characteristics required to apply wetland classification. SMUMN GSS facilitated and mediated project team meetings and provided procedural guidance for wetland functional assessment exercises and the development of the quality assurance process.

The primary stakeholders included the SWQB of the NMED and the Region 2 USFWS NWI Program. Ralph Tiner of the USFWS provided expertise on the LLWW classification system and functional assessment.

The core project team is listed below:

Maryann McGraw – NMED SQWB - Wetlands Program Coordinator

Karen Menetrey - Environmental Scientist, NMED SWQB

John Anderson – SMUMN GSS - Senior Image Interpreter

Andy Robertson – SMUMN GSS - Project Manager

David Rokus - SMUMN GSS - QA/QC Specialist

Zack Ansel - SMUMN GSS – GIS Technician

Josh Balsiger - SMUMN GSS – GIS Technician

Gary Hunt – USFWS Regional Wetland Coordinator

The task of remote mapping and classifying of wetlands involves both the application of a scientific process as well as skilled project coordination. The Methods portion of this report discusses the entire wetland classification workflow as well as key project management activities.

Wetland Mapping and Classification Work Flow

To complete the project, SMUMN GSS applied a GIS workflow process developed and proven for wetland mapping and classification projects. The workflow process relied on a combination of digital datasets supported by field verification to delineate and classify wetland and riparian areas, validate image signatures, and also determine wetland function and hydrology. The completion of each workflow process step described below was critical to the success of the project's overall goal to develop a comprehensive wetland geodatabase for the project area using NWI standards in compliance with the FGDC.

Selection of digital imagery and collateral GIS datasets for the project

Digital imagery and collateral GIS datasets selected for the project included the most current digital orthophotography, scanned aerial photographs, data from the NRCS, the Soil Survey Geographic database (SSURGO) and county-specific soils inventory. In addition, digital topographic maps (digital raster graphic [DRG] format from the United States Geological Survey [USGS]), digital elevation models (DEM), and surface hydrology data (National Hydrology Dataset [NHD], along with state, and county level datasets) specific to streams, lakes, and rivers were used for analysis.

<u>Digital Imagery</u>

The primary source used for the study area came from aerial imagery supplied by the National Agriculture Imagery Program (NAIP) administered by the USDA's Farm Service Agency. NAIP aerial imagery is captured during growing seasons (referred to as "leaf-on" imagery) and taken with digital sensors during the day when there is less than 10% of cloud cover (so as to retain image integrity). The resulting digital orthophotography is typically made available for use to the public within a year; 2016 (the imagery chosen for this project) represented the eighth year that this process was completed for the entire state of New Mexico using one-meter specifications. This means that a one-meter ground sample distance had a horizontal accuracy that matched within six meters of photo-identifiable ground control points.

Spectral resolution used for NAIP imagery is RGB (Red, Green, and Blue) or natural color. This "true-color" imagery is typically the primary product of NAIP projects, with occasionally a fourth band providing CIR. True-color imagery shows the ground features as they appear to the human eye. Green vegetation appears green on the imagery, while water is generally black or blue, etc.

Google Earth™ software and imagery for the project area was also utilized. The image interpreter used the identify button to locate the coordinates of a signature or feature of interest, and those latitude and longitudes were then imported from ArcMap into Google Earth™. The "Time Slider" tool provided the image interpreter with the ability to view multiple years of aerial imagery, providing an advantage of reviewing average to current conditions, especially when determining the NWI (Cowardin et al. 1979) Modifiers for Water Regime (Figure 11, Figure 12). This option is particularly helpful if primary imagery is from a dry year, when wetland signatures are faint. The program also allowed a user to spin the cardinal direction of the imagery for a multiple aspects and raise or lower the altitude point of view and quickly zoom in and out with the use of the mouse buttons. These options allow for many different observations of the wetland feature.

Figure 11. Historical imagery, like this 1991 aerial photograph of Rio Grande floodplain and farming community near Los Padillas, New Mexico. The excavated ponds in the center will become future water hazards of a golf course.

Figure 12. An impounded wetland complex south of San Fidel in two different years, as seen in Google Earth. The image on the left is from July 2013 and the image on the right is from June 2016. The image interpreter is able to note changes in the boundaries and vegetation over time on these true color images.

<u>Topographic Data</u>
The most up-to-date USGS DRG topographic data was used with a resolution of 1:24,000. DRGs are scanned, digitized and georeferenced topographic maps in a digital tiff file format. Digital images were georeferenced to a true ground coordinate and projected for consistency with USGS Digital Ortho Quadrangles (DOQ). The DRG data was used in the project area to accurately determine modifiers for water regime and determine the existence and location of flow paths in the NWI (Cowardin et al. 1979) classification system.

<u>Soils Data</u>
SMUMN GSS analysts and technicians used existing soils data from the SSURGO, maintained by the NRCS. This database provided information about the soil in the project area including water capacity, soil reaction, electrical conductivity, frequency of flooding, yields for cropland, woodland, rangeland, and pastureland, as well as limitations affecting recreational development, building site development, and other engineering uses.

<u>Hydrology Data</u>
Data for streams, rivers, lakes and ponds from the USGS NHD was consulted. The Springs Stewardship Institute and the USFS provided additional springs layers and the NMED's SWQB provided cienagas data.

<u>Photointerpretation Expertise</u>
Certified staff from SMUMN GSS utilized their experience in wetland image analysis and ground-truthing, in addition to their individual competencies in the field of wetland science, to determine imagery selection and the need for additional collateral data sources.

Development and Implementation of Continuous Quality Assurance Plan

Quality control was a critical component throughout this wetland mapping and classification project. In order to formalize required quality control procedures, SMUMN GSS worked with SWQB and USFWS personnel to develop a formal Project Quality Assurance Project Plan (PQAPP). Guidance was provided from the EPA using the document "Guidance for Geospatial Data Quality Assurance Project Plans" (EPA 2003).

The PQAPP addressed several requirements to ensure the quality of the mapping and classification project. This plan received formal approval from the EPA and SWQB in April 2016. The PQAPP also clarified several components within each major quality assurance task, including the following specific processes:

- Project Management: communication distribution list, project organization and line of authority charts, problem definition and background for the project, project task description, quality objectives and criteria, special training and certifications of personnel as well as documentation and record-keeping requirements.

- Data Generation and Acquisition: sampling process design, sampling and image acquisition methods, sample handling and custody, analytical methods, quality control, instrument and equipment testing, data acquisition and data management.

- Assessment and Oversight: acquisition and response actions, reports to management.

- Data Validation and Usability: data review, validation, and verification including validation and verification methods and reconciliation with data quality objectives.

Review of Original Wetland Delineations and Regional Datasets

These data were provided by NMED and USFWS, NWI Region 2. Additional wetland maps were collected from the USFWS. The information was used to assess original mapping conditions, to provide reference stereographic coverage, and to aid in signature confirmation for the 2016 NAIP imagery.

Development and Coordination of the Geodatabase

Implementation and complete support for hardware, software and database technology used for the project was provided by SMUMN GSS. Development of the geodatabase was completed using Environmental Systems Research Institute (Esri)™ software, ArcGIS™ (v10.7.1). Completed data were also submitted to the USFWS for the NWI Program in the required format and projection.

Establishment of Project Mapping Conventions

On-screen delineation of wetlands appropriate to the scale and accuracy of the aerial imagery was completed. Specifications included a minimum mapping unit size, maximum on-screen zoom scale for boundary delineation, maximum on-screen zoom scale for classification decisions, and determinations regarding the handling of NWI classifications updates. SMUMN GSS facilitated key meetings with project partners to define all mapping and image interpretation conventions. These were reviewed and approved by the EPA. Specifications included a minimum mapping unit size for polygon features (+/- one half acre in size). This met all specifications required for the NWI.

In 2015, the NWI program initiated a conversion to "NWI 2.0" mapping, which incorporates standard width flowpaths that were previously excluded from the NWI dataset as a polygonal feature class. These were, however, provided as linear features to the NMED as a secondary wetland dataset. This was an effort by NWI to capture additional wetland habitat features or "to complete existing segmented connections between wetlands" (USFWS 2021). An additional goal, particularly in arid and semi-arid regions such as New Mexico, is "to map potential connectivity for water and sediment transport" across the landscape (USFWS 2021). For example, in alluvial fan or overland flow situations, areas should be connected by a buffered centerline, so that connectivity of flow is captured (USFWS 2021). Additional direction includes using two primary data sources as guidance in the decision-making process of adding flowpaths and enhanced connectivity. USGS NHD flowpaths and USGS intermittent streams symbols on topographic DRGs influenced the flowpath presence and its spatial location when imagery signatures were absent. The NWI code for these features was R4SBJ (no streambed subclass), and the HGM Modifier was "2.0 Addition" so the features could be distinguished from other flowpaths in the dataset.

The decision point for image interpretation of whether a wetland should be a buffered linear feature (as per NWI 2.0 conventions) as opposed to a polygon feature depended on a variety of factors including: size (width, extent), dryness, substrate type, association with other wetlands, and representation on collateral data. In general, wetlands captured as buffered linear features had a width of less than ten meters, although occasionally wetlands of that width or smaller were captured as polygons if they were part of a larger polygonal wetland or contained permanent water.

Aerial Imagery Verification / Check Site Field Review

This step involved the performance of on-site field review of project area study sites to validate actual wetland conditions identified using area image signatures or other collateral data. The field review for the MRG project area was conducted in late April of 2018.

The field verification process involved three steps: 1) check-site selection; 2) in-field verification; and 3) post trip documentation.

Check-Site Selection

Leaf-on, 2016 True Color NAIP imagery was reviewed for check-site selection. Points representing sites to be visited were created interactively using ArcGIS 10.7.1. Check sites were selected in advance for areas that could not be clearly identified as upland or wetland or classified accurately on the imagery with the aid of the available NWI database coverage, DRG topographic maps, NRCS SSURGO data, and collateral imagery (e.g., Google Earth™). Additional image sources accessed for check site selection included 2006, 2009, 2011, and 2014 NAIP as well as 1991 USGS DOQQ.

Field verification points were located at those sites where imagery signatures indicated that a wetland might exist, but wetland features were not obvious. Other check-site points were included where the NWI or Riparian classification needed clarification. For example, areas shaded as open water or contour intervals indicating topographic depressions were referenced to select possible locations of basins and ponds. Areas mapped as hydric soil in SSURGO provided check site locations for other wetland types including floodplain and saturated wetlands.

Additionally, site selection focused on identifying signatures of plant communities of interest such as sedge meadows, spring-fed wetlands (cienegas), and fens or bogs. Dominant riparian species such as cottonwood, willow, elm, and invasive salt cedar and Russian olive were also noted on aerial imagery and later captured in the project wetland geodatabase.

A total of 288 check-sites were pre-selected based on the above criteria. Hard-copy images showing accessible check sites were printed as map layouts at a scale of 1:20,000 for use under field conditions. Paper copies of 1:100,000-scale topographic maps were used in the field where hard copy imagery was absent and for overall study area guidance.

A field check site at a recreational impounded pond in Manzano (SMUMN GSS photo).

Field data sheets, plant field guides, a magnification loupe, tree-spade, soil probe, laptop with ArcGIS, and a Munsell Soil Color Chart were accessible during the trip. Pre-trip logistics were arranged with NMED personnel. Sites and routes were recorded by a global position system (GPS) and image comparisons were completed on a field laptop running ArcGIS 10.7.1 to display the project imagery (2016 NAIP True Color).

<u>Field Verification</u>

The field trip in April of 2018 consisted of a rapid inventory by vehicle of as many wetland features as possible in the project area. The field verification team included the Project Manager and Photo Interpreter from GSS SMUMN, and the Wetland Program Coordinator and

Environmental Scientist from NMED SWQB. Most of the accessible or visible wetlands were located along public and accessible roads or in parklands that were easily reached by short hikes.

Over 280 points were pre-selected in advance as potential field check sites (Appendix D). While not all points could be reached due to time and access limitations, approximately half of the sites were visited. Selected check sites were documented using the NWI Field Data Sheet format. At these sites, surface hydrology indicators were observed, soil profiles were characterized where possible, and species of hydrophytes were documented to determine the presence or absence of wetland, classify wetland, and describe associated photo-signatures. The remaining sites were reviewed via a windshield survey and were documented with hand-written notes on the hard-copy images. Features were classified in the NWI Cowardin Classification System. At each site, a GPS point and a series of ground-level photos were taken. A map of the field verification sites is displayed in Figure 13.

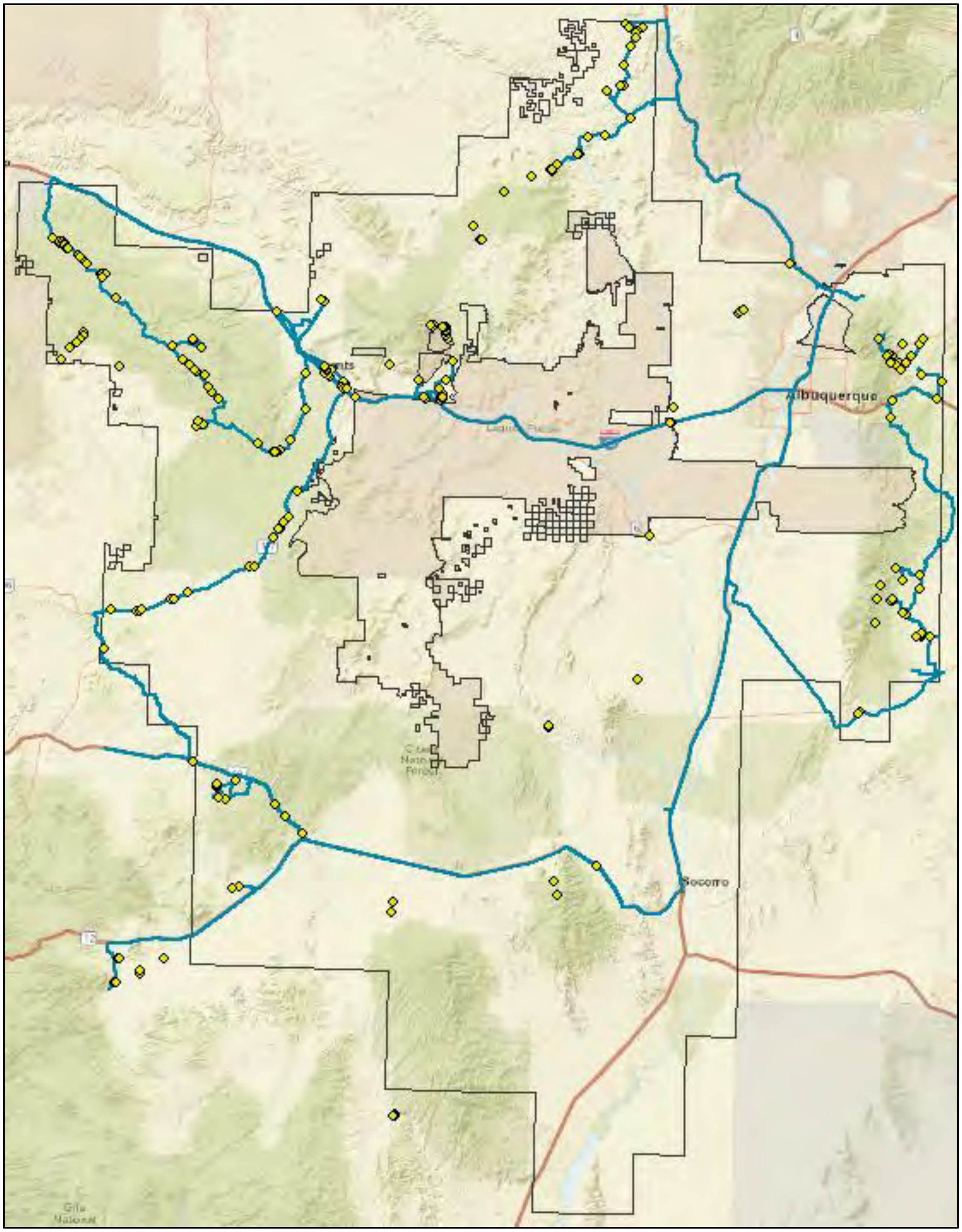

Figure 13. Field verification check sites (yellow points) and GPS route (blue-green line) for the April 2018 field trip to the MRG project area.

<u>Documentation</u>

Baseline imagery and collateral data were reviewed and documented upon return from the field visit. A list of common wetland classifications and their associated photo signatures was compiled. Considerations as to applicability of collateral data to wetland/upland calls and wetland classification were documented. Outside signature questions were leveled on-screen and forwarded to local experts for discussion and assessment.

Field information was compiled into working documents entitled “Photointerpretation Conventions for the Middle Rio Grande Project Area”. Photointerpretation of complex wetland resources is a collaborative process. A continuous dialogue through the course of the production phase of the project helped to produce a high-quality product.

Figure 14. A depressional playa basin wetland visited during field verification, approximately 20 miles southwest of Grants, NM (SMUMN GSS photo).

Observations

Ground-truthing found the wetlands to be generally “drier” in terms of Water Regimes than those experienced in previous projects in northern New Mexico. Palustrine wetlands with Water Regimes A (Temporarily flooded), B (Seasonally Saturated), and C (Seasonally Flooded) were most commonly found in the field. “A” and “C” wetlands were most commonly associated with playas, livestock tanks, and narrow floodplains. “B” Water Regime-dominated wetlands were found primarily on slopes and mostly dominated by emergent, herbaceous plant species.

Saline wetlands were found to be somewhat common during field investigation, especially in the portion of the study area around Grants, NM. It is hoped that collateral data will be obtained that will assist in assigning NWI Water Chemistry Modifiers for Inland Salinity to specific image signatures. If this is possible to determine, Water Chemistry Modifiers could include. Hypersaline, Eusaline, Mixosaline, Polysaline, Mesosaline, or Oligosaline. If relevant collateral data is unavailable, wetlands with white photographic tones, will be designated as Alkaline or Saline.

Polygons drawn to represent springs and seeps were no smaller than 0.1 to 0.25 acres in size and were delineated where present on DRGs (1:24,000 scale USGS topographic maps), identified on collateral GIS data from project partners or visible on aerial imagery.

Saturated "B" Water Regime wetlands on slopes and flats were much more common higher in mountains. Those Cowardin "B" class wetlands which were seen to cross two contours were classified as Saturated, although many Bs on flats were also found at higher elevations. During discussions with the USFWS, it was acknowledged that we were likely to find these areas while in the montane portions of the study area.

Lacustrine areas are absent from the project area due to a lack of lakes and reservoirs. However, as per National conventions, wetlands dominated by unconsolidated shore material and larger than 20 acres in size will be classified as Lacustrine even if no standing water is present.

Riparian areas, by national conventions, can include areas where channels are absent. These areas are influenced by subsurface hydrology (lateral groundwater and hyporheic flows) and have distinctive plant communities or mixed deciduous species. Riparian mapping included orchards within floodplains below the first "bench" or floodplain terrace.

Water Regimes for stream channels visited included "H" (Permanently Flooded), "G" (Intermittently Exposed), "C" (Seasonally Flooded), "A" (Temporarily Flooded), and "J" (Intermittently Flooded). Longer flooding duration segments are located in mountains and foothills. Intermittently Flooded "J" features dominate lowland areas. Acequias were determined to be Seasonally Flooded. As the area is experiencing record drought those channels where water was found to be present will be assigned the "H" Permanently Flooded Water Regime.

Channels with faint gray signatures will be assigned the "A" Water Regime or "wetter" depending upon presence of springs and water on one or more dates of imagery. Drainage features that are Intermittently Flooded will be characterized using the "J" Water Regime. Intermittently flooded features mapped as R4SBJ (Riverine, Intermittent, Streambed, Intermittently Flooded) were commonly arroyo streambeds or over wash floodplain areas where scouring was present. Streambed channels will be further characterized using NWI Subclass categories.

Streams and arroyos occupied by Bedrock will receive the numeral "1" (e.g., R4SB1J). Those covered with Cobble-Gravel will be classified as "3" (e.g., R4SB3J). Channels occupied by Sand will be assigned a "4" (e.g., R4SB4J). Vegetated channels will be classified as such using the numeral "7" (e.g., R4SB7J). NWI 2.0 connections across overland flow paths, joining stream bed channels with subclasses will have the subclass devoid of any number (e.g. R4SBJ). They will also have "2.0 Connection" in the HGM modifier field and not have the arroyo (ar) modifier applied to the LLWW code.

Draft Map Production

Following approval of previous steps in the methodology by the project team and the completion of image interpretation conventions for each watershed, SMUMN GSS completed the wetland delineation and classification across the entire project study area. Collateral GIS data, field derived decision rules, team and wetland expert input, as well as established guidelines for each watershed were incorporated to ensure accuracy and consistency of the wetland database.

NWI – Wetlands and Deepwater Habitats Classification System (Cowardin et al. 1979)
Wetlands were delineated and classified for the NWI on screen using collateral data. Nearly 38,500 wetland polygons were identified and classified. Linear wetland features were buffered and included in the polygon count, as per NWI Version 2.0 requirements. The original imagery was broken into working units, typically by quadrangles, counties, or sub-watersheds. A file structure for work units was created in the geodatabase. The SMUMN GSS photo interpreter completed the on-screen digitizing and NWI classification for the entire project area. All wetland mapping was based on imagery, field investigations, collateral data and observations, and input from local and regional experts as needed. An example of delineated wetland boundaries displayed over aerial photography is displayed in Figure 15.

