  

Paso del Norte Watershed

RESTORATION ACTION STRATEGY

Table of Contents

Table of Figures 6
Table of Tables 7
Executive Summary 9

I. Introduction 10

The Paso del Norte Watershed Council (Council) 12

II. Project Area Background 13

Geographic and Geologic Location of the Project Area 13
Historical Description of the Rio Grande in the Project Area 14
    Colonization and Agricultural Development 14
Land Ownership 15
The Rio Grande Project 15
Rio Grande Canalization Project 16
Watershed Hydrology 17

III. Identification of Causes and Sources of Impairment 18

New Mexico Water Quality Standards 18
    The 303(d) List 18
    Total Maximum Daily Load 19
Current state of knowledge 20
    Biological Analysis 21
    The Coordinated Database Project 24
    Relevance of the CDP to the lower Rio Grande WRAS 25
Stakeholder Input and Process 26
    Stakeholder Outreach Events 27
    Neighborhood Conversations 29

IV. Best Management Practices (BMPs) 30

Limitations of the TMDL Study and Identification of Data Gaps 30
    BMPs for Pathogen Abatement 31
    BMP Conclusions 33

V. Future Recommendations 34

Future Biological Analysis 34
Monitoring 34
    Monitoring Program Objectives 35
    Designing a Water Quality Monitoring Program 36
BMPs – Future Recommendations 36
    BMP Implementation with Stakeholder Support 37

Recommendations for Future Stakeholder Outreach / Public Education 39
A Water Quality Outreach Campaign 39
Outreach Recommendations at a Glance 41
Future Interim Measurable Milestones 41
Future Funding 44
Nonpoint Source Implementation Grants 44
Environmental Quality Incentives Program 45
Targeted Watershed Grants Program 45
Small Watershed Rehabilitation Program 46
National Research Initiative Competitive Grants Program 46
Acronyms and Abbreviations 47

Appendix I - Paso Del Norte Watershed Council 48

Appendix II - Clean Water Subcommittee 51

Appendix III - Biological Analysis 52

Habitat and Land cover 52
Upland Habitats 53
Chihuahuan Semi-Desert Grasslands 53
Chihuahuan Mixed Desert and Thorn Scrub 55
Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub 56
Apacherian-Chihuahuan Mesquite Upland Scrub 57
Riparian Habitats 58
Aquatic Habitats 60
Perennial Marsh/Cienega/Spring/Seep 60
Perennial 1st and 2nd Order Stream 61
Perennial 5th Order Stream 61
Wildlife Distributions 62
Distribution and Abundance of Vertebrates 62
Geographical Distributions and Abundance of Terrestrial Vertebrates 62
Geographical Distributions and Abundance of Aquatic Vertebrates 64
Distribution and Abundance of Invertebrates 65
Wildlife Borne Infectious Diseases 66
Avian influenza 66
West Nile Virus 66
Cryptosporidium 66
Avian Botulism 67
Factors Affecting Habitat and Conservation Actions 67
Chihuahuan Semi-Desert Grasslands 67
Riparian Habitats 69
Perennial Marsh/Cienega/Spring/Seep 72
Perennial 1st and 2nd Order Stream 72
Perennial 5th Order Stream 73
Biological Analysis - Literature Cited 74

Appendix IV - Lower Rio Grande Stakeholders.....84

Appendix V - Stakeholder Interviews.....87

Municipal Point Source Discharges.....87
Urbanized High Density Areas.....90
Storm Water Management.....90
Parks and Open Space.....92
On-Site Treatment Systems.....93
Permitted Runoff from Confined Animal Feeding Operations.....94
Rangeland Grazing.....95
Federal Management.....96
State Management.....97
Private Management.....98
Waste from Pets.....99
Wildlife Other Than Waterfowl.....100

Appendix VI - Outreach Neighborhood Conversations.....102

Appendix VII – Best Management Practices (BMP's).....105

Filter Strip.....105
Detention Basin.....106
Grazing Management.....107
Improved Stormwater Management of Unpermitted CAFOs.....107
Improvements to Municipal Stormwater Management.....107
Waste Disposal and/or Utilization.....107
Replanting and Seeding of Disturbed Areas.....108
Watering Facility.....108
Domestic Pet Waste Management.....108
Cover Crop.....108
Constructed Wetland.....109

Appendix VIII - Future Stakeholder Outreach / Public Education Recommendations.....110

Appendix IX - Data Analysis.....112

U.S. Geological Survey (USGS).....112
U.S. International Boundary and Water Commission (USIBWC).....113
New Mexico Environment Department SWQB.....115

Appendix X - Paso del Norte Watershed Restoration Activities Potentially Complementary to the Watershed Restoration Action Strategy.....117