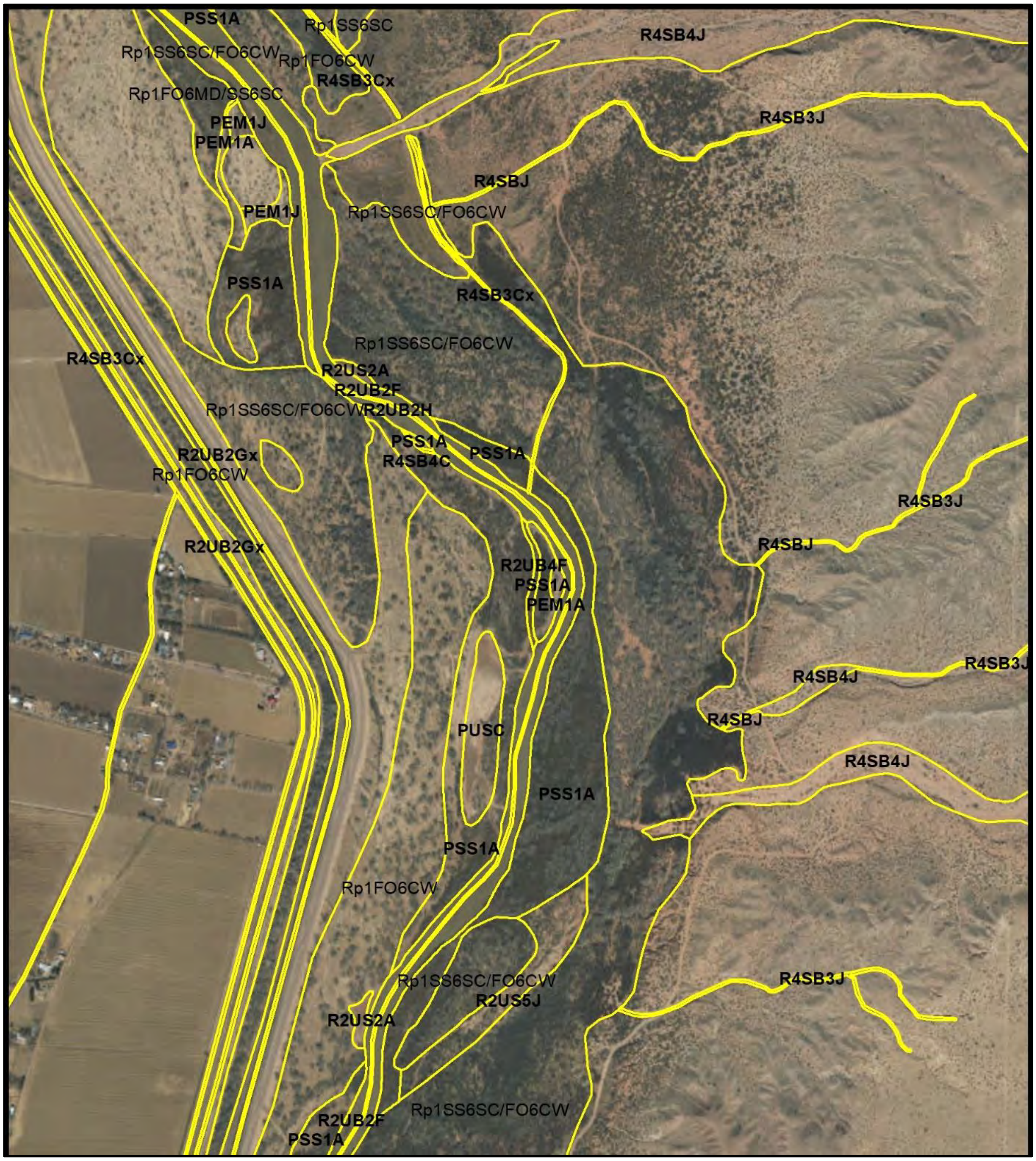

Figure 15. Sample of aerial photography along the Rio Grande, northeast of Socorro. This image is viewed at a scale of 1:15,000. The image interpreter has digitized the physical boundaries of each wetland (wetland delineation) in ArcMap and has also assigned a Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) attribute to each of the wetlands (classification).

While the delineation and classification steps were being completed, internal quality assurance steps were continually in process. These included personnel completing a zoomed-in review of each polygon to verify its appearance. Each feature was accepted, merged, or deleted as appropriate. Signature matching occurred by panning through the entire dataset at a scale of

1:10,000, which ensured that features within a complex were categorized accurately and consistently. This also verified hydrologically connected drainage systems or wetland complexes across roads or other human influences.

Digital line work for all wetlands was first reviewed at a scale of 1:5,000, which ensured that polygon features were appropriately pieced together. The entire dataset was then panned at a scale of 1:3,000 where jags, spikes, horns, zigzags, intersections, and corners (potential errors that can occur with digital delineation) were located and adjusted accordingly.

LLWW Classification System

The LLWW classification was completed on-screen using collateral GIS data including surface hydrology, DEM, and DRGs to define wetland functional values. SMUMN GSS previously collaborated with Ralph Tiner of USFWS to assist with regional considerations for this classification process (Figure 16).

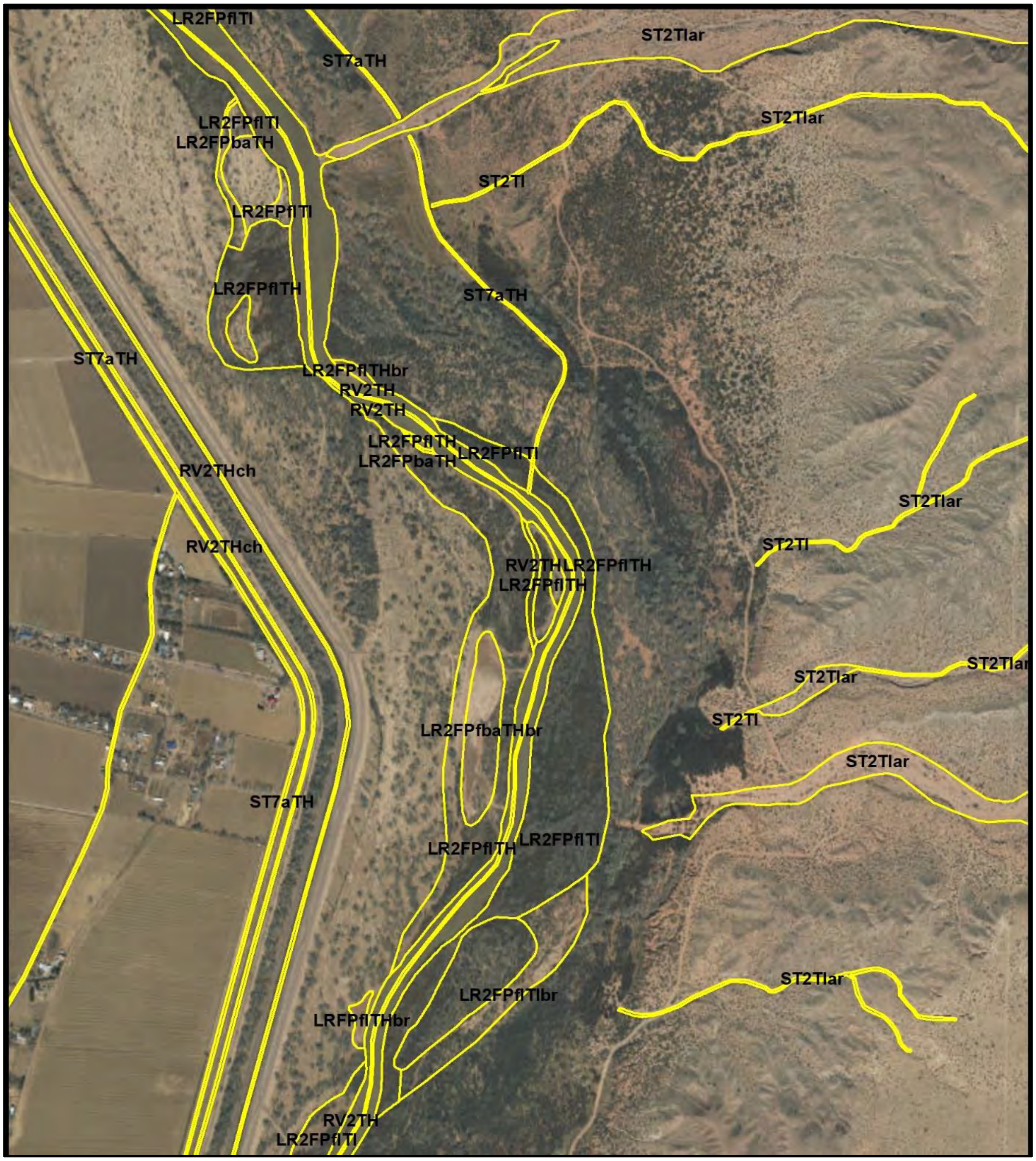

Figure 16. Aerial photography along the Rio Grande, northeast of Socorro, viewed at a scale of 1:15,000. After completion of the wetland delineation, the image interpreter has assigned LLWW attributes to each wetland.

To ensure quality and consistency for the application of the LLWW classification system, SMUMN GSS analysts applied consistent mapping conventions determined by project team members. This process included the proficient crosswalk of attributes between the NWI (Cowardin et al. 1979) and LLWW classification systems. Typical guidelines for the application of various LLWW attributes included:

LLWW Terrene Feature Guidelines

- Wetlands with the Water Flow Path of *OU* (Outflow) in proximity to NHD streams were assigned *ds* (discharge to stream). While by LLWW definition only the *B* (Seasonally Saturated) Water Regime typically has this designation, the *A* (Temporarily Flooded) and *C* (Seasonally Flooded) Water Regimes also reflected this Water Flow Path and condition in the project area.

LLWW Lotic River and Lotic Stream Feature Guidelines

- All *R2* and *R3* streams and rivers were *TH* (Throughflow). *R4* streams and rivers were either *TH* (Throughflow) or *TI* (Intermittent Throughflow).

- *3* (High Gradient) was assigned to all first and second order *R3* (Riverine, Upper Perennial) and *R4* (Riverine, Intermittent) streams and rivers (ex. R3 = *ST3*)

- *3* (High Gradient) or *2* (Intermediate Gradient) was assigned to third order, and lower, streams and rivers and was also based on distance between contours

- *hw* (headwater) was assigned to first and second order streams and associate wetlands as interpreted

- *ST2%* was a typical second order stream of *R4SBJ* or *R3RBH* (ex. *R4SBJ* became *ST2TI*),

  **NOTE: the use of the percent sign (%) is a wildcard or placeholder indicating that other coded information may occur here within the string of LLWW or NWI codes*

- There were some situations where a wetland was in a floodplain location but was designated as a *TE* (Terrene) Landscape (as opposed to a standard Lotic River or Lotic Stream). This is a valid assignment in the LLWW classification system for those wetlands that are accumulating surface water from rainfall or snow melt, as opposed to having a direct connection to the river or stream as their water source.

- Arroyo coding reflected intermittent or ephemeral flow in LLWW code (ex. *ST2TI* for *R4SB%A* or *ST3arTI* for *R4SB%J*)

- *PEM1C* segments in *R4SBJ* arroyos were coded a *LS4BATI*

- *R_US%J* outwash areas were *LR1* or *LS* with a *TH* or *TI* flow path and *brow* (barren outwash) modifiers

- Topographical DRGs from the USGS were useful in determining Water Flow Path for the LLWW classification.

LLWW Modifier Guidelines

- Terrene or Lotic wetlands along first or second order streams, as interpreted by the project image analyst, were coded as *hw* (headwaters)

- *P%B* features adjacent to streams were coded as *ds* (discharge to stream)

Playa Feature Guidelines

- Image interpretation was used to locate both alkaline and non-alkaline playas. Lake sized wetlands greater than 20 acres and recognizable as playas were coded as *LK1IN* or *LK1fVR*. The *i* (Alkaline) modifier was used to identify playa ponds with noticeable salt content (ex. either *PEM1Ci* or *PUSCi* for *TEBAplVR*).

- *PUB%x* with playa ponds were coded as *PD3kVR*

- *TEBAplVR* was primarily used for A (Temporarily Flooded) or *J* (Intermittently Flooded) Water Regimes for playa basins.

LLWW Water Flow Path Guidelines

- Small water retention impoundments such as *P%h* were coded as *TEBAipTIhi* with inflow and outflow or *TEBAipINhi* if the feature was at the terminus of a stream. *PUB%h* ponds coded as *PD2%* were coded similarly as *TI* or *IN*.

- Wetland polygons at the top of a watershed were coded *OU* (Outflow) if they were part of a continuous stream or river system in either the NWI mapping or the NHD flowlines.

- Excavated basins or ponds regardless of substrate, or regime, *P%x* were most often attributed with vertical flow, *TEBAVRhi* or *PD3VR.*

Wetland Functional Correlation Development

A correlation table documenting the characteristics of wetlands performing 12 specific functions was developed in a series of meetings with the project advisory team. This involved a review of similar processes completed for other regions in the country as well as in-depth discussion and planning with national and regional wetland experts. Of greatest concern was the applicability of functions to the semiarid region of the project area. The functional analysis was based on completed NWI and LLWW mapping and classification, and also the consequent correlation of these wetland characteristics to one of the 12 identified functions for the project area (Table 4). These functions were coded and placed in the geodatabase. A series of functional assessment maps were then produced, one map for each of the twelve functions in the project area. These maps served as a basis for the validation field review completed later for the project area.

Table 4. Wetland functions selected for inclusion in the MRG project area's wetland functional assessment

Function	Function
Aquatic invertebrate habitat	Other wildlife habitat
Bank and shoreline stabilization	Sediment and other particle retention
Carbon sequestration	Streamflow maintenance
Fish habitat	Surface water detention
Groundwater recharge	Waterfowl and waterbird habitat
Nutrient transformation	Unique, uncommon, or highly diverse wetland plant communities

Riparian Classification System

Upon completion of the NWI and the LLWW classification systems, as well as the completion of the project area's functional analysis, riparian areas found in the project study area were delineated and classified. Riparian areas were mapped using standards and technical procedures compatible with other standards outlined for the collection of data by the USFWS NWI. The mapping of these areas allows planners to understand the location and characteristics of important riparian habitat areas for the purpose of both regional and national conservation efforts. Many riparian habitats support wildlife species with state or federal protection status.

HGM Classification

HGM wetland classifications (after Brinson 1993) were assigned to each polygon during the image interpretation process. In order to make the HGM assignments, the analyst took into account the first-hand knowledge of this landscape generated through ground-truthing project imagery, in consultation with NMED SWQB resource experts. HGM classifications were attributed after wetland and deepwater habitat polygons were delineated and attributed in the NWI and LLWW classification systems. These data were then used to make informed decisions regarding assignment of HGM classifications. Other important collateral datasets used included EPA Level IV Ecoregions mapping and characterizations and USGS Digital Raster Graph (DRG) symbols.

Table 5. HGM Classes, Subclasses, and Modifiers used in the project study area.

HGM Class	HGM Subclass	HGM Modifier
Depressional	Playa	Bi-directional Throughflow
		Excavated Inflow
		Excavated Throughflow Intermittent
		Excavated Vertical Flow
		Inflow
		Outflow
		Throughflow
		Throughflow Intermittent
		Vertical Flow
	Artificial	Excavated
		Impounded
	Natural	Inflow

HGM Class	HGM Subclass	HGM Modifier
		Outflow Vertical Flow Throughflow Throughflow Intermittent
Riverine	Episodic	2.0 Connection
	Montane Unconfined	Null
	Montane Canyon Confined	Null
	Lowland Unconfined	Excavated Null
	Lowland Canyon Confined	Excavated
Slope	Headwater	Spring-fed
	Spring-fed	Null
	Other	Outflow Throughflow Vertical Flow
Flats	Mineral	Null

The following sections describe each HGM class and provide a brief narrative for which wetlands (i.e., NWI & LLWW codes) and collateral data were used to identify each class, subclass, and modifier applied in the project area.

HGM Class - Depressional

Depressional wetlands occur in topographic depressions that allow accumulation of surface water. On a topographic map, these wetlands occur within a closed elevation contour. Dominant sources of water are precipitation and/or overland flow from adjacent uplands, but these wetlands may also have a ground water component to them. The direction of water movement is normally from the surrounding uplands toward the center of the depression. Depressional wetlands may have any combination of inlets and outlets or lack them completely. They may lose water through intermittent or perennial drainage from an outlet, by evapotranspiration, and, if they are not receiving groundwater discharge, may slowly contribute to groundwater. Depressional wetlands are not further defined by locations within other landform types.

HGM Subclasses

Natural

These are natural depressional wetlands where the water supply was primarily determined to be from groundwater or overland flow, not stream sources and where human impacts to surface hydrology are absent.

Playa

Playa wetlands were attributed in the LLWW System with the “pl” Modifier. HGM Modifiers consist of waterflow direction as assigned in LLWW coding (e.g., Inflow, Outflow, or Vertical Flow). Playas that have been partially altered through excavation were classified as Excavated Inflow, Excavated Throughflow, and Excavated Vertical Flow.

Artificial
These are artificial depressional wetlands designed to capture or reduce the volume of flow in moving water. Those identifiable impacts were classified as Excavation (x) or Impoundment (h). Wetland areas that have been created and/or where ponding duration has become established inadvertently (e.g., road construction) were classified in the LLWW System as 'human induced" (hi).

<u>HGM Class- Riverine</u>
Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow or side channel flow from the channel, or subsurface hydraulic connections between the stream channel and adjacent wetlands (hyporheic flow). Additional water sources include overland flow from adjacent uplands and precipitation. When overbank flow occurs, surface flows down the floodplain may dominate hydrodynamics. At the headwaters, riverine wetlands often intergrade with slope or depressional wetlands as the channel (bed) and bank disappear, or they may intergrade with poorly drained flats or uplands.

HGM Subclasses

Episodic Riverine
These riverine areas were classified as R4SB#J or R4SB#A in the NWI Classification System and as Stream - Throughflow Intermittent in the LLWW System, often with an arroyo (ar) modifier. Many episodic riverine polygons were assigned a "2.0 Connection" modifier, referring to the fact that these features were added during the process of upgrading original mapping to NWI 2.0 standards. The transition to NWI 2.0, initiated in 2015, incorporates buffered linear features that were previously excluded from the polygonal feature class, in an effort to capture additional wetland habitat features or "to complete existing segmented connections between wetlands" (USFWS 2021). An additional goal, particularly in arid and semi-arid regions such as New Mexico, is "to map potential connectivity for water and sediment transport" across the landscape (USFWS 2021). For example, in alluvial fan or overland flow situations, areas should be connected by a buffered centerline, so that connectivity of flow is captured (USFWS 2021).

Montane Unconfined Riverine
The Montane Unconfined Riverine Wetland subclass includes unconfined streams and wetlands that are associated with mid-elevations between the lowlands and subalpine and alpine elevations (Muldavin et al. 2011).

This classification was attributed based on two criteria. Firstly, these valleys were identified within EPA Level IV Ecoregions in the Semiarid Tablelands (22j), Plains of San Agustin (22l), Montane Conifer Forests (23c), Conifer Woodlands and Savannas (23e), or Rocky Mountain Conifer Forests (23f). Secondly, using the ArcGIS Measuring Tool, the distance contour lines representing the location of the first bench on either side of a river or stream measured greater than 70 meters on the corresponding DRG overlay.

Montane Canyon (Confined) Riverine
The Montane Canyon (Confined) Riverine Wetland subclass is primarily found along confined stream reaches in the same elevation zone and intermixed with Montane Riverine Wetlands (Muldavin et al. 2011). This subclass is characterized by steep stream systems confined by the

underlying bedrock, with channel substrates dominated by boulders and cobble. Typically, the streams have a narrow riparian zone and may lack a distinct floodplain (Muldavin et al. 2011).

This classification was attributed based on two criteria. Firstly, these valleys were identified within EPA Level IV Ecoregions in the San Juan/Chaco Tablelands and Mesas (22i), Semiarid Tablelands (22j), Montane Conifer Forests (23c), Arizona/New Mexico Subalpine Forests (23d), Conifer Woodlands and Savannas (23e), Rocky Mountain Conifer Forests (23f), or Chihuahuan Desert Grasslands (24b). Secondly, using the ArcGIS Measuring Tool the distance contour lines representing the location of the first bench on either side of a river or stream measured less than 70 meters on the corresponding DRG overlay.

Lowland Riverine (Unconfined)
At lower elevations, Montane Riverine Wetlands transition to Lowland Riverine Wetlands. This subclass is associated with high-volume river systems with large drainage areas that can move various sediment size classes, creating complex fluvial terrains made up of large mid-channel and point bars, as well as multiple terraces and back channels (Muldavin et al. 2011).

This classification was attributed based on two criteria. Firstly, these valleys were identified within the Rio Grande Floodplain (22g, 24f), San Juan/Chaco Tablelands and Mesas (22i), Semiarid Tablelands (22j), Plains of San Agustin (22l), Albuquerque Basin (22m), Conifer Woodlands and Savannas (23e), Chihuahuan Basins and Playas (24a), Chihuahuan Desert Grasslands (24b), and the Central New Mexico Plains (26o) Level IV Ecoregions. Secondly, using the ArcGIS Measuring Tool the distance contour lines representing the location of the first bench on either side of a river or stream measured greater than 70 meters on the corresponding DRG overlay.

Lowland Confined (Canyon) Riverine
The Lowland Confined (Canyon) Riverine wetlands sub-class is typically found along confined stream reaches in the same elevation zone. This subclass is characterized by steep stream systems confined by the underlying bedrock or valley sides. These streams typically have a narrow riparian zone and may lack a distinct floodplain.

This classification was attributed based on two criteria. Firstly, these valleys were identified within the Rio Grande Floodplain (22g, 24f), San Juan/Chaco Tablelands and Mesas (22i), Semiarid Tablelands (22j), Albuquerque Basin (22m), Conifer Woodlands and Savannas (23e), Chihuahuan Basins and Playas (24a), Chihuahuan Desert Grasslands (24b), and the Central New Mexico Plains (26o) Level IV Ecoregions. Secondly, using the ArcGIS Measuring Tool the distance contour lines representing the location of the first bench on either side of a river or stream measured less than 70 meters on the corresponding DRG overlay.

<u>HGM Class - Slope</u>
Slope wetlands are normally found where groundwater discharges to the land surface (NRCS 2008). They typically occur on sloping land; however, elevation gradients may range from steep hillsides to slight slopes. Slope wetlands are usually not capable of depressional water storage because the ground lacks the necessary enclosed basin or is convex in shape. The principal water source is usually groundwater flow, however interflow from surrounding uplands as well as precipitation may contribute. Hydrodynamics are dominated by downslope unidirectional water

flow (NRCS 2008). Slope wetlands can occur in nearly flat landscapes where groundwater discharge is a dominant contributor to the wetland surface. These wetlands primarily lose water through surface flows, subsurface saturation, and evapotranspiration (NRCS 2008).

In this project area, wetlands identified as occurring on slopes were classified as having a Seasonally Saturated (B) or Continuously Saturated (D) NWI Water Regime. They generally also were intersected by one or more DRG contour interval lines.

HGM Subclass

Spring-fed
During the wetland mapping exercise, spring locations were identified from data sources including project imagery, USGS DRGs, Springs Stewardship Institute data, and an NMED SWQB cienegas point layer. Any visible wetland that contained a spring or was interpreted to be directly downstream and adjacent to a spring was coded with the LLWW sf (spring-fed) HGM Modifier. The spring-fed code was also applied to hill slope springs in valley walls that were adjacent to riverine wetlands but not dominantly hyporheic in nature.

Headwater
The Headwater HGM Modifier was applied to wetlands adjacent to first and second order streams in the mountain ranges of the project area, particularly the Zuni Mountains of Cibola National Forest. These were also assigned the HGM Modifier "Springfed" where they occurred along first and second order streams.

Other
These HGM Subclass areas are disconnected from channels. The HGM Modifier "Outflow" was applied if they were disassociated headwaters areas and springs.

<u>HGM Class - Flats</u>

HGM Subclass

Mineral Soil Flats
Mineral soil flats are most common on interfluves (a region of higher land between two rivers), extensive relic lake bottoms, or large floodplain terraces where the main source of water is precipitation (NRCS 2008). They receive virtually no groundwater discharge which distinguishes them from some depressional and slope wetlands. The dominant hydrodynamics are vertical fluctuations (NRCS 2008). These flats lose water by evapotranspiration, saturation overland flow, and seepage to underlying groundwater. They are distinguished from flat upland areas by their poor vertical drainage and low lateral drainage, usually due to low hydraulic gradients (NRCS 2008).

Mineral soil flats in the MRG project area were identified as PEM1J and PEM1B or PSS1B wetlands in NWI that were interpreted as Terrene Flat (TEFL) in LLWW. This interpretation was supported by the fact that intersecting contours, as seen on corresponding DRGs, were largely absent from these wetland types.

Field Review of Draft Map

After the pre-mapping field check sites were created and visited during the spring of 2018, draft mapping was completed for the most of the project area over the following several months (summer 2018). Then the draft maps were verified during a field trip from October 14-19, 2018. A ground-level photo of one of the draft map review field sites is provided in Figure 17. Field trips were conducted for the purpose of comparing and assessing delineated and classified draft map samples with wetland features and no-wetland features in the field. This was a quality assurance exercise accomplished in order for New Mexico's SWQB and the USFWS to evaluate the accuracy of the interim data before the final data production. The result of the Draft Map review process was refinement of mapped wetland data prior to final Quality Control steps and submission into the NWI.

Figure 17. One of the check sites in the MRG project area visited during October 2018 field work (SMUMN GSS photo).

The Field Review of Draft Map team included the Project Manager and Photo Interpreter from SMUMN GSS, New Mexico's SWQB Wetlands Program Coordinator and Project Officer, and also the NWI Regional Wetlands Coordinator. Hard copy maps were created by SMUMN GSS for use during both Draft Map Field Reviews with project team members. Each watershed was visited to complete these spot checks.

Quality Assurance – Review of Geodatabase

The USFWS NWI Master Geodatabase Verification Tool, established topology rules for NWI projects, and the wetland integrity of the geodatabase were all reviewed and validated. This step was completed using the Wetlands Data Verification Toolset developed for the NWI Program which helps to automate quality control steps for the wetland geodatabase.

SMUMN GSS also developed and applied a customized quality control assessment script in ArcGIS™ which resolved data integrity issues (e.g. topology, gaps, overlaps, ghosts and adjacent attributes). These automated tools completed the rigorous visual quality control process undertaken by the professional wetland image interpreter and geospatial analysts.

Visual checks of the mapping also assessed classification and delineation accuracy resulting in corrections, when appropriate, for errors of omission or commission. 100% of the spatial data was reviewed to ensure accuracy of the final mapping product to meet specifications of the FGDC National Wetland Mapping Standard.

Customer Review

Several draft datasets were submitted for review to both New Mexico's SWQB and NWI Region 2 coordinator. These draft reviews occurred in October 2019, February 2020 and April 2021. The database included all wetlands for a specified area of interest or the entire study area. The entirety of the submitted draft data, regardless of status, was finalized to complete data standards. Wetland polygons were clipped to the study area boundary, run for topologic consistency, attribute and size errors, and packaged into the NWI database schema. A supplemental map report accompanied the data to provide basic information about the study area and collateral data as well as included photo interpretation conventions. Wetland data was reviewed for missing wetlands, spatial accuracy, 2.0 connectivity, accuracy of attribution, precision of linework, and overall consistency of the data. These issues were expressed in a shapefile that included specific locations and a description of error type. GSS would then host a dialogue for addition review and input as needed, and revise the data in question. In addition, a complete survey of all remaining data was scanned and sorted to apply the suggested changes to the entire dataset.

Submission of Final Mapping Product

All mapping products, including a single geodatabase, hardcopy maps and the final report were submitted to the state of New Mexico for review and approval. A version of the geodatabase without LLWW or HGM codes was then submitted to the NWI program of the USFWS for inclusion into the NWI Master Geodatabase. The final database delivery to New Mexico was made in September 2021, which includes all riparian and wetland polygons with NWI, LLWW, and HGM attribution. This data includes wetland functions, parsed NWI attributes, and comprehensive metadata.

Results

Overview

The purpose of this project was to map and classify existing wetland resources found in the MRG sub-project study area in west-central New Mexico. Wetland data were summarized for both the NWI (Cowardin et al. 1979) and LLWW classification systems. The mapping and classification of riparian areas and a wetland functional analysis for the project area were also completed.

Acreages were determined from several spatial data layers which reside in the newly developed geodatabase using ArcMap (ver. 10.7.1) spatial and statistical analysis tools (Figure 18). Summary statistics and tables for each classification system are included here, along with representative images.

Figure 18. The use of a geodatabase allows for extensive analysis of many data layers. In the location shown above, the wetland classification was developed using spatial data layers such as hydrology, beaver habitat, vegetative cover, land use and land ownership.

NWI - Wetlands and Deepwater Classification Summary

Wetlands and deep water habitats comprised 103,821 acres (1.5%) of the total land in the

7,032,691 acre project area. Just over 38,500 polygons were mapped and classified from the Palustrine, Lacustrine or Riverine Systems using the Wetlands and Deepwater Habitats Classification System (Cowardin et al. 1979) for the NWI. In total, 163 unique NWI codes were employed to classify wetland polygons (Appendix E).

Of the 38,544 polygon features delineated and classified, the Riverine System accounted for 68% of the polygons and just over 73% of the wetland area. The majority of Riverine polygons were intermittent (R4). The Lacustrine System polygons were less than 0.1% of all polygons and nearly 1% of the total wetland area. The Palustrine System represented 32% of polygons and accounted for 12% of wetland area.

A summary table and comments for polygon wetland features found in the project area follow (Table 6). It should be noted that in these tables the System and Class sections should not be expected to sum to 100%. This is due to some entries in the table being not mutually exclusive of each other.

Table 6. NWI Polygon Wetland Summary.

Summary Parameters		No. of polygons	% of total polygons*	Area (acres)*	% of project area*	% of wetland area*
General						
All Polygons		38,544	--	103,821	1.5	--
NWI System/Subsystem						
P (all palustrine)	Palustrine, (no Subsystems in System)	12,326	32.0	27,052	0.3	11.9
L (all lacustrine)	Lacustrine, (combined subsystems)	24	<0.1	810	<0.1	0.8
L1	Lacustrine, Limnetic	3	<0.1	84	<0.1	<0.1
L2	Lacustrine, Littoral	21	<0.1	726	<0.1	0.7
R (all riverine)	Riverine, (combined subsystems)	26,194	68.0	75,959	1.1	73.2
R2	Riverine, Lower Perennial	612	1.6	5,322	<0.1	5.1
R3	Riverine, Upper Perennial	841	2.2	2,222	<0.1	2.1
R4	Riverine, Intermittent	24,741	64.2	68,415	1.0	65.9
NWI Class/Subclass						
AB (total)	Aquatic Bed	16	<0.1	18	<0.1	<0.1
AB3	Rooted Vascular	4	<0.1	12	<0.1	<0.1
AB4	Floating Vascular	12	<0.1	6	<0.1	<0.1
EM	Emergent	8,519	22.1	16,203	0.2	15.6
EM/SS	Emergent/Scrub-Shrub	6	<0.1	6	<0.1	<0.1
FO	Forested	117	0.3	1,477	<0.1	1.4
RB (total)	Rock Bottom	31	<0.1	25	<0.1	<0.1
RB1	Bedrock	21	<0.1	5	<0.1	<0.1
RB2	Rubble	1	<0.1	<0.1	<0.1	<0.1
SS	Scrub-Shrub	883	2.3	7,799	0.1	7.5
SB (total)	Streambed	24,741	64.2	68,415	1.0	65.9

Summary Parameters		No. of polygons	% of total polygons*	Area (acres)*	% of project area*	% of wetland area*
SB1	Bedrock	23	<0.1	19.4	<0.1	<0.1
SB3	Cobble-Gravel	10,805	28.0	39,514	0.6	38.1
SB4	Sand	749	1.9	7,220	0.1	7.0
SB5	Mud	4	<0.1	36	<0.1	<0.1
SB7	Vegetated	1,655	4.3	2,147	<0.1	2.1
UB (total)	Unconsolidated Bottom	2,145	5.6	7,190	0.1	6.9
UB1	Cobble-Gravel	166	0.4	289	<0.1	0.3
UB2	Sand	136	0.3	3,981	<0.1	3.8
UB3	Mud	26	<0.1	782	<0.1	0.7
UB4	Organic	8	<0.1	6	<0.1	<0.1
US (total)	Unconsolidated Shore	2,086	5.4	2,687	<0.1	2.6
US1	Cobble-Gravel	1	<0.1	2	<0.1	<0.1
US2	Sand	868	2.2	1,667	<0.1	1.6
US3	Mud	11	<0.1	22	<0.1	<0.1
US5	Vegetated	158	0.4	418	<0.1	0.4
NWI Modifiers - Water Regime						
A	Temporarily Flooded	5,881	15.3	16,847	0.2	16.2
B	Seasonally Saturated	956	2.5	1,262	<0.1	1.2
C	Seasonally Flooded	3,407	8.8	6,314	<0.1	6.1
D	Continuously Saturated	7	<0.1	6	<0.1	<0.1
E	Seasonally Flooded/Saturated	3	<0.1	1	<0.1	<0.1
F	Semipermanently Flooded	1,550	4.0	5,357	<0.1	5.2
G	Intermittently Exposed	309	0.8	994	<0.1	1.0
H	Permanently Flooded	167	0.4	738	<0.1	0.7
J	Intermittently Flooded	25,874	67.1	70,303	1.0	67.7
K	Artificially Flooded	390	1.0	2,000	<0.1	1.9
NWI Modifiers - Special Modifiers						
b	Beaver	3	<0.1	29	<0.1	<0.1
d	Partly drained/ditched	8	<0.1	60	<0.1	<0.1
h	Diked/impounded	4,758	12.3	10,079	0.1	9.7
x	Excavated	2,415	6.3	4,454	<0.1	4.3
NWI Modifiers - Water Chemistry						
i	Alkaline	64	0.2	308	<0.1	0.3

*Percentages rounded to the nearest 1/10th percent and area rounded to the nearest acre.

Palustrine System Feature Summary

Within the MRG study area, the Palustine System accounted for nearly one-third of the total number and approximately one-tenth of the area of polygon wetland features. In total, there were approximately 27,000 acres of Palustrine polygon wetlands in the project area.

Within the Palustrine System the most frequent polygon feature classification was PEM1A (Palustrine, Persistent Emergent Vegetation, Temporarily Flooded). Over 1,800 wetlands were classified as this particular wetland type. Some additional common codes in the Palustrine System included PEM1Ah (Persistent Emergent Vegetation, Temporarily Flooded, Impounded) with around 1,460 features; PEM1C (Persistent Emergent Vegetation, Seasonally Flooded) with approximately 1,080 features; and PEM1B (Persistent Emergent Vegetation, Saturated) with 930 features.

Figure 19. A PEM1A wetland in the MRG study area (SMUMN GSS photo).

Lacustrine System Feature Summary

The Lacustrine wetland polygon features identified in the project area represented less than 1% of all the polygons and total area (810 acres) of all wetlands mapped. Eight different Lacustrine System attributes (codes) described 24 Lacustrine polygon features. The most common wetland features in the Lacustrine System were L2UBFh (Lacustrine, Littoral, Unconsolidated Bottom, Semipermanently Flooded, Diked/Impounded) and L2UBGh (Unconsolidated Bottom, Intermittently Exposed, Diked/Impounded) with six polygons each. Another common type was L2UBKx (Unconsolidated Bottom, Artificially Flooded, Excavated). The largest single Lacustrine System polygon feature in terms of acreage was an L2UBGh of 230 acres in size. This impoundment is along the Rio Grande in southern Socorro County.

Riverine System Feature Summary

Some Riverine features were mapped initially as polygons while others were mapped first as linears and then buffered to create polygons. The Riverine System comprised 68% of all polygon features and 73% of total wetland area.

The most common attributes (code) among the Riverine features, by far, were R4SBJ (Riverine, Intermittent, Streambed, Intermittently Flooded) with 11,505 features and R4SB3J (Riverine, Intermittent, Cobble-Gravel Streambed, Intermittently Flooded) with 10,108 features. Other common attributes included R4SB7J (Intermittent, Vegetated Streambed, Intermittently Flooded) with 1,104 features, R4SB4J (Intermittent, Sand Streambed, Intermittently Flooded) with 498 features, and R2US2C (Lower Perennial, Unconsolidated Shore [Sand], Seasonally Flooded) with 314 features.

Nearly 76,000 acres of riverine polygons were mapped, the majority of which were considered intermittent (Table 6). Perennial Riverine areas (R2, R3) mapped included the Rio Grande, portions of the Rio Puerco and Rio Salado, west of the Rio Grande.

Figure 20. An R4SB3J wetland in the southwest portion of Socorro County (SMUMN GSS photo). Also sometimes referred to as an arroyo, dry creek, or streambed, that temporarily fills and flows after sufficient rainfall and/or snow melt.

LLWW - Landscape Position, Landform, Water Flow Path, Water Body Type

Many unique LLWW attributes or codes were identified in the MRG project area. These included nearly 550 codes for polygon wetland features.

To enhance the LLWW classification system being applied for New Mexico, the team utilized the Water Regime classifications from the NWI (Cowardin et al., 1979) data to contribute to the identification of LLWW Landforms. These Landforms included Basin, Flat, Floodplain, Fringe, or Slope wetland areas.

The most common Landscape Position classification for wetland polygons within the study area was Terrene (TE), which accounted for over 23% of total features and 13% of total wetland area. The Lotic River (LR) Landscape Position was second most common, representing 6.9% of total wetland area (Table 7).

LLWW Water Body Type classifications were completed for lakes, ponds, rivers and streams. Streams (ST) were most numerous, comprising 64.5% of features and 67% of total wetland area. The majority of streams, both in number of polygons and area, were Middle Gradient (ST2). No other water body type accounted for more than 5% of wetland area.

The most common LLWW Landform was Basin (BA), with 22% of features and about 12% of total wetland area. Floodplain (FP) wetlands accounted for 8% of wetland area, Flat (FL) wetlands for 6%, and Slope (SL) wetlands for <1%.

The LLWW Water Flow Path classification included inflow, outflow, throughflow, vertical flow, and bidirectional-nontidal. The most common flow path was Throughflow - Intermittent (TI) with 69% of polygons and 66% of wetland area, followed by Throughflow (TH) at 12% of polygons and 21% of wetland area.

Additional descriptors, known as "Other Modifiers", were added towards the end of LLWW codes. Over 30 Other Modifiers exist in the LLWW classification system, with many different combinations between these modifiers. For the project area, the most common modifiers were as follows: arroyo (ar) (28.7% of polygons), severely human-induced (hi) (13.0%), barren (br) (5.4%), and spring-fed (sf) (1.9%).

The summary for the LLWW polygon data is presented in Table 7. The reader should note that not all of the table sections sum to 100%, because vegetated wetlands were classified with the LLWW Landscape Position while open water wetlands were classified with LLWW Waterbody Types. They are mutually exclusive of each other because LLWW Water Body Types do not receive a LLWW Landform classification. Also, multiple modifiers can be applied to a single polygon.

Table 7. Summary of LLWW Codes for wetland polygons.

Summary parameter	No. of features	% of total features*	Area (acres)*	% of total wetland area	% of total project area
General					
Project Area	--	--	7,032,691	--	--
All Wetlands (polygons)	38,544	--	103,821	--	1.5
Landscape Position/Type					
Lentic (LE)	362	0.9	6,273	6.0	<0.1
Natural Deep Lake (1)	1	<0.1	35	<0.1	<0.1
Dammed River Valley Lake (2)	11	<0.1	33	<0.1	<0.1
Reservoir (2a)	292	0.8	4,968	4.8	<0.1
Flood Control Basin (3b)	7	<0.1	42	<0.1	<0.1
Other Artificial Lake (6)	51	0.1	1,195	1.1	<0.1

Summary parameter	No. of features	% of total features*	Area (acres)*	% of total wetland area	% of total project area
Lotic River (LR)	1,380	3.6	7,156	6.9	0.1
Low Gradient (1)	11	<0.1	5	<0.1	<0.1
Middle Gradient (2)	1351	3.5	7,023	6.8	0.1
Lotic Stream (LS)	1,087	2.8	2,166	2.1	<0.1
Low Gradient (1)	1	<0.1	3	<0.1	<0.1
Middle Gradient (2)	881	2.3	2,076	2.0	<0.1
High Gradient (3)	205	0.5	87	<0.1	<0.1
Terrene (TE)	8,996	23.3	13,402	12.9	0.2
Water Body Type					
Lake (LK)	14	<0.1	550	0.5	<0.1
Natural (1)	1		9		<0.1
Dammed River Valley (2)	2	<0.1	67	<0.1	<0.1
Other Dammed (3)	1	<0.1	1	<0.1	<0.1
Shallow Excavated (5)	4		116		
Other Artificial (6)	6	<0.1	357	0.3	<0.1
Pond (PD)	1,725	4.5	988	1.0	<0.1
Natural (1)	48	0.1	17	<0.1	<0.1
Dammed/Impounded (2)	718	1.8	365	0.4	<0.1
Excavated (3)	957	2.5	604	0.6	<0.1
Beaver (4)	2	<0.1	1	<0.1	<0.1
River (RV)	117	0.3	3,635	3.5	<0.1
Low Gradient (1)	2	<0.1	12	<0.1	<0.1
Middle Gradient (2)	114	0.3	3,609	3.5	<0.1
Stream (ST)	24,869	64.5	69,668	67.1	1.0
Low Gradient (1)	96	0.2	148	0.1	<0.1
Middle Gradient (2)	22,944	59.5	60,594	58.4	0.9
High Gradient (3)	1,364	3.5	6,167	5.9	<0.1
Artificial (7)	460	1.2	2,762	2.7	<0.1
Landform/Modifier					
Basin (BA)	8,546	22.2	12,794	12.3	0.1
Impoundment (ip)	3,595	9.3	2,138	2.1	<0.1
Pond (pd)	504	1.3	1,218	1.2	<0.1
Playa (pl)	2,931	7.6	6,180	6.0	<0.1
Wildlife management (wm)	107	0.3	1,636	1.6	<0.1
Flat (FL)	367	0.9	5,955	5.7	<0.1
Impoundment (ip)	65	0.2	489	0.5	<0.1
Pond (pd)	48	0.1	439	0.4	<0.1
Playa (pl)	2	<0.1	24	<0.1	<0.1
Wildlife management (wm)	57	0.1	809	0.8	<0.1
Floodplain (FP)	1,850	4.8	8,780	8.3	0.1

Summary parameter	No. of features	% of total features*	Area (acres)*	% of total wetland area	% of total project area
Basin (ba)	234	0.6	554	0.5	<0.1
Flat (fl)	1,602	4.2	8,210	7.9	0.1
Impoundment (ip)	2	<0.1	124	0.1	<0.1
Oxbow (ox)	14	<0.1	16	<0.1	<0.1
Wildlife management (wm)	11	<0.1	51	<0.1	<0.1
Fringe (FR)	120	0.3	585	0.6	<0.1
Impoundment (ip)	58	0.2	175	0.2	<0.1
Pond (pd)	92	0.2	228	0.2	<0.1
Playa (pl)	6	<0.1	50	<0.1	<0.1
Wildlife management (wm)	24	0.1	177	0.2	<0.1
Slope (SL)	935	2.4	820	0.8	<0.1
Pond (pd)	28	0.1	76	0.1	<0.1
Water Flow Path					
Bidirectional-nontidal (BI)	9	<0.1	24	<0.1	<0.1
Inflow (IN)	1,806	4.7	2,745	2.6	<0.1
Outflow (OU)	1,087	2.8	1,318	1.3	<0.1
Throughflow-intermittent (TI)	26,592	69.0	68,592	66.0	1.0
Throughflow (TH)	4,714	12.2	21,523	20.7	0.3
Throughflow-entrenched (TN)	32	0.1	125	0.1	<0.1
Vertical Flow (VR)	3,913		4,121		
Other Modifiers					
arroyo (ar)	11,078	28.7	42,584	41.0	0.6
barren (br)	2,085	5.4	2,685	2.6	<0.1
beaver (bv)	1	<0.1	28	<0.1	<0.1
channelized flow (ch)	112	0.3	1,047	1.0	<0.1
partially drained (dr)	137	0.4	1,901	1.8	<0.1
discharge to stream (ds)	376	1.0	756	0.7	<0.1
fragmented (fg)	117	0.3	256	0.2	<0.1
severely human-induced (hi)	5,004	13.0	11,384	11.0	0.2
headwater (hw)	621	1.6	661	0.6	<0.1
irrigated (ir)	71	0.2	63	<0.1	<0.1
overwash (ow)	209	0.5	700	0.7	<0.1
spring-fed (sf)	722	1.9	1,088	1.0	<0.1
tinaja (tj)+	106	0.3	9	<0.1	<0.1

*Percentages rounded to the nearest 1/10th percent and area rounded to the nearest acre.

+ A “tinaja” is a depression that is carved out of bedrock by springflow, seepage, sand/gravel scour, or waterfalls on intermittent water bodies.

Riparian Areas Summary

Serving as transitional areas between wetlands and adjacent uplands, riparian areas provide critical habitat for both resident and migratory wildlife. These areas are also important in maintaining wildlife corridors, especially in the western United States where the climate may be semi-arid or arid. The mapping of these areas for this project included the delineation and classification of features as outlined by the NWI Program of the USFWS. The classification system employed in the mapping process was the System for Mapping Riparian Areas in the Western United States (USFWS 2009).

Within the MRG project area, a total of 42,729 riparian acres were mapped and classified. Twenty-one unique riparian codes/types were mapped. Nearly all of the riparian acreage (>99%) was in Lotic (flowing) subsystems, with <1% in Lentic (still) subsystems. The majority of these areas (63% by acreage) supported scrub-shrub (SS) vegetation, with a smaller portion (26%) in forested (FO) vegetation. The majority of riparian areas (99.8%) were also classified in the Deciduous (6) Subclass. Five Dominance Types were found: Salt Cedar (24,788 acres), Mixed Deciduous (9,827 acres), Cottonwood (3,420 acres), Juniper (99 acres), and Russian Olive (95 acres). Mixes of these dominance types accounted for an additional 4,500 acres. These classifications are summarized in Table 8 and all mapped riparian areas within the study boundary are shown in Figure 21.

Table 8. Riparian areas summary for the MRG project area.