U.S. International Boundary and Water Commission..117
World Wildlife Fund..117
Elephant Butte Irrigation District..117
The U.S. Army Corp of Engineers...117
Southwest Environmental Center...118
The New Mexico State Parks Division 118
U.S. Fish and Wildlife Service (USFWS) 118
New Mexico Department of Game and Fish 119
U.S. Bureau of Land Management (BLM)...119
Natural Resource Conservation Service 119
Dona Ana Flood Commission 121
Dona Ana Planning Department 121
The City of Las Cruces Public Works Department..122

Appendix XI - Watershed Restoration Efforts in New Mexico.....................123

A Framework for a Restoration Vision for the Rio Grande, Hope for a Living River 123
New Mexico Forest and Watershed Health Plan an Integrated Collaborative Approach to Ecological Restoration 123
New Mexico Non-native Phreatophyte/Watershed Management Plan..............124
New Mexico State Water Plan 124
Restore New Mexico, U.S. Bureau of Land Management.................................124
Bibliography 126

List of Figures

Figure 1: Project area, showing location of *E. coli* sampling points and wastewater treatment plants. 13

Figure 2: 2004 SWQB averaged results of *E. coli* analyses from lower Rio Grande sampling points. 20

Figure 3: Participants of the PdNWC tour visit Mesilla Dam. 28

Figure 4: Representative site of Chihuahuan Sandy Plains Semi-Desert Grassland as an ecological system grouped into the Chihuahuan Semi-Desert Grasslands land cover type. Photo courtesy of SWReGAP. 54

Figure 5: Representative site of Chihuahuan Mixed Desert and Thorn Scrub ecological system mapped by the Southwestern Regional Gap Analysis Project. Photo courtesy of SWReGAP. 55

Figure 6: Representative site of Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub mapped by the Southwestern Regional Gap Analysis Project. Photo courtesy of SWReGAP. 56

Figure 7: Representative site of Apacherian-Chihuahuan Mesquite Upland Scrub mapped by the Southwestern Regional Gap Analysis Project. Photo courtesy of SWReGAP. 57

Figure 8: USGS bacteriological data from the Rio Grande at El Paso (Courchesne Bridge), 1978-2005. 112

Figure 9: USIBWC *E. coli* data for the Rio Grande above the confluence with the East Drain, at Anapra, and Courchesne Bridge. The maximum reporting level is 2,420 CFU/100 mL. 113

Figure 10: *E. coli* versus fecal coliform for USIBWC and USGS data sets. 114

Figure 11: SWQB *E. coli* data for 2004 from below Caballo to Leasburg. 115

Figure 12: SWQB *E. coli* data for 2004 from Leasburg to below Sunland Park (D/S SNLND). 116

List of Tables

Table 1: List of five major land owners within the watershed as mapped by the Southwest Regional Gap Analysis Project (Ernst et al. 2006). 15

Table 2: Data survey elements. 23

Table 3: Summary of estimated load reductions and BMP effectiveness. 32

Table 4: Future BMPs. 38

Table 5: Conversation series for public outreach. 41

Table 6: Proposed Phase II actions and potential participants. 43

Table 7: Proposed Phase II WRAS measurable milestones implementation schedule. 44

Table 8: Key habitats as defined by the NMDGF. 53

Table 9: Number of terrestrial vertebrate species that may be found within the watershed as mapped by the Southwest Regional Gap Analysis Project (Boykin et al. 2006). 63

Table 10: Number of terrestrial vertebrate species that may be found within the watershed as mapped by the Southwest Regional Gap Analysis Project (Boykin et al. 2006). 64

Table 11: List of fish species identified within the PdN HUC by NMDGF (2005). 65

Table 12: List of Crustaceans species identified within the PdN HUC by NMCWCS (2005). 65