Summary Parameter	Count	% of total riparian features	Area (acres)	% of riparian area	% of project area
General					
Total Project Area	--	--	7,032,691	--	--
Riparian Features	3,697	--	42,729	--	0.6
Subsystem					
1 (Lotic)	3,693	99.9	42,618	99.7	0.6
2 (Lentic)	4	0.1	111	0.3	<0.1
Class					
Forested	1,240	33.5	11,135	26.1	0.2
Scrub-shrub	2,291	62.0	26,986	63.1	0.4
Mixed Forested/ Scrub-shrub	166	4.5	4,608	10.8	<0.1
Subclass					
Deciduous	3,687	99.7	42,630	99.8	0.6
Evergreen	10	0.3	99	0.2	<0.1
Dominance Types					
Cottonwood	106	2.9	3,420	8.0	<0.1
Salt Cedar	2,142	57.9	24,788	58.0	0.4
Russian Olive	27	0.7	95	0.2	<0.1

Summary Parameter	Count	% of total riparian features	Area (acres)	% of riparian area	% of project area
Mixed Deciduous	1,249	34.0	9,827	23.0	0.1
Cottonwood/Salt Cedar	89	2.4	2,833	6.6	<0.1
Salt Cedar/ Mixed Deciduous	44	1.2	1,431	3.3	<0.1
Cottonwood/Russian Olive	2	<0.1	8	0.1	<0.1
Russian Olive/Mixed Deciduous	20	0.5	167	0.4	<0.1
Salt Cedar/Russian Olive	8	0.2	61	0.1	<0.1
Juniper	10	0.3	99	0.2	<0.1

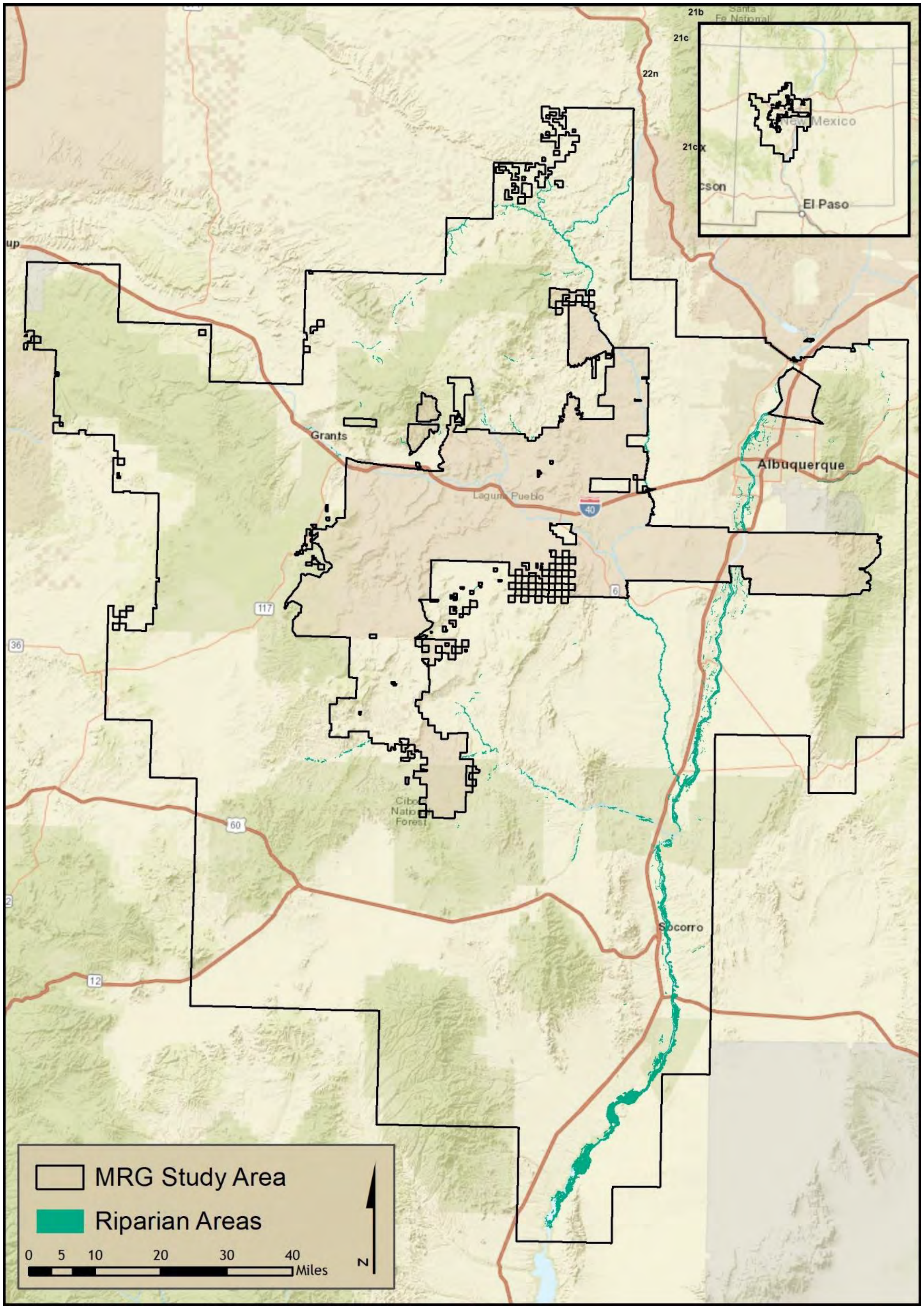

Figure 21. Riparian areas in the MRG project area.

HGM Classification Summary

The wetland polygons mapped in the MRG project area fell into four HGM classes and 12 HGM subclasses. Among the four classes, riverine wetlands were most common, with over 71% of total polygons and nearly 80% of wetland area (Table 9). Depressional was second most common, comprising 18.6% of total area. Flats and Slope took up the least area at just 1% and 0.8%, respectively.

Among Riverine subclasses, episodic wetlands were most prevalent, making up 60.9% of all wetland polygons and approximately 61% of total area. Lowland unconfined riverine wetlands comprised nearly 14% of total wetland area. Among Depressional wetlands, the artificial subclass was most common, with 16.8% of all polygons and 12.3% of total area. Playa Depressional wetlands were 7.9% of total polygons and 6.1% of total area. Mineral flats were just 0.1% of polygons and 1% of wetland area.

Modifiers were assigned to some polygons to provide additional information on HGM characteristics. Nearly 13% of all mapped polygons received an Impounded modifier. An additional 4.7% were classified as Excavated (including Excavated Inflow, Throughflow, and Vertical Flow modifiers). A very small number of wetlands (0.1%) in the project area were spring-fed.

Table 9. Summary of HGM classifications for wetland polygons.

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
General					
Project Area	--	--	7,032,691	--	--
All Wetlands (polygons)	38,544	--	103,821	--	1.5
HGM Class					
Depressional	10,125	26.3	19,330	18.6	0.3
Riverine	27,435	71.2	82,622	79.6	1.2
Slope	942	2.4	824	0.8	<0.1
Flats	42	0.1	1,044	1.0	<0.1
HGM Subclass[1]					
Playa (D)	3,039	7.9	6,307	6.1	<0.1
Artificial (D)	6,476	16.8	12,722	12.3	0.2
Natural (D)	610	1.6	302	0.3	<0.1
Episodic (R)	23,490	60.9	63,745	61.4	0.9
Montane Unconfined (R)	472	1.2	928	0.9	<0.1
Montane Canyon Confined (R)	454	1.2	881	0.8	<0.1
Lowland Unconfined (R)	2,768	7.2	14,578	14.0	0.2
Lowland Canyon Confined (R)	251	0.7	2,491	2.4	<0.1
Headwater (S)	177	0.2	225	0.2	<0.1
Other (S)	631	0.5	483	0.5	<0.1
Mineral (Fl)	42	0.1	1,044	1.0	<0.1
Springfed (S)	134	0.3	115	0.1	<0.1

Summary parameter	No. of features	% of total features	Area (acres)	% of total wetland area	% of total project area
Modifiers					
Excavated (including exc inflow, throughflow, & vertical flow)	1,824	4.7	1,355	1.3	<0.1
Impounded	4,838	12.6	11,446	11.0	0.2
Spring-fed	47	0.1	80	0.1	<0.1
Inflow	85	0.2	1,813	1.7	<0.1
Outflow	643	1.7	484	0.5	<0.1
Throughflow	392	1.0	214	0.2	<0.1
Throughflow intermittent	107	0.3	778	0.7	<0.1
Vertical flow	2,864	7.4	3,684	3.5	<0.1
Bi-directional throughflow	3	<0.1	40	<0.1	<0.1
NWI 2.0 Connection	11,505	29.8	19,478	18.8	0.3

*Percentages rounded to the nearest 1/10th percent and area rounded to the nearest acre.

[1] Letters in parentheses represent the class for each subclass (D = depressional, R = riverine, S = slope, Fl = flat).

Wetland Functional Assessment

The NWI classification system was applied to provide general baseline information about surface hydrology, plant communities, water chemistry, soils, and human impacts and wildlife influences on wetland hydrology and hydrophytic plant communities. Selection of specific NWI (Cowardin et al. 1979) system attributes in the project area during the mapping process also allowed for correlations with LLWW and HGM metrics to be made during the initial phased of the project. The final analysis of these combined coding systems resulted in the identification and classification of important wetland functions for the project area.

Wetlands perform a number of ecological functions that help improve and maintain environmental quality. When natural wetlands are degraded or filled, some wetland functions still occur through human intervention or technology. Healthy natural wetland systems technically provide functions most effectively in terms of cost and performance. Twelve wetland functions were identified as most pertinent for this project area in New Mexico.

- Aquatic Invertebrate Habitat (AIH) – habitat for aquatic invertebrates, a key component in the food chain and potential indicators of water quality,
- Bank and Shoreline Stabilization (BSS) – wetland plants help bind soil to limit or prevent erosion,
- Carbon Sequestration (CAR) – serve as carbon sinks that help to trap atmospheric carbon, a component of several greenhouse gases,
- Fish Habitat (FH) – habitat for a variety of fish (including a special category containing factors that maintain cold water temperatures for certain species including trout),

- Groundwater Recharge (GR) – sustaining sub-surface water storage and supporting base flows,

- Nutrient Transformation (NT) – breaking down of nutrients from natural sources, fertilizers or other pollutants; essentially treating the runoff,

- Other Wildlife Habitat (OWH) – habitat for other wildlife (resident and migratory),

- Sediment and Other Particulate Retention (SR) – acting as filters to physically trap sediment particles before they are carried further downstream,

- Streamflow Maintenance (SM) – providing a source of water to sustain streams from drying up during periods of drought conditions or low discharge,

- Surface Water Detention (SWD) – storage of runoff from rain events or spring melt waters which reduce the force of peak flood levels downstream,

- Waterfowl and Water Bird Habitat (WBIRD) – habitat for waterfowl and other water birds,

- Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC) – sustains natural vegetation and ecosystems including rare species.

Since the NWI and the LLWW systems are complimentary, classification of functions may result from queries in the geodatabase of the Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) codes, LLWW codes, a combination of NWI and LLWW codes, or analysis and consideration of spatial constraints (such as adjacency or physical size). Using their best professional judgment, a correlation table was developed and refined by project team experts familiar with wetland science and regional conditions unique to New Mexico (Appendix C). The result of this collaboration was the creation of specific metrics to determine which wetlands performed various functions as identified from classification attributes available in the geodatabase.

Functional Assessment Model

The mapping of the project area included both wetland delineation and the assignment of individual attributes for the NWI (Cowardin and LLWW classification systems). This information was populated in the comprehensive geodatabase permitting a variety of queries, including the ability to classify wetlands by specific functions performed.

For example, the Bank and Shoreline (BSS) Function was one of twelve wetland functions identified for the project area. To locate wetlands that perform the BSS Function in the project area, a special GIS model was developed. The example of code and related models used to query the geodatabase is found below (Figure 22). Note that the SQL code was written to query attributes from both the NWI and LLWW classification systems to identify wetlands performing, in this case, the BSS function at a high capacity (bolded numbers represent different input parameters):

1.) ("LLWW" LIKE('LR%') AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR "NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND NOT (("LLWW" LIKE ('LR%IL%') OR "LLWW" LIKE ('LR%IL')) OR ("LLWW" LIKE ('%fm') OR "LLWW" LIKE ('%fm%')))) **2.)** OR ("LLWW" LIKE('LS%') AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR "NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND NOT ("LLWW" LIKE ('%fm') OR "LLWW" LIKE ('%fm%'))) .**3.)** OR ("LLWW" LIKE('LE%') AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR "NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND NOT (("LLWW" LIKE ('LE%IL%') OR "LLWW" LIKE ('LE%IL')) OR ("LLWW" LIKE ('%fm') OR "LLWW" LIKE ('%fm')))) **4.)** OR ("NWI_System" = 'R' AND "NWI_Class" = 'RS') OR ("NWI_System" = 'L' AND "NWI_Subsystem" = '2' AND "NWI_Class" = 'RS')" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND NOT (("LLWW" LIKE ('LR%IL%') OR "LLWW" LIKE ('LR%IL')) OR ("LLWW" LIKE ('%fm') OR "LLWW" LIKE ('%fm%')))) **5.)** OR ("LLWW" LIKE('LS%') AND ("NWI_Class" = 'AB' OR "NWI_Class" = 'EM' OR "NWI_Class" = 'FO' OR "NWI_Class" = 'SS' OR "NWI_Class2" = 'AB' OR "NWI_Class2" = 'EM' OR "NWI_Class2" = 'FO' OR "NWI_Class2" = 'SS') AND NOT ("LLWW" LIKE ('%fm') OR "LLWW" LIKE

Figure 22. Functional Assessment SQL Model.

Basically, the model in the example above was used to query the geodatabase and locate all vegetated lentic, lotic river, and stream polygons that were not islands or floating mats, and in addition, riverine or lacustrine rocky shores. These were the types of wetlands determined to perform the BSS Function in the project area.

For this report, narrative summaries, individual tables demonstrating the codes and conditions for each wetland function, and sample maps are included below. Since the project area is quite large, maps for each function are merely samples of particular focus areas selected for this review. The digital geodatabase, the primary deliverable for this project, contains the extensive attribute list of classification codes as well as function assignment for every wetland mapped and classified for the project.

Functional Assessment Codes and Conditions Notation

Several “Codes and Conditions” descriptions were created for each of the 12 wetland functions found in the MRG project area. These were developed as examples to define the relationship of codes between the wetland and deepwater Habitats Classification (Cowardin et al. 1979) and the LLWW classification attributes residing in the geodatabase. The Codes and Conditions for each function demonstrate how particular wetland functions might be identified.

These descriptions represent equivalent relationships to NWI and LLWW classification hierarchies per parameters defined by the best professional judgment of project team members. In general, the NWI (Cowardin et al. 1979) and LLWW classifications are joined together by the “AND” condition (to denote that one must contain a defined model parameter) or the “NOT” condition (to denote they must never contain a particular defined model parameter). Wildcard values denote that all values are present such as “%” for a single classification, “%” for mixes, conditional primary “/%” or conditional secondary “%/” mixes. Superscripted text may be found in any of the Codes and Conditions tables. These indicate that an additional comment or special condition exists.

The Codes and Conditions correlated descriptions were designed to be read from top to bottom and were split into categorical sections based strictly on their association between Landscape Position (LLWW) and System for NWI (Cowardin et al. 1979). The following sections include examples which demonstrate how the NWI and LLWW codes were integrated to identify wetland functionality.

As noted, there were twelve wetland functions identified for the project area. Descriptions, summaries and sample maps from selected focus areas all follow. Readers may want to review the wetland functional conditions and summaries in conjunction with model-defined parameters outlined in the Correlation between Functions and Wetland Types, New Mexico (Appendix C**)**.

Aquatic Invertebrate Habitat (AIH) Function

Over 6,645 acres of wetlands were identified to perform the AIH function at the high level and approximately 4,261 acres of wetlands were ranked as moderate for this function. Aquatic invertebrate species live in all kinds of wetlands including lakes, rivers, streams, seeps, and ponds. As part of the aquatic food web, species such as mollusks, crustaceans, dragonflies, stoneflies, mayflies and water fleas all play a critical role in sustaining healthy aquatic ecosystems. Many winged adult forms of aquatic insects also provide food for various terrestrial birds, bats or reptiles. Aquatic invertebrate species and the habitats that sustain them are seriously imperiled due to wetland degradation. Some aquatic invertebrate species require a variety of habitats for their life cycle, while others tend to stay in much wetter areas throughout their lives. Typically, seasonally flooded to permanently flooded and shallower wetlands provide critical habitat to aquatic invertebrate species.

NWI and LLWW codes for wetlands performing the AIH function at a *high* level included:

- *L1%* (Lacustrine, Limnetic) and *L2%* (Lacustrine, Littoral) wetlands in either the *F* (Semipermanently Flooded), *G* (Intermittently Exposed), *H* (Permanently Flooded) Water Regime,
- *P%* (Palustrine) with *UB* (Unconsolidated Bottom), *RB* (Rock Bottom), *AB* (Aquatic Bed), *EM* (Emergent), in the *F* (Semipermanently Flooded), *G* (Intermittently Exposed) or *H* (Permanently Flooded) Water Regime,
- *R%UB* (River, Unconsolidated Bottom), in the *F* (Semipermanently Flooded), *G* (Intermittently Exposed), or *H* (Permanently Flooded) water regime,
- <u>*PD2a*</u> (Pond, Impounded, Agriculture), <u>*PD3a2*</u> (Pond, Excavated, Livestock), <u>*PD3k*</u> (Pond, Excavated, Playa [altered]), in the *F* (Semiperminanetly Flooded) or *G* (Intermittently Exposed) Water Regimes.
- <u>*PD*</u> (Pond) including <u>*PD2a*</u> (Pond, Impounded, Agriculture), <u>*PD3a*</u> (Pond, Excavated, Agriculture), <u>*PD3e*</u> (Pond, Excavated, Residential), <u>*PD3i*</u> (Pond, Excavated, other recreational), associated with *P* (Palustrine) wetlands with *UB* (Unconsolidated Bottom) in the *H* (Permanently Flooded) Water Regime,
- <u>*LE%FR*</u> (Lentic, Fringe) and *LK%* (Lake)

- Water Regimes *A* (Temporarily Flooded), *B* (Seasonally Saturated), *D* (Continuously Saturated), *E* (Seasonally Flooded/Saturated), *J* (Intermittently Flooded), and *K* (Artificially Flooded) were excluded.

NWI and LLWW codes for wetlands performing the AIH functions at a *moderate* level included:

- *LE%* (Lentic) that are also *PEM1C* (Palustrine, Emergent, Persistent, Temporarily Flooded),
- *LR%* (Lotic River) that are also *PEM1C* (Palustrine, Emergent, Persistent, Temporarily Flooded), *PUSC* (Palustrine, Unconsolidated Shore, Temporarily Flooded), or *R2USC* (Riverine, Lower Perennial, Unconsolidated Shore, Seasonally Flooded)
- *LS* (Lotic Stream) that are *PEM1C* (Palustrine, Emergent, Persistent, Temporarily Flooded) or *R%USC* (Riverine, Unconsolidated Shore, Seasonally Flooded),
- *PD* (Ponds), including *PD2a* (Pond, Impounded, Agriculture), *PD3a* (Pond, Excavated, Agriculture), *PD3f* (Pond, Excavated, Sewage Treatment), *PD3k* (Pond, Excavated, Playa [altered]),
- *TEFRpd* (Terrene, Fringe, Pond) along those ponds, and *TEBA* (Terrene, Basin) including those impounded (*ip* modifier) and spring-fed tinajas (*sf* and/or *tj* modifiers),
- *LR_FPba* (Lentic River, Floodplain, Basin),
- Water Regimes of *A* (Temporarily Flooded), *B* (Seasonally Saturated), *D* (Continuously Saturated), *E* (Seasonally Flooded/Saturated), *J* (Intermittently Flooded), and *K* (Artificially Flooded) were excluded.

Figure 23. The New Mexico Spadefoot Toad (*Spea multiplicata*) resides in floodplains or washes across the state and feeds on aquatic invertebrates (NMED SWQB photo).

Due to the semi-arid/arid conditions in New Mexico, all ponds were selected as at least moderate for the AIH Function. This category may contain some industrial, agricultural or quarry ponds based on the classification system. As noted above, this function should not include *A, B, J,* or *K* Water Regimes. This query also did not include any deep water habitats as mapped by NWI unless the LLWW wetland types were included in the query above.

A correlation table (Table 10) with specific conditions and codes that determine wetlands performing the AIH function from the project area geodatabase follows. Following the table is a map of a focus area displaying wetlands performing the AIH function (Figure 24). The focus area for the sample map is an area along the Rio Grande north of Socorro.

Table 10. Aquatic Invertebrate Habitat (AIH) Codes and Conditions.

Level of Function	Wetland Types
High	L1; L2_ F, G or H regimes; L2AB; L2UB/__(AB, EM, SS, FO); LE__ (vegetated; AB, EM, SS, FO) H or G regimes; PAB (not excavated or impounded); PUB/__(AB, EM, SS, FO); P__(UB,

Level of Function	Wetland Types
	EM, SS5, FO5) H or G; R2AB or R2EM; R2__H; RV or ST and F, G, or H regime; LEBApl (playa = L2USC); LEFRpl; R4SBC reaches with beaver wetlands or adjacent vegetated wetlands (C or wetter); P__F and adjacent to PD (PD1, PD2 b, and h, PD3b and h, and PD only), LK, RV (all except LR4), or ST (all except LS4) waters; PD (PD1, PD2 a3,b,and h, PD3b and h , and PD4 only) associated with P__(UB, AB, EM, SS, FO)F; PD (PD1, PD2b, 2h, PD3b, and 3h, and PD4) associated with P__(AB, EM, SS5, FO5)H.
Moderate	LE__ and PEM1C/F (and mixes and contiguous with waterbody) or LR__ and PEM1C/F (and mixes and contiguous with waterbody) or LS__ and PEM1C/F (and mixes and contiguous with waterbody); All PD not already selected as High; TEFRpd (along ponds); PAB (impounded or excavated and not associated with PD2 c,d,e,f,and g or PD3 c,d,e,f, and g); LR_FPba; P_USC; All rivers or streams with C regimes.
	NOTE: Exclude A, B, D, J, and K regimes from High and Moderate.

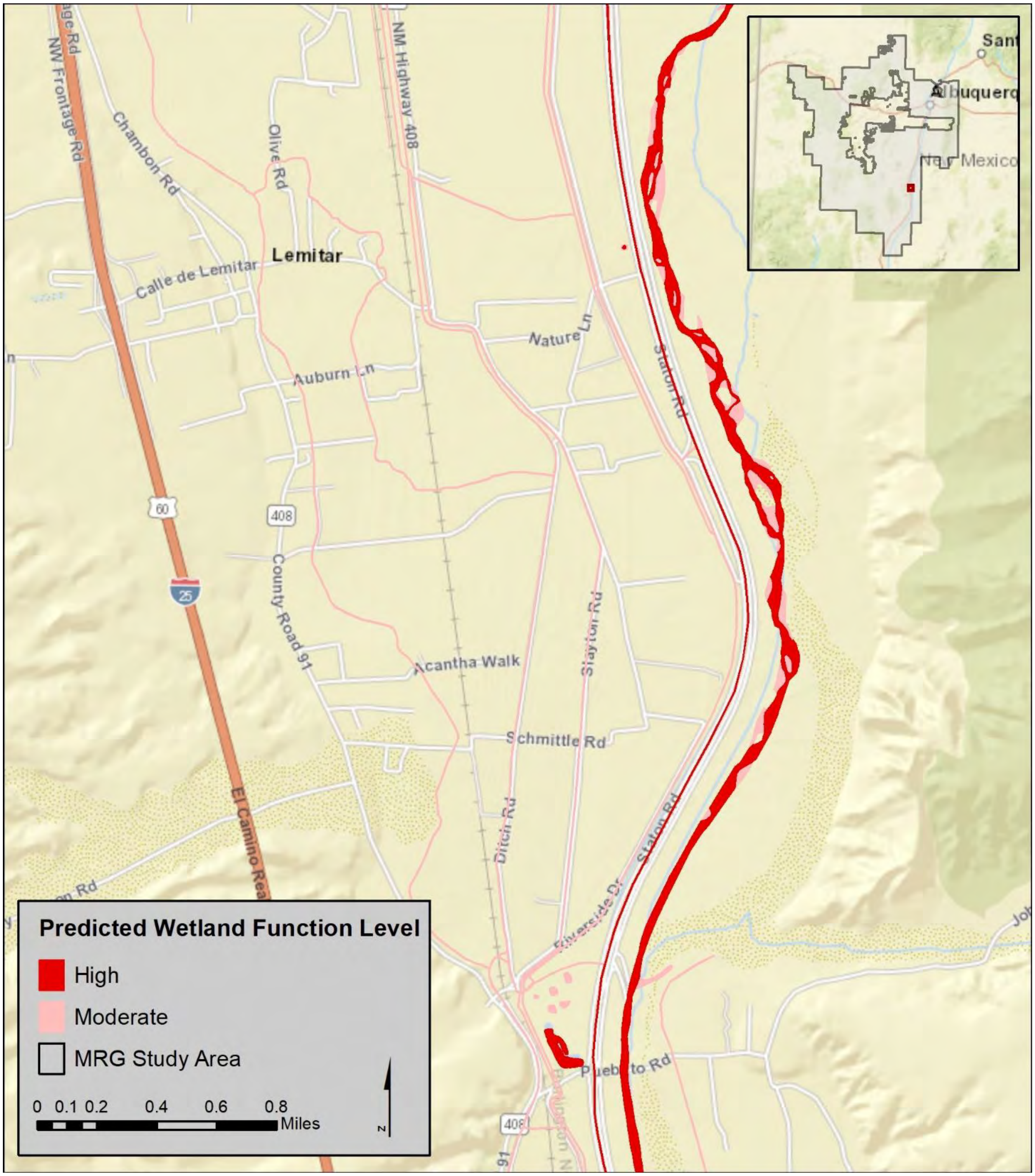

Figure 24. Aquatic Invertebrate Habitat (AIH) function sample map (area along the Rio Grande north of Socorro).