Table 13: Lower Rio Grande stakeholders by interest area. 86

Table 14: Study area waste water treatment plants. 88

Table 15: Bureau of Land Management projects in the lower Rio Grande 120

Table 16: City of Las Cruces Public Works Department projects. 122

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Executive Summary

A Watershed Restoration Action Strategy (WRAS) is the product of efforts funded by 319(h) grant from the United States Environmental Protection Agency (USEPA) which is intended to assist in the remediation of water quality impairments. Portions of the Rio Grande from Caballo Reservoir to Texas-Mexico boundary have exceeded state water quality standards and were placed on the USEPA 303(d) list of impaired waters. In August of 2005, the New Mexico Environment Department Surface Water Quality Bureau solicited a request for proposals (RFP) to examine the *E. coli* impairment of the lower Rio Grande in New Mexico. *E. coli* is a bacterium found in the gut of warm blooded animals and its detection in water indicates contamination by fecal matter. While certain strains of *E. coli* are known to be pathogenic, its detection is generally used as an indication that other pathogens may also be present. In the spring of 2006, the Paso del Norte Watershed Council (Council) was awarded a 319(h) grant to form a watershed group comprised of local stakeholders to examine the impairment on the Rio Grande, develop BMPs, and write a WRAS for the watershed. To initiate this process; the Council, which was established in 2000, formed a 319(h) technical advisory subcommittee, called the Clean Water Subcommittee (Appendix II), to oversee these activities. This subcommittee has met regularly for a total of 22 times since July 1, 2006 to discuss the details of the grant progress and work with associated contractors. Four contractors were utilized by the subcommittee to accomplish the task of writing the WRAS: data and biological analysts, a stakeholder outreach coordinator, and a Council coordinator were all contracted for this process. Stakeholder perspectives were gathered through individual interviews, information sessions, and discussions with stakeholders in the Paso del Norte watershed regarding the 319(h) grant goals and process. These were followed by several larger public meetings to increase stakeholder involvement, to discuss the watershed data analysis, and to initiate discussions for appropriate BMP(s) selection. This WRAS contains the results of those efforts.

I. Introduction

According to the United States Environmental Protection Agency (USEPA) nonpoint source pollution (NPS) is the leading cause of water quality degradation in the United States and poses a substantial problem for the health of New Mexico's streams and rivers. NPS pollution is caused by diffuse contaminants and coordinated efforts are needed for remediation. In 1987, the U.S. Congress recognized that state and local water authorities were in need of financial resources to develop and implement measures to control NPS pollution. In order to meet these needs, the U.S. Congress created the 319(h) grant amendment to the Clean Water Act (CWA). The New Mexico Environment Department's Surface Water Quality Bureau (SWQB) administers Clean Water Act (CWA) 319(h) funding from the USEPA to watershed groups in order to address surface waters within its boundaries that do not meet or are not expected to meet, established water quality standards.

The CWA does not regulate NPS pollution; rather, it encourages a watershed based approach and provides economic resources through the 319(h) grant funding to develop a Watershed Restoration Action Strategy (WRAS) in order to identify best management practices (BMPs) to reduce pollutant loading. A watershed-based approach focuses on geographic boundaries defined by drainage basins instead of political or jurisdictional boundaries. This approach provides a flexible, coordinated framework to focus public and private efforts on problems within specific basins.

The CWA requires each state to file a biennial list and report to identify water bodies that do not meet standards for water quality. Any impaired waters are listed in a 303(d) list; this is accompanied by a report describing the quality of the state's waters, called the 305(b) report. Under the 319(h) grant program, funds are made available to state and local agencies, non-profit organizations, and citizen watershed groups to address NPS water pollution in regions where there are deficiencies in water quality standards identified in the 303(d)-305(b) list and report.

The project area of concern for this WRAS is the Rio Grande basin from Caballo Reservoir, approximately 70 miles north of Las Cruces, N.M., to the Texas-Mexico boundary adjacent to the cities of El Paso, TX and Ciudad Juarez, Mexico, approximately 30 miles south of Las Cruces. Over the last seven years, portions of the Rio Grande between Caballo Reservoir and the Texas-Mexico boundary have exceeded water quality standards and have been included on the SWQB's 303(d) list of impaired waters for non-attainment of the designated use, secondary contact; fecal coliform was identified as the probable cause of impairment.

Ordinarily, the SWQB makes 319(h) grant funds available to establish a watershed group that then engages in the process of creating the WRAS. The

Paso del Norte Watershed Council (Council), however, was established prior to applying for the 319(h) grant funds. The Council applied for and received the 319(h) grant funding for use beginning in July 2006. The task of the Council has been to lead the WRAS process to expand stakeholder involvement to address the impairment for this reach of the Rio Grande that does not meet water quality standards.

The guiding principles for creating a WRAS are stakeholder partnerships, a geographic focus, and sound science. Over the years successful 319(h) projects have demonstrated the positive effects of involving stakeholders in watershed management decisions by generating sustainable levels of long-term support.
A good WRAS document institutes a plan for protecting and restoring watershed health and water quality.

A watershed approach is most effective due to the integration of the wide variety of issues between land use, climate, hydrology, drainage, and vegetation within a watershed basin. A WRAS provides a non-regulatory, stakeholder driven, voluntary approach to addressing NPS impacts to water quality within a designated watershed. This WRAS is not based on legal obligations; it is a general blueprint for a comprehensive, watershed-wide restoration program. A WRAS consists of nine key criteria (USEPA and SWQB). They are listed as follows:

1) Identification of the causes and sources of non-point source water pollution that will need to be controlled;
2) Estimation of load reductions expected for the management of measures used to achieve water quality goals;
3) A description of the management measures that will need to be implemented to achieve pollution load reductions, i.e., implementation of pollution control and natural resource protection measures;
4) Funding needs to support the implementation and maintenance of restoration measures;
5) The public outreach method(s) and structure that will be used to engage an maintain public and governmental involvement including local, state, federal, and tribal governments;
6) A schedule for implementation of needed restoration measures and identification of appropriate lead agencies to oversee implementation, maintenance, monitoring, and evaluation;
7) A description of interim, measurable milestones for the actions to be taken and desired water quality goals and outcomes;
8) A set of criteria that can be used to determine whether load reductions are being achieved over time and substantial progress is being made towards achieving water quality standards;
9) Any monitoring and evaluation activities need to refine the problems or assess progress towards achieving water quality goals.

The Paso del Norte Watershed Council (Council)

The Council is an alliance of private citizens, non-governmental organizations, representatives of federal and state agencies, water utilities, municipal governments, and universities that partner and provide an integrated vision for watershed management in the Paso del Norte watershed region. Within the Council, diverse regional interests and interdisciplinary expertise provide specialized perspectives on watershed issues. The Council provides an open and inclusive forum for communication, collaboration, and innovative thinking concerning watershed issues for the benefit of agricultural, environmental, and municipal interests. The watershed lies within a bi-national, tri-state region that serves towns, municipalities, and irrigation districts. A full description of the Council can be found in Appendix I. Its mission is as follows:

> Investigate, develop, and recommend options for watershed planning and management and to explore how water-related resources can best be balanced to benefit the Rio Grande ecosystem and the interests of all watershed stakeholders. The Council's focus is the Paso del Norte Watershed, defined as the Rio Grande basin between Elephant Butte Dam/Reservoir in southern New Mexico and Fort Quitman, Hudspeth County, Texas. The Council provides an open forum for the encouragement and development of activities that lead to a healthy watershed.

II. Project Area Background

Geographic and Geologic Location of the Project Area

The project area is the Rio Grande basin from Caballo Reservoir, approximately 70 miles north of Las Cruces, N.M., to the Texas-Mexico boundary adjacent to the cities of El Paso, TX and Ciudad Juarez, Mexico, approximately 30 miles south of Las Cruces. The area is a sub unit of the El Paso-Las Cruces Watershed (USGS HUC unit 13030102) of the northern Chihuahuan Desert and is located in Sierra and Doña Ana counties of south-central New Mexico. The watershed begins at the Caballo Reservoir dam, a main stem impoundment of the Rio Grande, and extends south to the Texas-New Mexico border and the international boundary with Mexico. The eastern edge of the watershed is bordered by the Caballo, Dona Aña, Organ, and Franklin mountain ranges. The western edge of the watershed is bordered by the Mimbres Mountains of the southern Black Range, the Sierra de las Uvas, the Robledo Mountains, and fault block volcanic uplands extending south to the East Potrillo Mountains (Hawley 2004).