Bank and Shoreline Stabilization (BSS) Function

For this function, 12,636 acres of wetlands in the project area were predicted to function at a high level for bank and shoreline stabilization; another 2,412 acres were predicted to be moderate for bank and shoreline stabilization. Both natural shoreline stabilization structures and wetland vegetation prevent and mediate existing erosion through the binding of soils (Figure 25).

Vegetation and mixed vegetation along lake, river, stream, and pond shorelines prevent soil from being washed or blown away.

Figure 25. Vegetation helps to stabilize the banks of this stream in New Mexico (SMUMN GSS photo).

The presence of vegetation is the main factor that contributes to high functionality for Bank and Shoreline Stabilization (BSS). Non-island lentic, lotic river and lotic stream wetlands with vegetated NWI classes all function highly with respect to shoreline stabilization. The query to identify wetlands performing the BSS function utilized both the NWI and LLWW classification systems.

LLWW and NWI codes for wetlands performing the BSS function at a *high* level included:

- *LR%* (Lotic River) and rivers with the NWI (Cowardin et al., 1979) codes for vegetation including *EM* (Emergent), *FO* (Forested), or *SS* (Scrub Shrub),

- *LS%* (Lentic Stream) with *EM* (Emergent), *SS* (Scrub Shrub), or *FO* (Forested),
- *LE%* (Lentic Lake) *EM* (Emergent), or *SS* (Scrub Shrub), or *FO* (Forested).

NWI and LLWW codes for wetlands performing the BSS function at a *moderate* level included:

- Vegetated wetlands with terrene LLWW attributes. These included *TE%pd* (Terrene, Pond) and *TE%OUhw* (Terrene, Outflow, Headwater) wetlands that were attributed as dominant vegetation from NWI codes including *EM* (Emergent), *FO* (Forested), and *SS* (Scrub Shrub).

Table 11. Bank and Shoreline Stabilization (BSS) Codes and Conditions.

Level of Function	Wetland Types
High	LR_(AB, EM, SS, FO and mixes; not LRIL and not “fm”) or LS_(AB, EM, SS, FO and mixes and not “fm”) or LE__(AB, EM, SS, FO and mixes; not LEIL and not “fm”); R_RS and L2RS.
Moderate	TE__pd (AB, EM, SS, FO and mixes) or TE__OUhw (AB, EM, SS, FO and mixes) excluding islands.

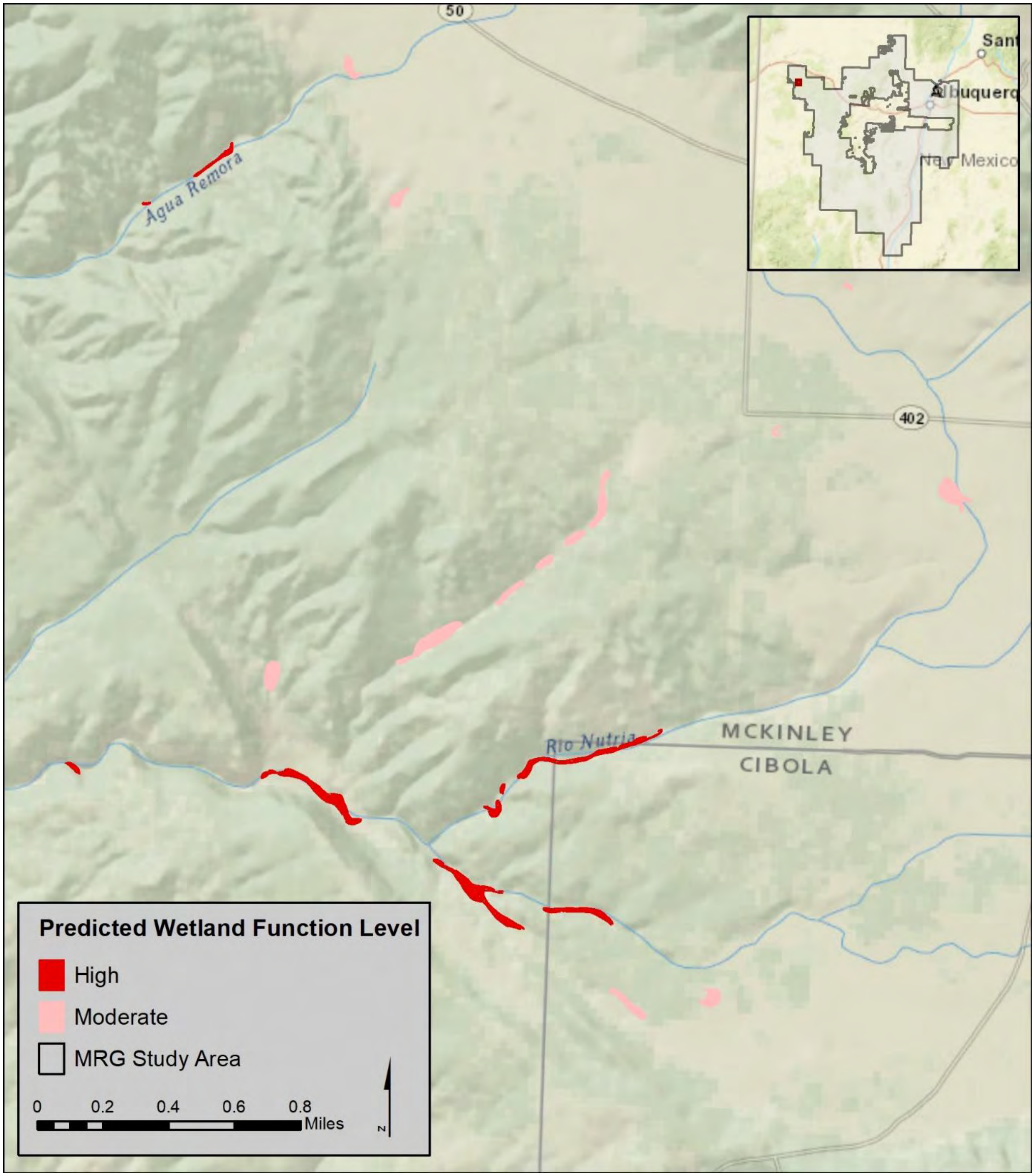

Figure 26. Bank and Shoreline Stabilization (BSS) function sample map (area along the Rio Nutria southeast of Fort Wingate).

Carbon Sequestration (CAR) Function

Wetlands performing the Carbon Sequestration (CAR) function at a high level included 3,643 acres. An additional 15,050 wetland acres were also identified as performing this function at a moderate level. Carbon sequestration occurs when wetlands act as reservoirs that absorb and store more environmental carbon than they release through chemical and biological processes such as photosynthesis. Typically, wetlands performing carbon sequestration are vegetated to some degree. Therefore, the attributes from the Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979) were the primary source of information in making predictions regarding the CAR function. Soil and Water Regime information was also generally important in determining whether a wetland functioned at a high or moderate level.

NWI codes for wetlands performing the CAR Function at a *high* level included:

- *PAB* (Palustrine, Aquatic Bed) and PEM (Palustrine, Emergent) with F (Semipermanently Flooded) water regime,
- *PAB* (Palustrine, Aquatic Bed) with *H* (Permanently Flooded) or *G* (Intermittently Flooded) water regime,
- *PEM* (Palustrine, Emergent), *PSS* (Palustrine, Scrub Shrub), *PFO* (Palustrine, Forested), and mixes with *C* (Seasonally Flooded) water regimes.

Excluded were LLWW codes for dammed, excavated or isolated impoundments ponds. Farmed wetlands (*f*) were not included in this function.

Table 12. Carbon Sequestration (CAR) Codes and Conditions.

Level of Function	Wetland Types
High	P__ (AB,EM, SS, FO and mixes)F; P_(vegetated) H or G; P__ (AB, EM, SS, FO, and mixes)C; P___Ba (and mixes); P__g (=wetlands on organic soils); R_EMC or R_EMF; L2EM_F or L2EM_C; L2AB_F, or L2AB_H or L2AB_G; P__B (permanently saturated types; bogs noted with "a"); R_AB with F, G or H regimes; PAB_G. NOTE: Exclude J regime wetlands and algal beds (AB1) from High
Moderate	P__ (EM, SS, FO, and mixes)A; or P__ (EM, SS, FO, and mixes)B (seasonally saturated types; [permanently saturated types should be rated as High]); R_EMA or L2EM_A; PUB (and mixes; and not PD2 b,c,d,e1,and f or PD3 b,c,d,e1, f, and j1, or isolated impounded ponds); PUS/vegetated; L2US/vegetated. NOTE: Exclude wetlands with a J water regime and farmed wetlands (P__f) from Moderate

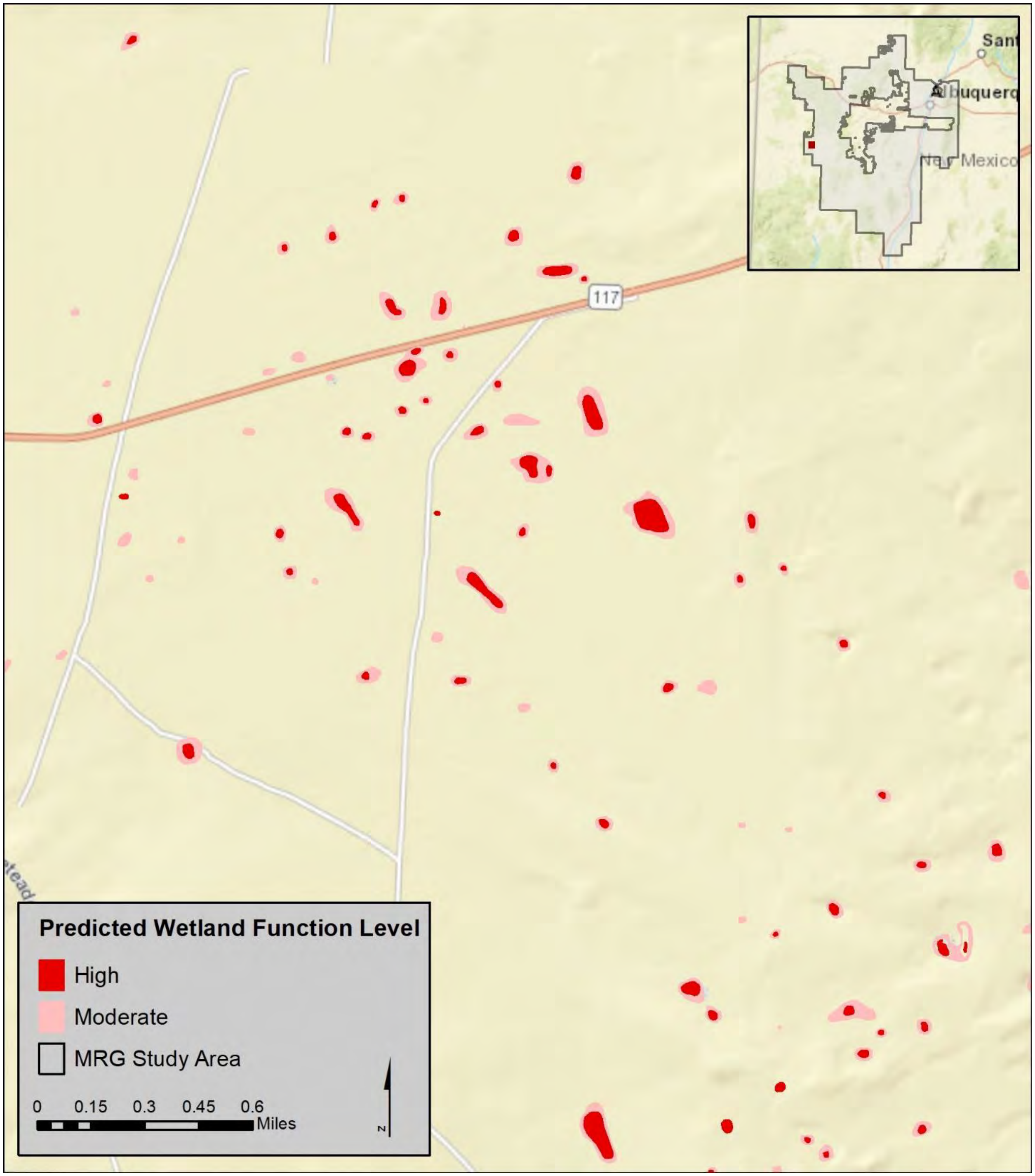

Figure 27. Carbon Sequestration (CAR) function sample map (area in southwestern Cibola County).

Fish Habitat (FH) Function

The FH function evaluation incorporated all streams and the water bodies that directly support fish life as well as adjacent wetlands that provide source water, nutrients, shade and woody debris. Wetlands performing this function included 2,804 acres of wetlands predicted as high and 1,247 acres as moderate. These wetlands include deep-water habitats such as the impoundments in the project area.

Stream shading, an important factor for cold-water fish species habitat was also predicted for wetland features. A total of 6,075 acres of wetlands were predicted to provide stream shading for fish. Streams within the MRG study area identified by the State of New Mexico as “trout streams” are shown in Figure 28.

Wetlands performing the FH function provide an environment for various stages of a fish’s aquatic life cycle. Organisms on which fish feed need wetlands to survive. Wetlands provide spawning and nursery areas and wetland vegetation provides cover for small and young fish avoiding predators. Shade provided by wetland trees or shrubs also helps maintain cooler water temperatures for cold water species.

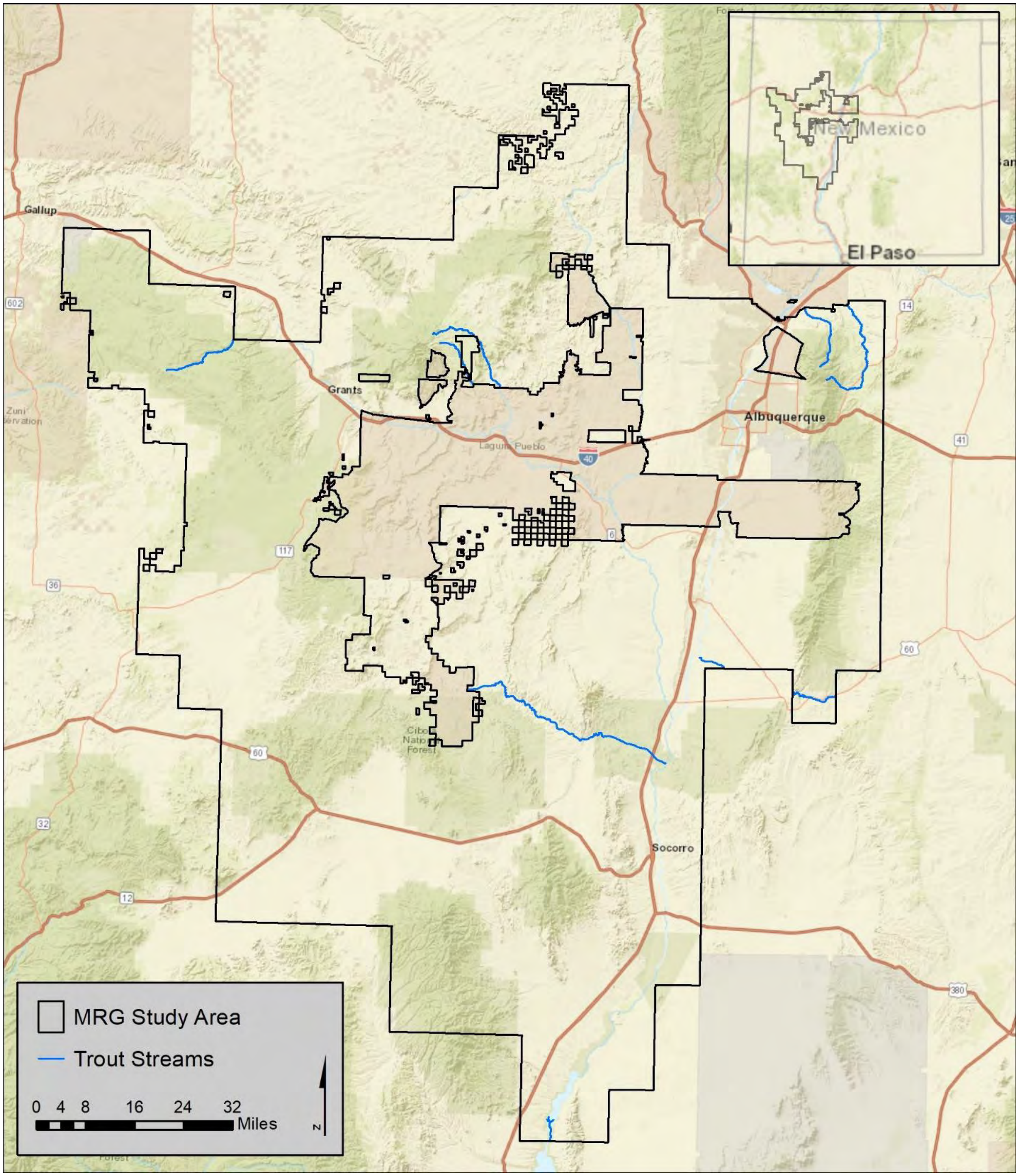

Figure 28. Trout streams within the MRG project area, as identified by the State of New Mexico.

Determining the FH function utilized a combination of both the Cowardin et al. (1979) and LLWW classification systems. Wetlands identified as high level for the FH function tended to have wetter water regimes and were typically associated with headwater wetlands or wetlands with large or moving bodies of water.

NWI and LLWW codes for wetlands performing the FH function at a *high* level included:

- Lakes or reservoirs which were coded as *L1* (Lacustrine, Limnetic) or *L2* (Lacustrine, Littoral) and which had a Water Regime modifier of either *F* (Semipermanently Flooded), *G* (Intermittently Exposed) or *H* (Permanently Flooded),
- *PAB* (Palustrine, Aquatic Bed) wetlands which were not excavated,
- *PUB* (Palustrine, Unconsolidated Bottom) wetlands with a F (Semipermanently Flooded), *G* (Intermittently Exposed) and *H* (Permanently Flooded) water regime,
- *R%USC* (Riverine, Unconsolidated Shore, Seasonally Flooded) wetlands and *R%UB* wetlands (Riverine, Unconsolidated Bottom) with F, G, or H regimes (Semipermanently Flooded, Intermittently Exposed or Permanently Flooded),
- *LK* (Lake) and *RV* (River),
- *PD* (Ponds) that were *PD1* (Pond, Natural), *PD2a* (Pond, Dammed/impounded, Agriculture), *PD2h* (Pond, Dammed/impounded, Wildlife Management), and *PD3h* (Pond, Excavated, Wildlife Management), associated with *PUB* (Unconsolidated Bottom) in the *F* (Semipermanently Flooded) Water Regime,
- *PD1* (Pond, Natural), *PD3a* (Pond, Excavated, Agriculture), *PD3e* (Pond, Excavated, residential), *PD3h* (Pond, Excavated, Wildlife Management), and *PD4* (Pond, Beaver) associated with *PUB* (Unconsolidated Bottom) wetlands in the *G* (Intermittently Exposed) or *H* (Permanently Flooded) Water Regime.

NWI Water Regimes *A* (Temporarily Flooded), *B* (Seasonally Saturated), *D* (Continuously Saturated), *E* (Seasonally Flooded/Saturated), *J* (Intermittently Flooded), and *K* (Artificially Flooded) were excluded.

LLWW and NWI codes for wetlands performing the FH function at a *moderate* level included:

- *LE%* (Lentic) AND *PEM1C* (Palustrine, Emergent, Persistent, Seasonally Flooded) as well as wetlands contiguous with the Waterbody Type,
- *LR%* (Lotic River) AND *PEM1C* (Palustrine, Emergent, Seasonally, Flooded) as well as wetlands contiguous with the Waterbody Type,
- *LS%* (Lotic Stream) AND *PEM1C* (Palustrine, Emergent, Seasonally Flooded) as well as wetlands contiguous with the Waterbody Type,
- *PD* (Pond) wetlands that were equal to or greater than one acre in size and were coded as *PD2a* (Pond, Dammed/impounded, Agriculture) or *PD3a* (Pond, Excavated, Agriculture),
- *TEFRpd* (Terrene, Fringe, Pond) along ponds.

Due to the very specific habitat conditions required for trout and other cold water species to thrive, a third level of performance specifically for trout was added to the FH function. These wetlands typically contribute to maintaining cooler water temperature through stream shading. Wetlands performing the FH shade function included:

- *LS%* (Lotic Stream) with *PSS* (Palustrine, Scrub-Shrub) or *PFO* (Palustrine, Forested) vegetation,
- *LR%* (Lotic River) with *PSS* (Palustrine, Scrub Shrub) or *PFO* (Palustrine, Forested) vegetation.

Table 13. Fish Habitat (FH) codes and conditions.