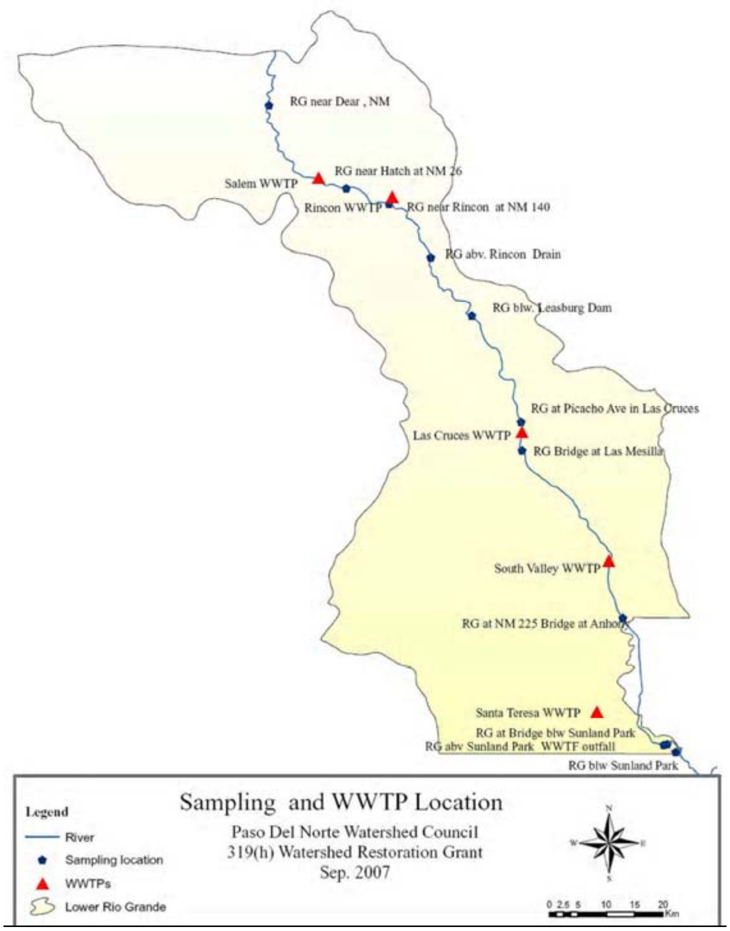

Figure 1: Project area, showing location of *E. coli* sampling points and wastewater treatment plants.

The Rio Grande is the major surface water feature in the project area. There are also two perennial streams in the far northwestern boundary of the watershed – Tierra Blanca Creek, and Berrenda Creek. While these two creeks are perennial in their upper reaches, they are ephemeral by the time they reach the Rio Grande. The remaining drainages in the watershed are ephemeral.

Historical Description of the Rio Grande in the Project Area

Historically, the Rio Grande in the project area had a fairly wide floodplain with a sinuous and sometimes braided, meandering channel with small oxbows, sloughs, cienegas, marshes, and other associated riparian features. A map prepared by John Pope in 1854 shows 25 meanders in the stretch of the Rio Grande from just above Doña Ana to Fort Fillmore a few miles south of Mesilla (Ackerly 1992). The map also depicts dual channels with small islands on many of the meander bends. Maps prepared for the Government Land Office (GLO) from the mid to late 1800's outlining the acequia system of the Mesilla Valley also depict a meandering channel and identify several sloughs and a lagoon (Ackerley 1992). Diego Perez de Luxan, a member of the Espejo expedition of 1582-1583, described pools and marshes including associated wetland vegetation along the Rio Grande in both the Mesilla and Palomas valleys (Luxan 1929). There are numerous similar accounts which also include descriptions of elevated salinity in many of these areas. A U.S. government survey in 1857 described incrustations of salt and alkali on soils in the bottom lands around present day Sunland Park and Mesquite, New Mexico.

The river channel was constantly evolving and changing location depending on the flow patterns which shifted from low flows during drought periods to catastrophic floods that realigned the channel. The high sediment load of the Rio Grande in southern New Mexico led to the formation of point bars, sand bars, islands, and plugging of the channel which often forced the river to find a new path. The effects of the sediment load were felt during both high and low flows. The United States Bureau of Reclamation (USBR) mapped the various known remnant river channels in the Mesilla Valley in 1914 and identified over nine different abandoned channels from 1844-1912 (Ackerly 1992). Sections of many of these remnant channels are still visible today.

Colonization and Agricultural Development

Native Americans of the Mogollon culture are the earliest known inhabitants of the area. Petroglyphs and several small village sites which date from 100 BC to 1400 AD have been discovered in the Sierra de las Uvas and Robledo Mountains. The earliest Spanish explorers mention the Manso Apache Indians (Manso), and reports from Don Juan de Oñate's expedition describe encounters with the Mansos in the area around present day El Paso and Dona Aña. The first formal European settlement did not occur until the Doña Ana Bend Colony was established in 1843. Within the next 15 years several communities and military outposts were established in the Palomas and Mesilla valleys including Mesilla, Las Cruces, Tortugas, Picacho, Fort Fillmore, and Fort Thorn. The principal economic activity was agriculture. The Rio Grande was tapped and extensive irrigation systems were built to supply water to the crops. It is not entirely clear when the first irrigation systems were established, but by 1858 they were extensive enough to warrant surveying and mapping by the GLO (Ackerley 1992). Today, the Mesilla and Palomas valleys are experiencing rapid growth. Agriculture remains a mainstay of the local economy with such diverse crops as pecans, cotton, onions, alfalfa, corn, and chile grown throughout the area. The population of Dona Ana County is 175,000, and with a population of 78,000, Las Cruces is the fastest growing metropolitan area in New Mexico. This growth has caused the conversion of agricultural lands in the Mesilla Valley to residential subdivisions, while the majority of the land and residents in the southern Palomas Valley, around the communities of Hatch, Rincon and Garfield, and remain deeply rooted in agriculture. The Rio Grande and its associated irrigation canals and drains still remain the lifeblood of the community today.

Land Ownership

The BLM is the majority land owner within the project area, managing 58% of the watershed (Table 1). Private landowners account for 22% of the watershed and the State of New Mexico accounts for 16%. USFS and the U.S. Department of Defense comprise 3% and 1%, respectively.

Land Owner	Hectares	Percent of Total
BLM	343,134	58
Private	133,729	22
State	94,859	16
USFS	15,140	3
DOD	6,833	1

Table 1: List of five major land owners within the watershed as mapped by the Southwest Regional Gap Analysis Project (Ernst et al. 2006).

The Rio Grande Project

The future of agriculture in the project area has not always been certain. Following the Civil War, agricultural growth in the San Luis Valley of southern Colorado and along the middle Rio Grande in New Mexico placed increasing demands on the waters of the Rio Grande. Downstream users in New Mexico and West Texas were getting less and less water, and at times the Rio Grande would dry up altogether. Beginning in the late 1800's fields in the Palomas and Mesilla Valleys began to dry up. In 1902, while on a trip through the Mesilla Valley, Bishop Henry Granjon described dry ditches, fallow and withered fields, and abandoned gardens (Ackerly 1992). Similar problems were apparent farther downstream as well. As a result the Rio Grande Dam and Irrigation Company (RGDIC) was formed by Dr. Nathan Boyd of Las Cruces with the intention of building a dam to capture spring runoff waters for use later in the season (Kelly 1986). The RGDIC also had no intention of sharing any captured water with its downstream neighbors in either Texas or Mexico. Incensed by this idea, the Mexican government filed a note of protest with the United States Secretary of State on March 21, 1895, claiming a violation of the treaty of Guadalupe-Hidalgo. There was a second concern as well. Since the Rio Grande had become the border between the United States and Mexico, its propensity to move laterally and change position had become a territorial boundary issue. All parties agreed that a dam was a reasonable solution to store water for later use, stabilize the boundary between the United States and Mexico, and reduce the impacts of flooding. After 10 years of political wrangling on both sides of the border, President Theodore Roosevelt signed a proclamation on a Convention between the United States and Mexico for Equitable Distribution of the Waters of the Rio Grande on May 21, 1906. Article I of the proclamation outlined a proposed storage dam to be built near Engle, New Mexico for the storage and subsequent delivery of 60,000 acre-feet of water annually from the United States to Mexico at the head of the Acequia Madre above Juarez, Mexico. On March 4, 1907 the United States Congress appropriated an initial $1,000,000 to the Rio Grande Project to build a dam and associated distribution system, and on June 3, 1913, the first concrete was poured for what would later become Elephant Butte Dam.

Farmers in the Rio Grande Project area received their first deliveries of water in January of 1915, and by March 21, 1915 (the first day official records were kept) Elephant Butte Reservoir was already holding 47,515 acre feet a full year before the dam was completed. For the first time in decades, farmers had a reliable supply of water. Being unaccustomed to such an abundant supply of water, and in conjunction with the high water table in many areas of the Palomas and Mesilla valleys, farmers over-watered their fields and flooded their crops. As a result, work began in 1917 on a series of drainage canals to drain off the excess water. Today, the New Mexico portion of Rio Grande Project includes Elephant Butte and Caballo Dams, three diversion dams, about 300 miles of canals and laterals, and about 350 miles of drains that provide irrigation water for over 4,000 farms consisting of 90,640 water-righted acres, of which about 70,000 acres are irrigated in a given year (King and Maitland, 2003). There are also 48 flood control structures on tributaries to the Rio Grande in the watershed that are not part of the Rio Grande Project.

Rio Grande Canalization Project

On February 1, 1933, a Convention was struck between the United States and Mexico to construct and maintain the Rio Grande Rectification Project which straightened, stabilized, and reduced the length of the Rio Grande from 155.2 miles to 85.6 miles along the Texas Mexico border. The Rio Grande Canalization Project was subsequently authorized on June 4, 1936, to straighten, stabilize, and shorten the Rio Grande from Caballo Dam to the Texas border.

Both projects were constructed and are maintained by the U. S. Section of the International Boundary and Water Commission (USIBWC).

The Rio Grande from Caballo Dam to the New Mexico-Texas state line has a channel width ranging from 110 to 500 feet, while the floodway ranges from approximately 50 to 2,100 feet in width. The Canalization Project is designed to provide a carrying capacity ranging from 2,500 cubic feet per second (cfs) above Leasburg Dam to 1,200 cfs at El Paso. The levees range from three to fifteen feet high, and have a total length of 130 miles. The levees on the west side are 57 miles long while the east side levees are 73 miles long. In the 8.6 mile reach through Selden Canyon, the river is relatively confined within the canyon and no channel control works were constructed.