Level of Function	Wetland Types
High	L1; L2_ with F, G or H regimes; L2AB; L2UB/__(AB, EM, SS, FO); LE__(vegetated; AB, EM, SS, FO) with H or G regimes; PAB (not excavated or impounded); PUB/__(AB, EM, SS, FO); P__(EM, SS, FO, UB)G or H regimes; R2AB or R2EM; R2__H; R4SBC reaches with beaver wetlands; P__F and adjacent to PD (PD1, PD2 b,and h, PD3b and h, and PD4 only), LK, RV (all LR except LR4), or ST (all LS except LS4) waters; PD (PD1, PD2 b,and h, PD3b and h , and PD4 only) associated with P__(AB, EM, SS, FO)F; PD (PD1, PD2b, 2h, PD3b, and 3h, and PD4) associated with P__(AB, EM, SS, FO)H; PD (PD1, PD2 b,and h, PD3b and h , and PD4 only) and P__(AB, EM, SS, FO)F or PD (PD1, PD2b, 2h, PD3b, and 3h, and PD4) and P__(AB, EM, SS, FO)H; R___C or wetter that are designated fish bearing streams (Requires outside dataset to create Fish Bearing Streams input).
Moderate	LE__ and PEM1C (and mixes and contiguous with waterbody), LR__ and PEM1C (and mixes and contiguous with waterbody) or LS__ and PEM1C (and mixes and contiguous with waterbody); R4SBC or wetter reaches with adjacent vegetated wetlands (C or wetter); PD (> 1 acre in size and PD1, PD2 a, b, h, PD3 b, h, or PD4); TEFRpd (along these ponds { PD (> 1 acre in size and PD1, PD2 a, b, h, PD3 b, h, or PD4)}); PAB (impounded or excavated and >1 acre and not associated with PD2 c,d,e,f,and g or PD3 c,d,e,f, and g); LR_FPba. NOTE: Exclude A, B, J and K regimes from High and Moderate
Stream Shading	LS (not LS4 unless adjacent to R4SBC or R4SBF; or not LS__pd) and PFO or LR (not LR4 unless adjacent to R4SBC or R4SBF; or not LR__pd) and PFO, or RV and PFO or ST and PFO; LS (not LS4 or not LS_pd) and PSS (not PSS_Ba), or LR (not LR4 or not LR_pd) and PSS (not PSS_Ba), or RV and PSS (not PSS_Ba) or ST and PSS (not PSS_Ba). NOTE: Shrub bogs (PSS4Ba) should be excluded from the Shade function

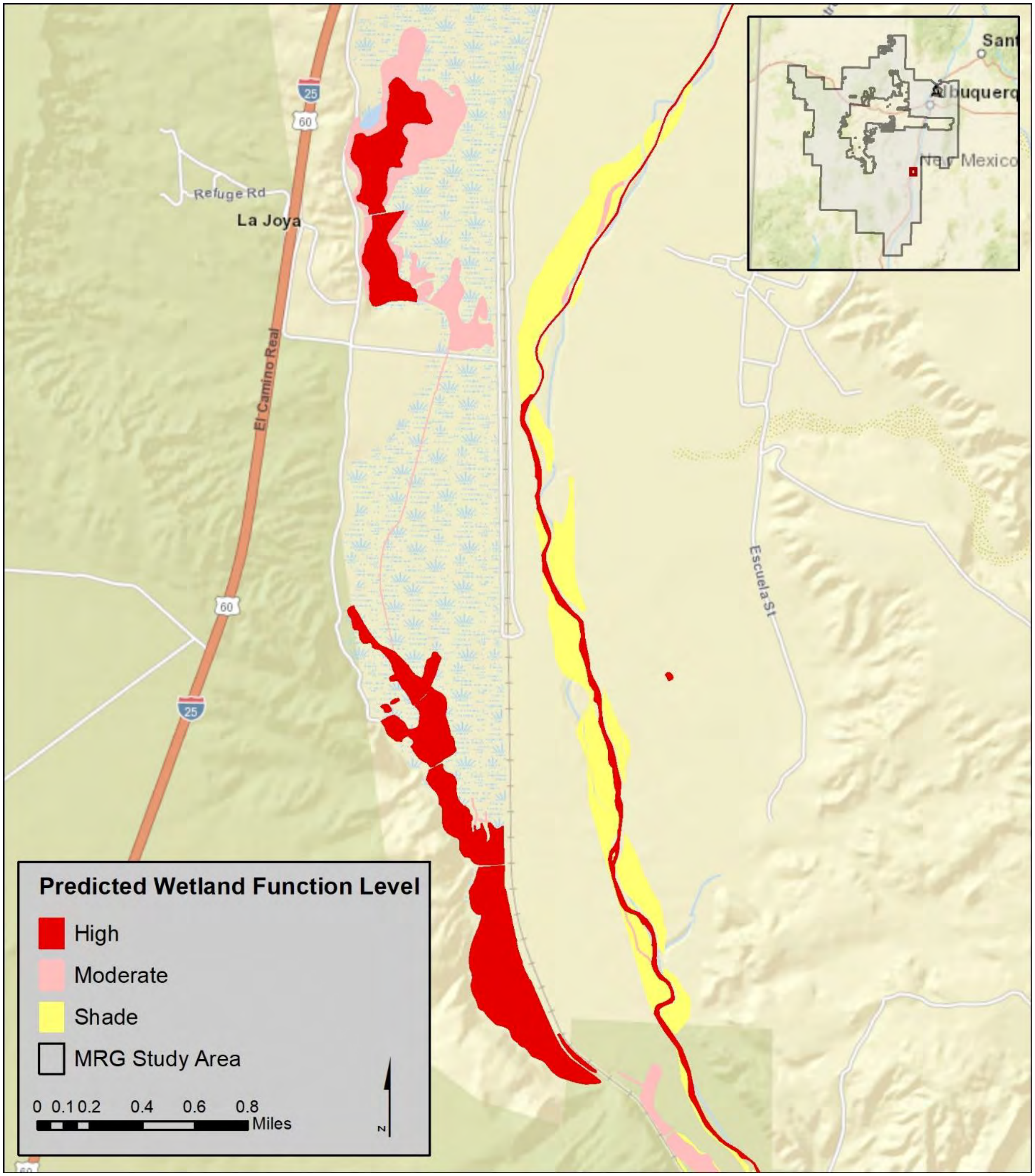

Figure 29. Fish Habitat (FH) function sample map (area along the Rio Grande, near La Joya, NM).

Groundwater Recharge (GR) Function

Approximately 81,952 acres of the wetlands mapped were found to perform the Groundwater Recharge (GR) function at a high capacity. Another 8,168 wetland acres were ranked as moderate.

Many wetlands contribute to the recharging of water tables known as the GR function. These wetlands are especially important for arid/semi-arid regions and may replenish aquifers or maintain groundwater resource important to wildlife. The GR function is primarily dependent upon the bedrock, soil, and the wetland's location. The wetland function was coded as either high or moderate depending on the permeability of underlying bedrock. A list of bedrock types assessed as being high or moderate for groundwater recharge was developed by the NMED SWQB based on assessment of the New Mexico Geology data layer using their best professional judgment. All wetland types falling within areas of high or moderate bedrock permeability were then ranked as high or moderate accordingly for this function (Table 14). For polygon wetlands that intersected with areas of high or moderate bedrock permeability, the entire polygon and any contiguous polygons (either within or outside of permeability zones) were selected as high or moderate for the function, respectively.

Table 14. Geologic Units & Groundwater Rating for intersection with wetland and riparian GIS data features.

Unit Abbreviation	Gradient / Geomorphology	Rating	Notes
Qa	*N/A*	High	Quaternary alluvium
Qa/QTs	*N/A*	High	Quaternary alluvium/Upper Santa Fe Group
Qb	Rubble/fissures	Moderate	Young Quaternary basalt
Qbo	*N/A*	Low	Older Quaternary basalt
Qe	*N/A*	High	Eolian deposits
Qea	*N/A*	High	Eolian deposits/alluvium
Qe/QTs	*N/A*	High	Eolian deposits/Upper Santa Fe Group
Ql	*N/A*	High	Quaternary landslides
Qp	*N/A*	High	Piedmont deposits
Qp/QTs	*N/A*	High	Piedmont deposits/Upper Santa Fe Group
Qp/QTsf	*N/A*	High	Piedmont deposits/Santa Fe Group, undivided
Qpl	*N/A*	Moderate	Lacustrine deposits and colluvium
QTb	*N/A*	Low	Basaltic to andesitic lava flows
QTs	*N/A*	High	Upper Santa Fe Group
QTsf	*N/A*	High	Santa Fe Group, undivided
Tfl	*N/A*	High	Fence Lake Formation
Ti	*N/A*	Low	Tertiary intrusive rocks, intermediate to silicic
Tla	*N/A*	Low	Lower middle Tertiary andesitic and dacitic lavas
Tlrp	*N/A*	Low	Lower middle Tertiary Datil Group rhyolitic dacitic
Tlv	*N/A*	Low	Lower middle Tertiary volcanic rocks
Tnb	*N/A*	Low	Basaltic to andesitic lava flows (Neogene)
Tnv	*N/A*	Low	Intermediate to silicic volcanic rocks (Neogene)
Tnr	*N/A*	Low	Silicic to intermediate lava rocks
Tsf	*N/A*	High	Santa Fe Group
Tpb	*N/A*	Low	Basaltic to andesitic lava flows (Pliocene)
Toa	*N/A*	High	Ojo Alamo Formation
Tos	*N/A*	Moderate	Upper Tertiary sedimentary units
Tual	*N/A*	Low	Lower-upper middle Tertiary basaltic andesites
Turf	*N/A*	Low	Upper middle Tertiary rhyolitic lavas/local tuffs
Tus	*N/A*	Moderate	Upper Tertiary sedimentary units
Tuv	*N/A*	Low	Upper middle Tertiary volcanic rocks
Tv	*N/A*	Moderate	Middle Tertiary volcanic rocks, undifferentiated
K	*N/A*	Moderate	Cretaceous Rocks, undivided

Unit Abbreviation	Gradient / Geomorphology	Rating	Notes
Kcc	*N/A*	High	Crevasse Canyon Formation
Kch	*N/A*	High	Cliff House Sandstone marine sandstone
Kd	*N/A*	High	Dakota Sandstone
Kdm	*N/A*	Moderate	Intertongued Dakota SS and Mancos Shale
Kdr	*N/A*	Moderate	Dakota SS/Rio Salado Tongue of Mancos Shale
Kg	*N/A*	High	Gallup Sandstone (SS)
Kgm	*N/A*	Moderate	Gallup SS/ D-Cross Tongue of Mancos Shale
Kkf	*N/A*	Low	Kirtland /Fruitland Formation
Kls	*N/A*	Low	Lewis Shale
Km	*N/A*	Low	Mancos Shale
Kma	*N/A*	Low	Moreno Hill Formation and Atorque Sandstone
Kmf	*N/A*	Moderate	Menefee Formation
Kmc	*N/A*	Moderate	McRae Formation
Kml	*N/A*	Low	Mancos Shale
Kmm	*N/A*	Low	Mulatto Tongue of Mancos Shale
Kmr	*N/A*	Low	Rio Salado Tongue of Mancos Shale
Kms	*N/A*	Low	Satan Tongue of Mancos Shale
Kmv	*N/A*	Low	Mesaverde Group
Kpc	*N/A*	High	Pictured Cliffs Formation
Kpg	*N/A*	Low	Pescado Tongue of Mancos Shale/Gallup SS
Kph	*N/A*	Low	Hosta Tongue of Point Lookout Sandstone
Kpl	*N/A*	High	Point Lookout Sandstone
Kth	*N/A*	High	Tres Hermanos Formation
Ku	*N/A*	Low	Upper Cretaceous rocks, undivided
J	*N/A*	Moderate	Jurassic, undivided
Jm	*N/A*	Low	Morrison Formation
Jsr	*N/A*	Moderate	San Rafael
Jz	*N/A*	Moderate	Zuni Sandstone
TR	*N/A*	Low	Triassic rocks, undivided
TRc	*N/A*	Low	Chinle Group
TRrp	*N/A*	Low	Rock Point Formation of Chinle Group
TRs	*N/A*	High	Santa Rosa and Moenkopi Formation
P	*N/A*	High	Pennsylvanian Rocks, undivided
Pct	*N/A*	Low	Marine redbeds
Pm	localized fractures/karst	High	Madera Group
Ps	localized fractures/karst	High	Sandia Formation
Py	tilted/faulted	Moderate	Yeso Formation
Pp	tilted/faulted	High	Permian/Pennsylvanian marine/non-marine
Ppsc	*N/A*	High	Sangre de Cristo Formation
Xm	fractured/faulted	Moderate	Metasedimentary and metavolcanics
Xp	*N/A*	Low	Granitic rocks

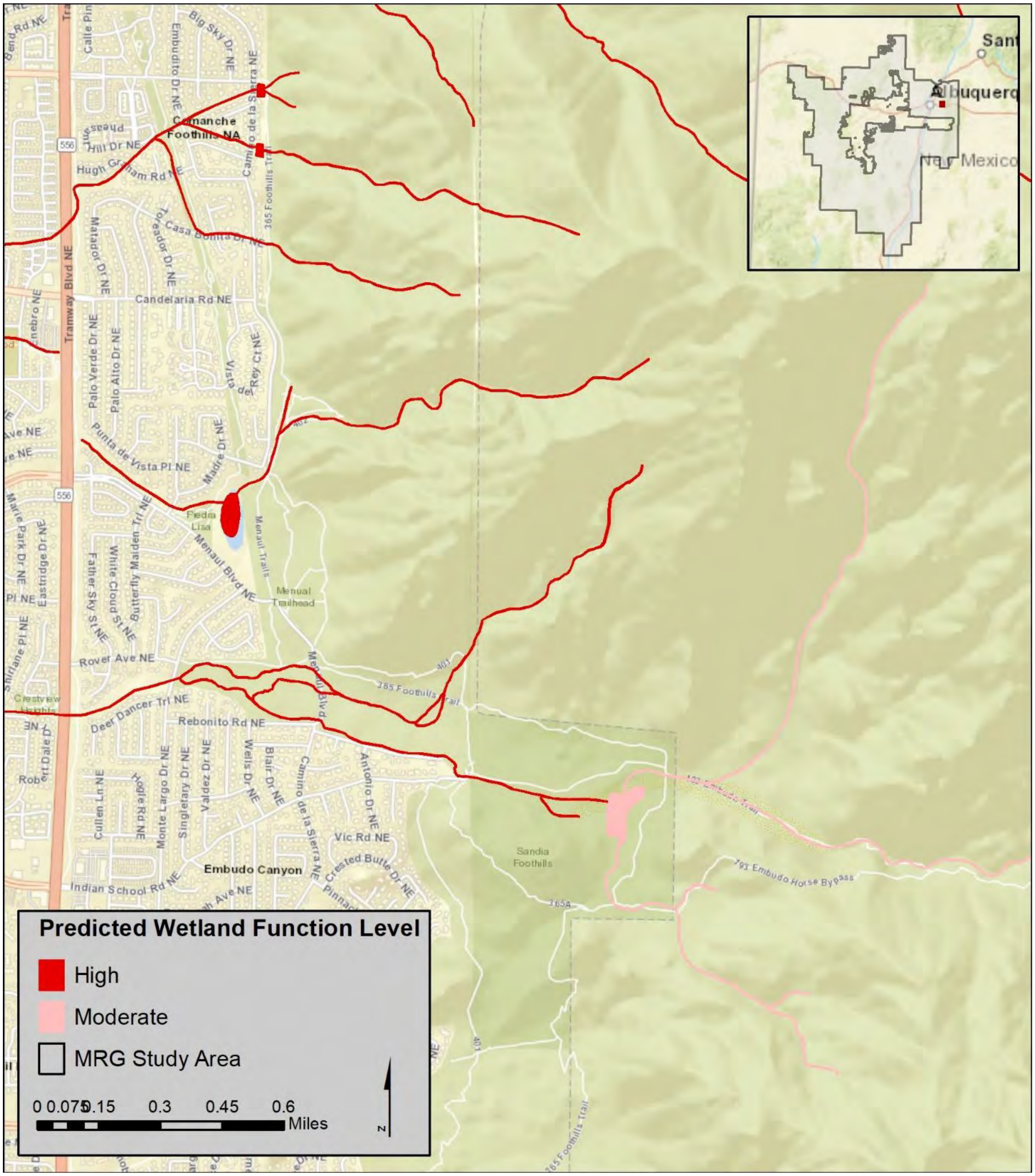

Figure 30. Groundwater Recharge (GR) function sample map (area on east edge of Albuquerque).

Nutrient Transformation (NT) Function

Around 5,662 acres of polygon wetland features were ranked as performing the Nutrient Transformation (NT) function at a high level while 12,787 acres were ranked as moderate. Nutrient transformation refers to the natural chemical processes that remove or recycle compounds in the environment. In the case of many wetlands, nitrates and phosphorous from agricultural runoff are the primary nutrients of concern. Wetlands performing the NT function are sinks for excess nutrients. The nutrients are prevented from moving further through the watershed through either storage or by wetland vegetation using the nutrients for their own life cycle. The NT function is important for the maintenance and improvement of water quality.

To identify wetlands performing the NT function, the Landscape Position (from the LLWW) was less important than other wetland characteristics such as vegetation or soil type. For this reason, the NWI (Cowardin et al. 1979) classification became the primary system that helped to define the NT function for this project.

Generally, vegetated palustrine wetlands in the project area that were classified as Seasonally, Semipermanently, or Permanently Flooded all were identified as performing the NT function to a high degree (Table 15). The NWI codes to determine the NT function included:

- *PEM* (Palustrine, Emergent), *PSS* (Palustrine, Scrub Shrub), *PFO* (Palustrine, Forested) and mixes that were *C* (Seasonally Flooded),
- *PAB* (Palustrine, Aquatic Bed) and *PEM* that were *F* (Semipermanently Flooded),
- *PAB* that were *G* (Intermittently Exposed) or *H* (Permanently Flooded),
- Concentric rings within the NWI codes for Water Regime *C* (Seasonally Flooded) involving playa basins, were also rated as highly functional for Nutrient Transformation (NT). These wetlands were identified with a special spatial adjacency query within the geodatabase.

For moderate NT function activity, vegetation was also important. Moderately functioning wetlands, however, tend to be drier than their highly functioning counterparts. NWI codes for wetlands performing the NT function at a *moderate* level included:

- PEM (Palustrine, Emergent), PSS (Palustrine, Scrub Shrub), PFO (Palustrine, Forested) and mixes that were in Water Regime B (Seasonally Saturated), D (Continuously Saturated), or E (Seasonally Flooded/Saturated),
- PEM (Palustrine, Emergent), PSS (Palustrine, Scrub Shrub), PFO (Palustrine, Forested) and mixes that were A (Temporarily Flooded),

Farmed wetlands were not rated as significant for the NT function.

Table 15. Nutrient Transformation (NT) Conditions.

Level of Function	Wetland Types
High	P__(EM, SS, FO and mixes)C; P__(AB, EM, SS5, FO5 and mixes including __/UB and UB/__, etc.)F; P__(AB, EM, SS5, FO5 and mixes)H or G; P__(EM, SS, FO and mixes)Bg (fen); L2_(AB, EM, SS5, FO5 and mixes) C, or L2_(AB, EM, SS5, FO5 and mixes) E, or L2_(AB, EM, SS5, FO5 and mixes) F or L2_(AB, EM, SS5, FO5 and mixes)H; All concentric rings within around C water regime playa basins.
Moderate	P__(EM, SS, FO and mixes)B (not "g." fen); P__(EM, SS, FO)A; L2EM_A; PUS/__(mixed with vegetation classes excluding FO5 and SS5); PUB/__(mixed with vegetation classes)H.
	NOTE: Farmed wetlands (PEM1_f) were not rated as significant for this function. Isolated J-types were not assigned a significant rating for this function.

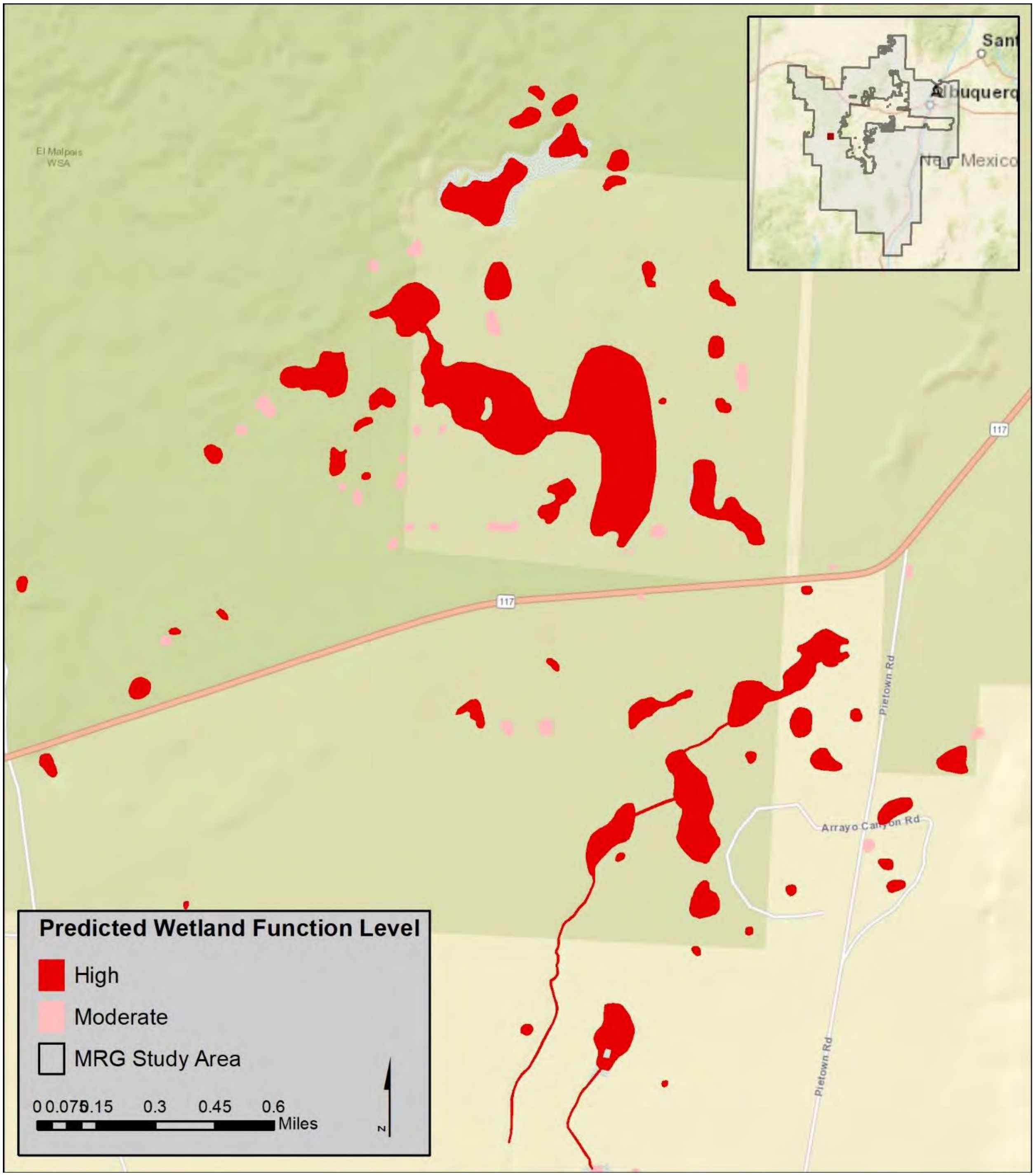

Figure 31. Nutrient Transformation (NT) function sample map (area on south edge of El Malpais National Monument).

Other Wildlife Habitat (OWH) Function

Due to the importance of this function for supporting natural wildlife populations, the queries for this function included both wetland and vegetated riparian features. For the MRG project area, approximately 97,173 acres of wetland were ranked as performing the OWH function at a high level; 36,781 acres of wetlands and riparian polygons ranked as moderate in the project area.

The OWH function is important for a variety of mammals, reptiles, and songbirds. While all wetlands and riparian areas containing vegetation are important for these species, the size of various wetlands and their mixtures of vegetation determine the level to which a wetland functions for the OWH function. Wetland/riparian complexes are also often comprised of different yet interconnected habitat types. This creates habitat corridors for both migratory and resident wildlife.

The size of the entire wetland complex determined the level of functioning versus the size of individual wetlands making up the complex. Characteristics of codes for wetlands performing the OWH function at a *high* level included

- vegetated wetland or a wetland complex equal to or greater than 12 acres in size (which was also consistent with New Mexico's Rapid Assessment Method for wetlands),
- wetland complexes 5 to 12 acres in size with two or more NWI vegetated classes,
- *PD1* (Pond, Natural) with modifiers including *f* (playa), *i* (sinkhole prairie), *hw* (headwaters), and *tj* (tinaja),
- Small wetlands (10 acres or less) which were Permanently Flooded (*H*), Intermittently Exposed (*G*), or Semipermanently Flooded (*F*), including *PUB* (Palustrine, Unconsolidated Bottom) and *PAB* (Palustrine, Aquatic Bed) water holes, except *PD2* (Pond, Dammed) or *PD3* (Pond, Excavated) wetlands with a *c* (commercial) modifier.

Vegetated wetlands that were not classified as highly functioning were classified as moderately functioning for the OWH function. The majority of these were *PEM1* wetlands in the *A* (Temporarily Flooded), *B* (Seasonally Saturated), *C* (Seasonally Flooded), or *J* (Intermittently Flooded) water regimes. Wetland complexes with two or more vegetation classes were attributed using a spatial adjacency query in the geodatabase. Vegetated riparian polygons (FO and SS) larger than 15 acres in size were also added to the OWH moderate function.

Vegetated wetlands were the focus, excluding *AB* (Aquatic Bed) from the size determination of a vegetated wetland complex. Included were vegetation mixes of *EM* (emergent), *SS* (Scrub Shrub) and *FO* (Forested) wetlands.

Table 16. Other Wildlife Habitat (OWH) Codes and Conditions.

Level of Function	Wetland Types
High	NOTE: All deep water habitats (L1 and R2__H) should be excluded from High Any "pl" wetland (whether grazed or not); Any vegetated wetland or wetland complex > 12 acres (consistent with NMRAM); certain ponds (PD1b, c, d, e, f, h, i, j, k, l, m, n, o, p, q1, q2, q3, q4); small (10 acres or less) permanently flooded or semi-permanently flooded wetlands (including PUBH, PUBG, and PUBF – watering holes, except PD2 c, d, e, f, and g, PD3 c, d, e, f, and g) and beaver wetlands (NWI b or LLWW bv); wetland complexes 5-12 acres with 2 or more vegetated classes (wetland polygons only).
Moderate	Deep water habitat (L1 and R2__H); grazed wetlands (not playas); Other vegetated wetlands; Rp1SS, Rp1FO 15+ acres (Requires ancillary dataset).

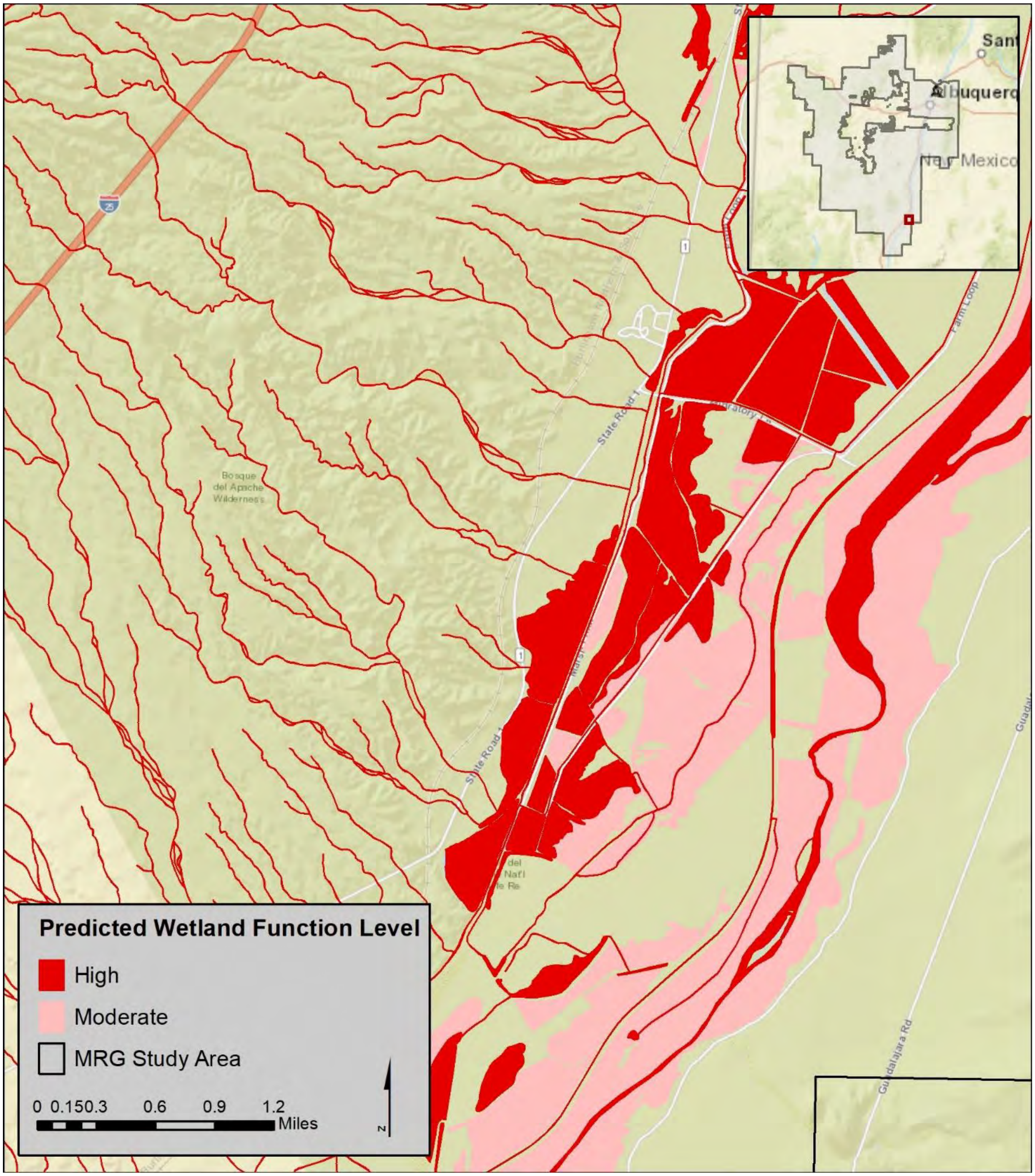

Figure 32. Other Wildlife Habitat (OWH) Function Sample Map (area along the Rio Grande within the Bosque Del Apache National Wildlife Refuge, south of San Antonio, NM).

Sediment and Other Particle Retention (SR) Function

Wetlands performing the Sediment and Other Particle Retention (SR) Function at a high level totaled 13,434 acres within the project area. Another 12,565 acres performed this function at a moderate level. Wetlands that physically trap particles affect water quality due to their sediment retention properties. In contrast to nutrient transformation, which involves chemical processes, the SR function is a physical process where the suspended particles are filtered by the soil and plant roots. This removal of suspended particles helps to improve water clarity and help maintain cooler temperatures on cold water streams.

Due to the physical nature of the SR function, the LLWW was the primary system used to make determinations, while the NWI vegetation class and Water Regime also factored into the classification process.

In general, wetlands functioning highly for the SR tended to be vegetated. However, *LEBA* (Lentic, Basins) and *LRFP* (Lotic River, Floodplain) were determined to perform sediment retention to a high degree regardless of the presence of vegetation. LLWW codes for wetlands performing the SR function at a *high* level included:

- *LS%BA* (Lotic Stream, Basins) wetlands,
- Several terrene wetland types were determined to function highly for sediment retention. All LLWW ponded terrene throughflow wetlands were included (*TE_pdTH*), such as *TEBATH* (Terrene, Basin, Throughflow) and *TEFRTH* (Terrene, Fringe, Throughflow), and
- In terms of LLWW Waterbody types, all ponds that were dammed/impounded, including *PD2a* (Pond, Dammed, Agriculture), *PD2h* (Pond, Dammed, Wildlife Management), and ponds that were excavated including *PD3a* (Pond, Excavated, Agriculture-Livestock), or *PD3d* (Pond, Excavated, Industrial).

LLWW or NWI codes for wetlands performing the SR function at a *moderate* level included:

- Non-vegetated *LEFR* (Lentic Fringe) and *LSFP* (Lotic Stream, Floodplains),
- LLWW classified ponds *TEBA* (Terrene, Basin), *PD1* (Ponds, Natural), *PD2* (Ponds, Dammed), and *PD3* (Ponds, Excavated) excluding commercial, industrial, residential sewage treatment, golf course, or mining ponds),
- *L2UB* (Lacustrine, Littoral, Unconsolidated Bottom) with an *F* (Semipermanently Flooded) or *G* (Intermittently Exposed) water regime.

It should be noted that the features coded as *R4SBJ* (arroyos) are known to contribute sediments to wetlands and were therefore excluded from this function. Saturated *B*, *D*, and *E* Water Regime wetlands were also not identified as either high or moderately significant for the SR function.

Table 17. Sediment and Other Particulate Retention (SR) Codes and Conditions.

Level of Function	Wetland Types
High	LEBA; LEFR (vegetated and mixes); LEIL(veg and mixes); LSBA; LRFP; LSFR (veg, not “fm”); LRIL (veg, not “fm”); PDTH or PDBT; TE__pd_TH or TE__pd_BT (including __pq); TEBATH, TEBABT, TEBATI, TEIFbaTH, or TEIFbaBT; PD2c1, PD2d1, PD2e1, PD3c1 or PD3e1.
Moderate	LEFR (nonveg); LEFL; LSFL (not P___B_), LRIL (nonveg), LRFR (nonveg) or LSFR (nonveg); Other TEBA (not P__B_); PD1; PD2 and PD3 (not c, d, e, f, g, j types); PD4; TEFLpd (not P__B_); TEFP__ (not P_B_); TEFL__ (P__A, not P__B_); TE__pdOU or TE__pdIN; P_, L2_ or R_ with J regimes.

Level of Function	Wetland Types
	NOTE: Exclude R4SBJ (arroyos) since they contribute sediments. No “B” wetlands should be identified as significant for this function; only flooded types: A, C, E, F, G, and H should be rated as significant either High or Moderate

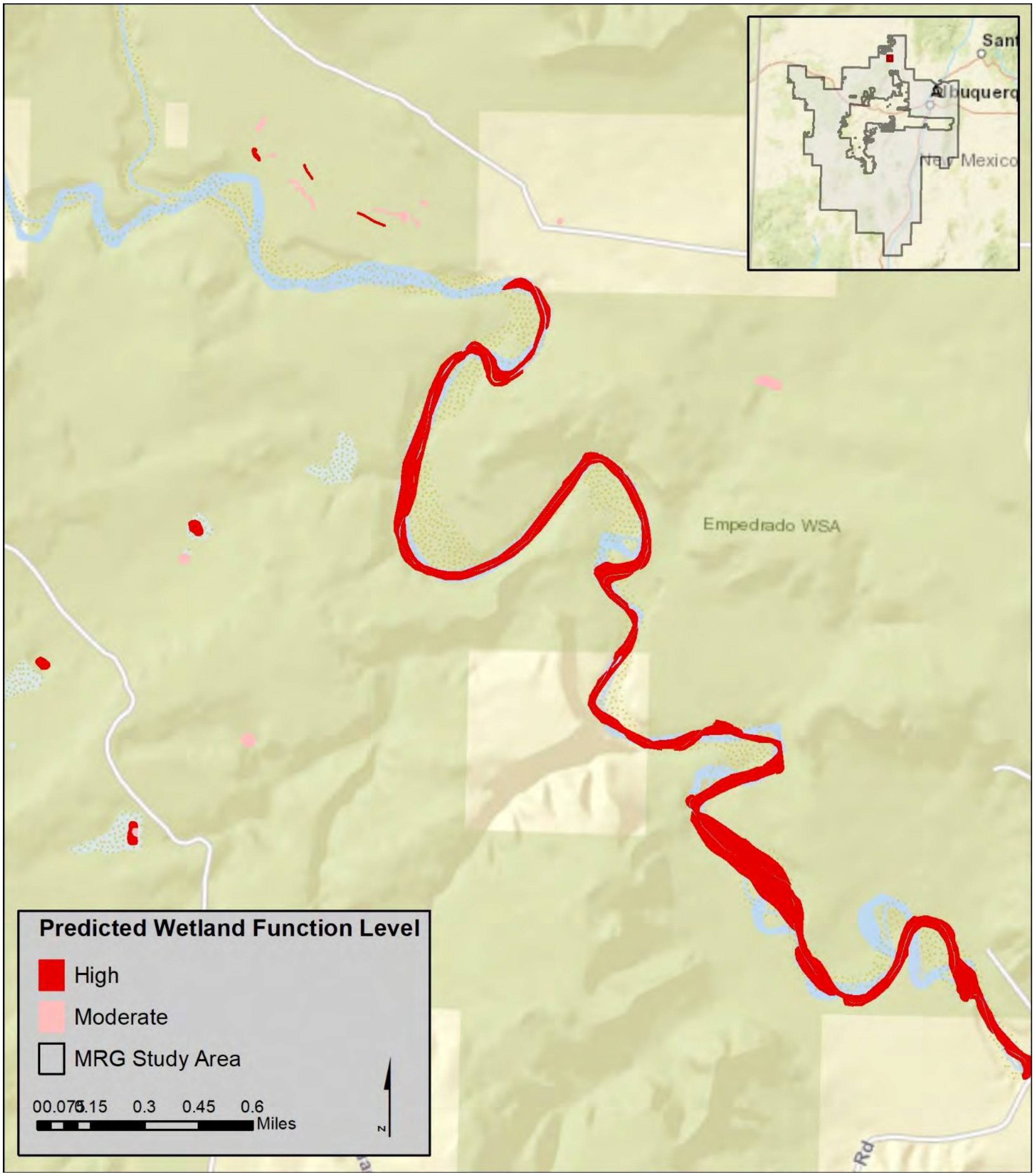

Figure 33. Sediment and Other Particulate Retention (SR) Function Sample Map (along Arroyo Chico in Sandoval County).

Streamflow Maintenance (SM) Function

Approximately 2,791 acres of the wetlands mapped in the project area were predicted to perform the Streamflow Maintenance (SM) Function at a high level. An additional 142 wetland acres performed at a moderate level.

Streamflow maintenance is the ability of a watershed to keep water traveling through a drainage system. Wetlands that help maintain streamflow are those that contribute water to the interconnected conduits within a watershed. The wetlands that typically provide the highest function for SM include headwaters and unaltered wetlands located in the upper reaches of a watershed or wetlands that contain soils with high water holding capacity.

Many streams visible on aerial photography, but not represented on USGS Digital Raster Graphics (topographic maps) or in the NHD database were identified during the image interpretation process for this project. These streams were delineated and classified during the project, and therefore now contribute to the inclusion of all headwater wetlands that are highly functional for the SM function.

Wetlands were classified as *%hw* (headwater) when they were found to be adjacent to First or Second Order Streams (as defined by hydrologic mapping for this project). These wetlands perform the Streamflow Maintenance function at a *high* level, in addition to unaltered wetlands coded in LLWW with modifiers such as *sf* (spring-fed) (Table 18). Excluded were wetlands coded with a *J* (Intermittently Flooded) Water Regime.

Table 18. Streamflow Maintenance (SM) Codes and Conditions.

Level of Function	Wetland Types
High	"hw" and "sf" wetlands (unaltered - excluding "d", "h", and "x" types and "J" types), or LR_FPba, or LRBA, or LSBA, or TEBAOUds or TESLOUds (excluding impounded wetlands from TEBAOUds and TESLOUds only).
Moderate	altered "hw" and "sf" wetlands (include NWI "d", "h" and "x" modifiers) or TEBATHds, TEBABTds. TESLTHds, or TESLBTds (excluding impounded wetlands from TEBATHds, TEBABTds, TESLTHds, and TESLBTds). Exclude J water regimes.

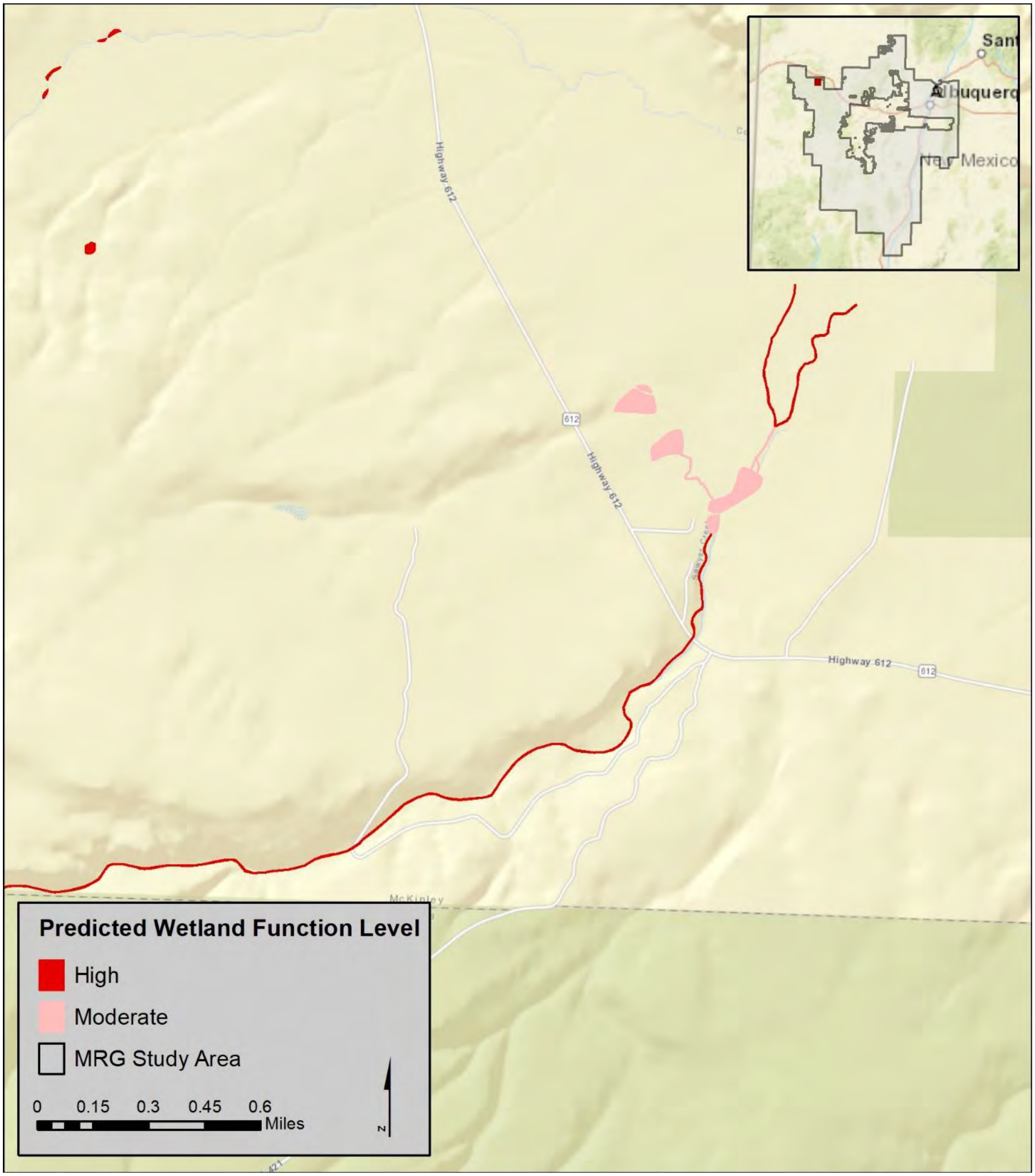

Figure 34. Streamflow Maintenance function sample map (west of Bluewater Lake).

Surface Water Detention (SWD) Function
Nearly 2,791 acres of the wetlands mapped were found to be performing the Surface Water Detention (SWD) function at a high level. Moderate performance for the SWD function included 19,311 acres of wetlands.

Wetlands trap and store surface water from precipitation or spring snowmelt. This water is slowly released through surface or underground hydrologic networks. In general, depressional wetlands that capture and store precipitation or runoff are performing the function known as Surface Water Detention (SWD). This important function provides ground water recharge points found in wetlands near stream or river floodplains or in lake basins, fringe areas, or islands. From the human perspective, this process equates to lower peak flood levels downstream.

There were a number of LLWW classifications that indicated that a wetland performed this function at a *high* level, such as wetlands coded as *LEBA%* (Lentic, Basins). This was true except when the *LE%* code was noted as a *LE5* (Lentic, Excavated) or *LE6* (Lentic, Other artificial lake) wetland when the NWI water regime modifier was *K* (Artificially Flooded), except for when the wetland was part of a reservoir or a dammed lake. Other wetlands performing this function at a high capacity included:

- Lentic/lake basins such as *LEFR* (Lentic, Fringe) which perform the surface water detention function at a high level. Again, this excluded *LE5* (Lentic, Excavated) and *LE6* (Lentic, Other artificial lake) wetlands, or wetlands with the NWI water regime modifier of *K* (unless the wetland was located within a reservoir or a dammed lake),
- *LRFPba* (Lotic River, Floodplain basin) wetlands except for *LR4* (Lotic River, Intermittent),
- Terrene Landscapes also performed the SWD function at a high level, particularly *TEBATH* (Terrene, Basin) LLWW Water Flow Paths where throughflow of water was present,
- LLWW Waterbody Types which were dammed or excavated ponds (*PD%*). Examples of these ponds might include commercial, industrial or residential storm water ponds or ponds that had been created by beavers.

The high function level for the SWD function generally did not include wetlands from the *A, B, D* or *J* Water regimes (Temporarily Flooded, Saturated, and Intermittently Flooded). Deepwater habitat (e.g., the deepwater portion of lakes such as NWI code *L1UBH*) was also excluded from this function as these features are not wetlands.

All wetlands not specifically identified as highly functioning, or wetlands listed as an exception, performed the function of SWD to a *moderate* level. But this was especially so for *LR%FP* (Lotic River, Floodplain), and terrene wetlands in a flat interfluve landform (*TEFL*), *TEFRpd* (Terrene, Fringe, ponds) or terrene basins (*TEBA*) other than noted above.

Table 19. Surface Water Detention (SWD) Codes and Condition.

Level of Function	Wetland Types
High	LSBA (not LS4 unless it is along a C-stream); LRFPba (not LR4 unless it is along a C-river); LR_BA (not LR4 unless it is along a C-river); LEBA (excluding LE5 and LE6 wetlands [excluding A, B, D, E, and J regimes] and wetlands with "K" water regime unless in a reservoir or dammed lake); LEFR (excluding LE5 and LE6 wetlands (excluding A, B, and J regimes) and wetlands with "K" water regime unless in a reservoir or dammed lake); LEFL (only in reservoir or dammed lake: LE2FL and LE3FL; not in impoundments) (NOTE: LE2FL and LE3FL meet the exception and can include "A", "B". or "J" wetlands.); LEIL (not "A" or "K" water regime); LSFR (not "A" water regime); LRFR (not "A" water regime); LRIL (not "A" water regime); PDTH, PDBT, TEFRpdTH, TEFRpdBT, TEBApdTH, TEBApdBT, TEBATH, TEBABT, TEBATI, TEIFba, PD2c1, PD2d1, PD2e1, PD3c1, PD3d1, PD3e1, PD3a2, PD4bv. NOTE: Unless otherwise noted no A, B, or J regimes or PEM_Bg wetlands in High. This function includes wetlands adjacent to deepwater habitat, but does not include the water bodies themselves.
Moderate	PEM1Ch wetlands along "A" or "J" streams; LR4FPba; LRFPfl; LRFR (other than previously selected); LS4BA; LSFL; LE1FL; LEIL (other than previously selected, excluding LE5 and LE6 wetlands); LSFR (other than previously selected); TEIFfl; TEBA (other than previously selected; excluding isolated impounded); TEBAVRbr; PD (other types but not PD2f , PD3f, and isolated impounded ponds); TE__pd (other, excluding slope wetlands TESLpd__); TEFP; TEFL.