Watershed Hydrology

Flow in the Rio Grande in the project area is almost entirely regulated and determined by irrigation needs. Annual water releases from Elephant Butte and Caballo reservoirs begin in February or March when the system is watered up and prepared for the irrigation season. Releases generally continue through mid-September to early October when the irrigation season ends. Flow during the winter months can be a combination of agricultural return flows from drains, groundwater inputs, and point source discharges such as those from municipal waste water treatment plants (WWTP's). During periods of drought, sections of the river may cease to flow entirely during the winter months. Stormwater inputs from ephemeral drainages and municipal storm drains sometimes carry a considerable amount of flow into the Rio Grande following intense thunderstorms which occur annually from July through September.

III. Identification of Causes and Sources of Impairment

New Mexico Water Quality Standards

Under the CWA and the New Mexico Water Quality Act, New Mexico is required to adopt water quality standards. New Mexico's water quality standards (*Standards for Interstate and Intrastate Surface Waters,* New Mexico Water Quality Control Commission, 20.6.4 NMAC) are written for three general categories; general criteria, designated use criteria and segment specific criteria. The general criteria apply to all surface waters of the state unless a specified criterion is provided under the designated use criteria, or the segment specific criteria. The designated use criteria were developed to ensure that designated uses can be maintained. These uses include, but are not limited to, domestic water supply, irrigation, livestock watering, aquatic life, and wildlife habitat. Under the segment specific criteria, water bodies are divided into specific segments based upon the physical and chemical characteristics as well as designated uses of that segment. Determination of whether these designated uses are being maintained is conducted by intensive water quality surveys performed by NMED-SWQB.

The 303(d) List

Over the last seven years, portions of the Rio Grande between Caballo Reservoir and the Texas-Mexico boundary have exceeded water quality standards and have been included on the 303(d) list of impaired waters. The El Paso-Las Cruces watershed is divided into two assessment units by the NMED-SWQB for purposes of conducting the water quality survey – the reach from Percha Dam downstream to Leasburg Dam, and Leasburg Dam downstream to the international boundary with Mexico. The reach from Percha Dam to Leasburg Dam was listed for pH in 1998, but was subsequently de-listed in 2000, due to an incorrect listing of a pH value of 9.3. This reach was listed as fully supporting its designated uses from 2000 through 2004.

Prior to 1998, the reach from Leasburg Dam to the international boundary was listed for ammonia, chloride, pH, and stream bottom deposits. In 1998, it was de-listed for all four impairments, but subsequently 1.7 miles were listed for unknown toxicity. It was de-listed in 2000 for unknown toxicity and was listed as fully supporting until 2004.

Sampling for fecal coliform by other agencies and submitted for review to the SWQB during development of the 2004-2006 303(d) list showed numerous exceedances for fecal coliform in several locations in the watershed. Like *E. coli*, fecal coliform is used as a surrogate to assess potential contamination of waters by bacterial pathogens. Data submitted by the USIBWC from a single station 1.7 miles upstream of American Dam near El Paso showed 53% exceedance in 272 samples. Data submitted by the City of Las Cruces collected above the Las

Cruces WWTP showed exceedances in 16% of 108 samples. Data submitted by El Paso Community College showed exceedances in 82% of 38 samples. As a result this reach was placed on the 2004-2006 State of New Mexico 303(d) list for non-attainment of the designated use of secondary contact, and fecal coliform was identified as the probable cause of impairment.

Total Maximum Daily Load

Stream segments that do not meet water quality standards for diffuse pollutants, must have a Total Maximum Daily Load (TMDL) calculated. A TMDL is the maximum amount of any given pollutant that a waterbody can assimilate (i.e., the loading capacity) without violating a state's water quality standards. A TMDL is calculated as the sum of the individual waste load allocations for point sources, nonpoint sources, and natural background conditions. A TMDL is also a non-regulatory document describing a budget for pollutant influx to a specific waterbody. The USEPA defines a TMDL as "a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standards, including consideration of existing pollutant loads, and reasonably foreseeable increases in pollutant loads."

From February through November 2004, the SWQB conducted an intensive water quality survey examining a wide variety of potential pollutants as part of its regular monitoring plan and to assess the non attainment of the designated use of secondary contact in the 319(h) grant project area. Samples were collected from 11 stations along the Rio Grande from Percha Dam just below Caballo Reservoir to Sunland Park just upstream of the Texas-New Mexico border and the international boundary with Mexico. Field measured parameters included dissolved oxygen, temperature, specific conductance, and pH. All samples were analyzed for nutrients, ions, and total and dissolved metals. More limited analysis was conducted for bacteria, radionuclides, and anthropogenic organic compounds. Subsequent to the 2004 listing for fecal coliform, the State of New Mexico adopted *E. coli* as the indicator organism to denote potential pollution by bacterial pathogens. As a result the 2004 study bacterial analysis included both fecal coliform and *E. coli*.