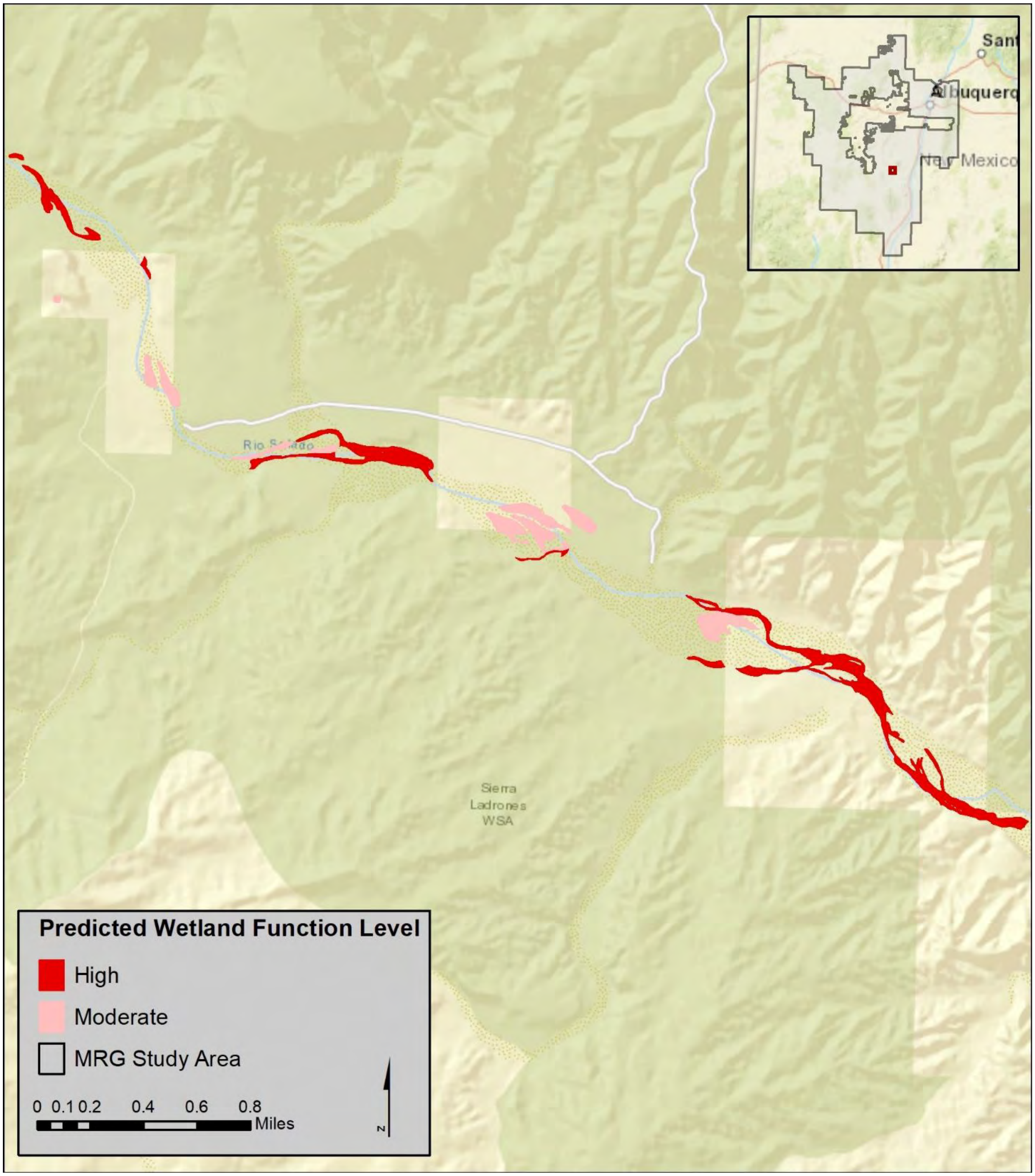

Figure 35. Surface Water Detention function sample map (along the Rio Salado, west of the Rio Grande).

Waterfowl and Water Bird Habitat (WBIRD) Function

The Waterfowl and Water Bird Habitat function (WBIRD) was performed at a high level in 2,740 acres of wetland polygons and at a moderate level in over 1,766 acres. Within the WBIRD function, the project team was interested in looking specifically at sandhill crane and wood duck habitat (Figure 36). Of the acres performing the WBIRD function, 1,764 acres were deemed sandhill crane habitat but just 261 acres were wood duck habitat.

Figure 36. The sandhill crane (left, NPS photo) and wood duck (right, USFWS photo) are two wetland-dependent birds of special interest in New Mexico.

A number of bird species rely on wetlands and associated habitats for survival. Depending on the species, critical habitat is typically associated with open water, from large littoral areas to forested ponds or streams. Wetlands performing this function provide semiaquatic or riparian habitats for many species of waterfowl, water birds or shorebirds. Due to the variety of species using these habitats, there are a range of wetland classifications that function at a high level for the WBIRD function.

NWI and LLWW codes for wetlands performing the WBIRD function at a *high* level included:

- *L2UBF* (Lacustrine, Littoral, Unconsolidated Bottom, Semipermanently Flooded),
- *P%* (Palustrine) in the *F* (Semipermanently Flooded) Water Regime and adjacent to *PD1* (Pond, Natural) or *PD2* (Pond, Dammed/impounded),
- *PUB* (Palustrine, Unconsolidated Bottom) in the *G* (Intermittently Exposed) and *H* (Permanently Flooded) water regimes,
- *PEM1%h* (Palustrine, Emergent, Persistent, Diked/impounded), in the *C* (Seasonally Flooded) and *F* (Semipermanently Flooded) water regimes,
- *LS%* (Lotic Stream) vegetated with *EM1* (Emergent, Persistent),
- *LR%* (Lotic River) vegetated with *EM1* (Emergent, Persistent) but not *LR4* (Lotic River Intermittent),
- *TE%hw* (Terrene, headwaters) also classified as *PEM1C* (Palustrine, Emergent, Persistent, Seasonally Flooded), and *TE%* with impounded or created for wildlife management (*ip* and *wm* modifiers),
- *PD2a2* (Pond, Dammed/impounded, Livestock), *PD2h* (Pond, Dammed/impounded, Wildlife Management), *PD3h* (Pond, Excavated, Wildlife Management), *PD4* (Pond, Beaver),
- *PD1* (Pond, Natural) associated with *P* (Palustrine) wetlands with *UB* (Unconsolidated Bottom) or *RB* (Rock Bottom) in either the *F* (Semipermanently Flooded) or *H* (Permanently Flooded) Water Regimes,
- Beaver wetlands coded with the *b* (Beaver) modifier or as *bv* (Beaver) in LLWW.

NWI and LLWW codes for wetlands performing the WBIRD function at a *moderate* level included *L%UB* (Lacustrine, Unconsolidated Bottom) wetlands not listed in the high category above.

- Ponds equal to or greater than one acre in size, *PD1* (Natural), *PD2a* (Pond, Dammed/impounded, Agricultural), or *PD3a* (Pond, Excavated, Agricultural),
- *PAB* (Palustrine, Aquatic Bed) that were impounded or excavated and greater than one acre in size,
- *LE%FR* (Lentic Stream, Fringe) with a *G* (Intermittently Exposed) water regime and *LK* (Lake) with a *G* (Intermittently Exposed) or *H* (Permanently Flooded) water regime,
- *TEBA%* (Terrene, Basin) and *TEFR%*, that are also classified as *PEM1* (Palustrine, Emergent, Persistent) in the *C* (Seasonally Flooded) or *F* (Semipermanently Flooded) water regimes.

The majority of wetlands providing sandhill crane habitat were *R%US* (Riverine, Unconsolidated Shore) in the *A* (Temporarily Flooded) or *C* (Seasonally Flooded) water regime. Most wetlands providing wood duck habitat were *PSS* or *PFO* (Palustrine, Scrub-shrub or Forested).

Table 20. Waterfowl and Waterbird Habitat (WBIRD) Codes and Conditions.

Level of Function	Wetland Types
High	L2_F (vegetated, AB, EM, SS, FO and mixes with non-vegetated); L2AB (and mixes with non-vegetated); L2US_with F,E, or C regimes; L2UB_F; L2_H (vegetated, AB, EM, SS, FO and mixes with non-vegetated); P__H (vegetated, EM, SS, FO including mixes with UB); PEM1Ch or PEM1Cb; LS__ and PEM1C (including mixes; not LS4); LR__ and PEM1C (including mixes; not LR4); TE__ hw and PEM1C (including mixes); LE__ and PEM1C (including mixes); PD2h, or PD3h or PD4; PUB__b; R_EMF; LEBApl, LEFRpl or LEFLpl; TE__pd and PEM1C (including mixes); beaver wetlands (NWI b or LLWW bv); P__F and adjacent to PD (PD1, PD2b, PD2h, PD3h, and PD4 only), LK, RV(not LR4) or ST(not LS4) waters; P__F and PD (PD1, PD2b, PD2h, PD3h, and PD4 only), LK, RV(not LR4) or ST(not LS4) waters; PAB (not excavated or impounded, except those associated with wildlife impoundment – “wi”); PD1 associated with P__(AB, EM, SS, FO)F, G, or H regimes.
Moderate	L1; R2__H; Other L2UB (not listed as high); Other PD (> 1 acre in size and PD1, PD2 a, h, PD3 a, h, or PD4); Other P__F (vegetated wetlands); PAB (impounded or excavated and >1 acre); LS4__ and PEM1C (>1 acre); TEBA__ and PEM1C (>1 acre).
Wood duck Habitat	LS(1 or 2)BA and PFO or SS (and mixes; not PSS3Ba); LS(1 or 2)FR and PFO or SS (and mixes; not PSS3Ba or PSSf); LR(1 or 2) FPba and PFO or SS (and mixes; not PSS3Ba or PSSf); LRFPba and PUB/FO.
Sandhill crane Habitat	P__f; LEBApl, LEFLpl or LEFRpl; R2USC or R2USA; R3USC (not montane) or R3USA (not montane).

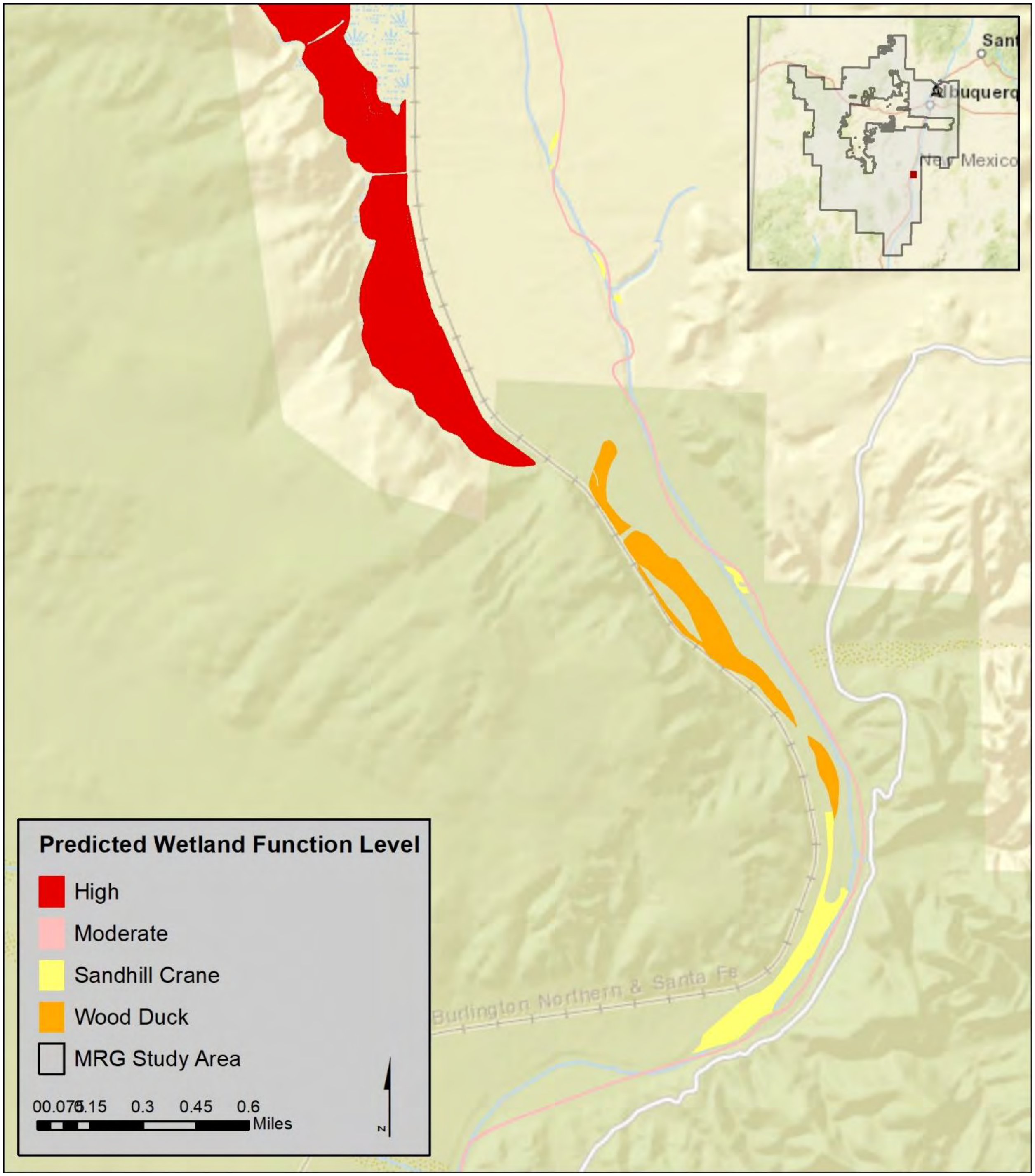

Figure 37. Waterbird and Waterfowl Habitat (WBIRD) Function Sample Map (area along the Rio Grande south of La Joya).

Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC) Function

The Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC) function is intended to identify wetlands having state or regional significance. For New Mexico, this function continues to be developed as the evaluation of unique wetland types is ongoing. Regionally-significant wetland types for the Southwest area of the country included sf (Spring-fed) wetlands that were coded as such based on image interpretation or which were within 125 meters of a spring identified by either a federal or State of New Mexico database. Examples include LLWW codes of *TESLOUsf* (Terrene, Slope, Outflow, Spring-fed) or *TEBA%sf* (Terrene, Basin, Spring-fed). Other regionally-significant wetlands include riparian, desert, or un-grazed wetlands which remain relatively undisturbed.

Analysis found that approximately 1,104 acres of wetlands provided the UWPC function (Figure 38). These wetlands were considered regionally significant, such as seeps and springs, and included slope, emergent, saturated wetlands (*PEM1B*), and spring-fed streams (*ST2%sf, ST3%sf*) and ponds (*PD%sf*).

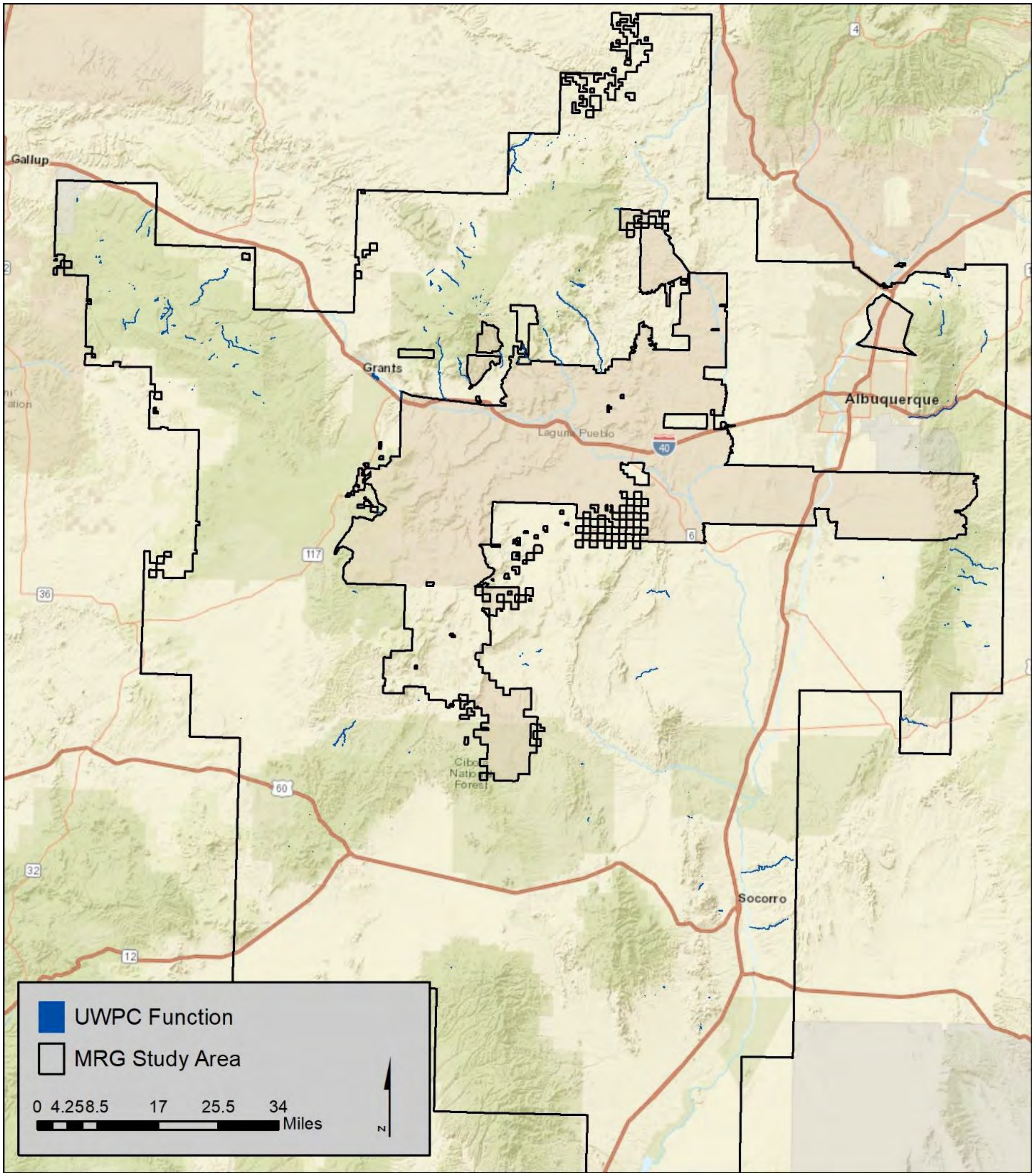

Figure 38. UWPC Function wetlands across the MRG study area.

Wetland Function Summary
Summaries of statistics for all twelve of the wetland functions identified for the project area are incorporated into a single table below (Table 21). Wetland acreages were calculated for both highly and moderately functioning conditions (and specific conditions as appropriate to each function). In order to better understand the contributions of wetlands in the watershed, the

percentage of wetlands performing each function was also calculated. While wetland classifications (e.g., NWI, LLWW) are discrete and a single feature cannot be assigned multiple classifications within the same system, a single wetland may perform multiple wetland functions. High and moderate designations within each function category are, however, mutually exclusive.

Table 21. Wetland and Aquatic Habitat Functional Assessment Summary.

Parameter	Polygon Wetland Features		
	Area (acres)	% of wetland polygons	% of project area
Project area	7,032,691	--	--
Wetlands	103,821	--	1.5
Aquatic Invertebrate Habitat (AIH)			
High	6,645	6.4	<0.1
Moderate	4,261	4.1	<0.1
Bank & Shoreline Stabilization (BSS)			
High	12,636	12.2	0.2
Moderate	2,412	2.3	<0.1
Carbon Sequestration (CAR)			
High	3,643	3.5	<0.1
Moderate	15,050	14.5	0.2
Fish Habitat (FH)			
High	2,804	2.7	<0.1
Moderate	1,247	1.2	<0.1
Stream Shading	6,075	5.8	<0.1
Groundwater recharge (GR)			
High	81,952	78.9	1.1
Moderate	8,168	7.9	0.1
Nutrient Transformation (NT)			
High	5,662	5.5	<0.1
Moderate	12,787	12.3	0.2
Other Wildlife Habitat (OWH)*			
High	97,173	93.6	1.4
Moderate	36,781	35.4*	0.5
Sediment & Other Particulate Retention (SR)			
High	13,434	12.9	0.2
Moderate	12,565	12.1	0.2
Stream-flow Maintenance (SM)			
High	2,791	2.7	<0.1
Moderate	142	0.1	<0.1
Waterfowl & Water Bird Habitat (WBIRD)			
High	2,740	2.6	<0.1
Moderate	1,766	1.7	<0.1

Parameter	Polygon Wetland Features		
	Area (acres)	% of wetland polygons	% of project area
Sandhill Crane	1,764	1.7	<0.1
Wood Duck	261	0.3	<0.1
Unique, Uncommon, or Highly Diverse Wetland Plant Communities (UWPC)			
Regionally Significant (SW U.S.)	1,104	1.1	<0.1

* Vegetated riparian areas (42,729 acres) were also considered for the OWH function at a moderate level in addition to NWI wetland area. The total acreage of NWI wetlands and riparian areas combined (146,550 acres) were used to calculate "% of wetland polygons" for this function's moderate level.

Observations

The purpose of this project was to describe the existing wetland conditions in the MRG region. This was accomplished by first mapping and classifying the wetlands using the FGDC National Wetland Mapping Standard and then applying the LLWW classification system to the mapped wetlands as additional descriptive metrics. Riparian areas were mapped using the System for Mapping Riparian Areas in the Western United States. Analysts also queried combinations of NWI and LLWW coded wetlands and other spatial layers (e.g., elevation bands) to assign wetlands to a New Mexico HGM Regional Subclass (e.g., Episodic Riverine, Spring-fed Slope). The classified wetland data combined with best professional judgment from local, regional and national experts was then used to develop a wetland functional assessment schema and perform a functional analysis. Functional analysis provides a better understanding of the roles played by these critical wetlands and watersheds in New Mexico. Wetland mapping also provides a better understanding of how conditions are changing over time. The knowledge gained through completion of the project provides the basis for the following observations:

1. The LLWW classification system provides a useful tool for storing HGM metrics of wetland function. The codes are quite detailed and must be regionally adapted.

2. Expert local and regional input is required for determining applicable/appropriate wetland functions for specific study areas and for defining the wetland types that perform those functions. A comprehensive understanding of both the FGDC and LLWW classification systems is essential for participating in this process.

3. FGDC, LLWW and spatial metrics (e.g., adjacency and connectivity) are required for adequate assignment of wetlands to functional categories because each plays a role. In particular, Cowardin et al. (1979) water regimes are critically important for determining wetland function.

4. During delineation and classification, image interpreters should employ as complete a range of FGDC, Cowardin et al. (1979), and LLWW modifiers as project imagery will support in order to provide detail for the functional assessment. Where feasible, this process should also include incorporation of classified upland buffers and vegetative species. Species may be coded with the wetland indicator status defined in the NRCS PLANTS database (https://plants.usda.gov).

5. Multiple dates of field work help to adequately validate image signatures, delineation, classification and functional assignments.

6. When available, detailed soils, surface geology and bedrock geology help to define subsurface and internal drainage, which may have implications for functional assessment assignments.

7. Image interpretation should capture standardized-width flowpaths, represented as narrow polygons, in order to adequately depict hydrologic connectivity and fully utilize the LLWW classification system. The incorporation of NWI 2.0 standards has increased that connectivity and improved the accuracy of wetland functional assessments. The new 2.0

guidance allows for overland flow connectivity and asks that water flowpaths be mapped farther up watershed reaches, thus linking more wetland polygons to these flow paths. The result is a more cohesive polygon dataset that is bound together in a more complete and interrelated representation.

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