The bacterium *E. coli* was the only pollutant found that did not meet New Mexico's water quality standards. A graph of the sampling results is shown blow in Figure 2. Of the 76 samples collected, 20 samples, or 26%, were found to exceed the water quality standard of 410 cfu/100 milliliter (ml) for *E. coli*. Out of these 20 samples, eight of these exceedances occurred in a reach of the river (Anthony to Sunland Park) that is known to have had problems with compliance for discharges from wastewater treatment plants. As a result the likelihood exists that the exceedance of *E. coli* in this reach was due to point sources that may have discharged fecal material into the river during the sample collection period. The remaining 12 samples, or 16%, that exceeded the standard for *E. coli*, were scattered along the reach, and appear to be associated with nonpoint sources. There is evidence the exceedances may have been related to precipitation events and subsequent storm water flow. As a direct result of the 2004 study, a TMDL was written for the lower Rio Grande for failing to meet the water quality standard for *E. coli*.

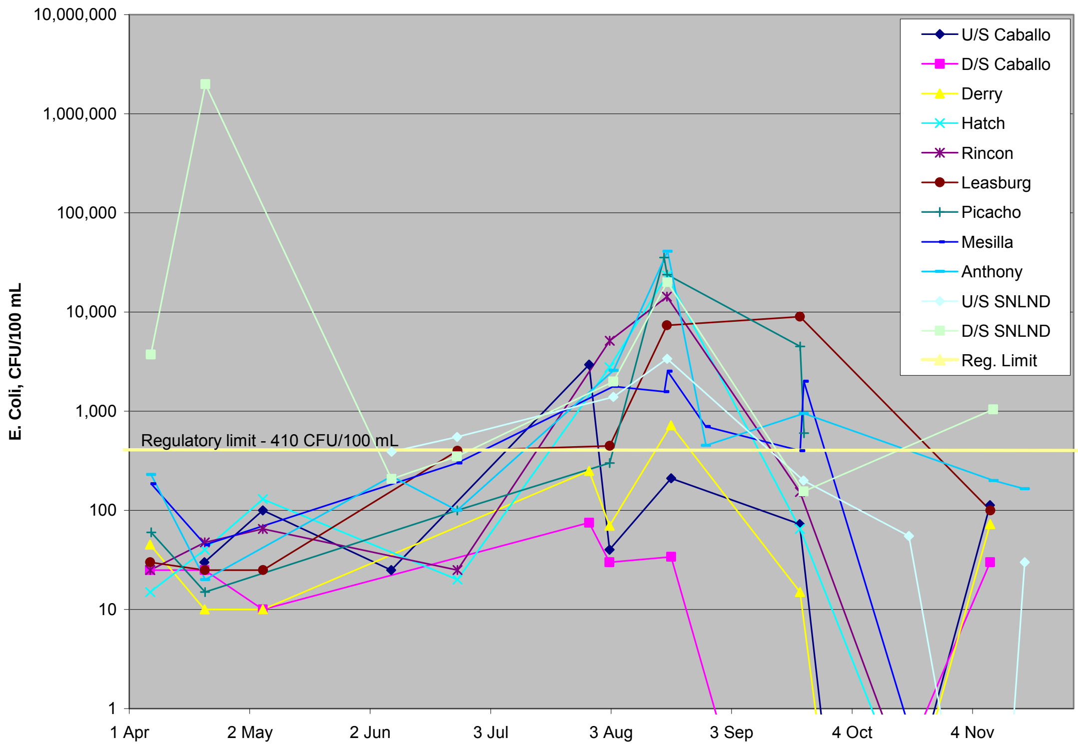

Figure 2: 2004 SWQB averaged results of *E. coli* analyses from lower Rio Grande sampling points.

Both the 303(d) list and the TMDL document written by the SWQB identify probable sources of impairment based on general watershed characteristics, watershed hydrology, and natural and anthropogenic activities within the watershed. Both documents identify nine probable sources of impairment which are:

1. Impervious surface/parking lot runoff
2. Municipal point source discharges
3. Urbanized high density areas
4. On-site treatment systems
5. Permitted runoff from confined animal feeding operations (CAFO)
6. Rangeland grazing
7. Waste from pets
8. Waste from waterfowl
9. Waste from wildlife other than waterfowl

Current state of knowledge

The Council engaged three contractors provide an analysis of the current state of knowledge with respect to the nonpoint source pollution problem in the watershed. Dr. Ken Boykin was contracted to provide insight regarding the biological nature of the watershed. A summary description of that work as well as contributions regarding the Council's Coordinated Database Project (CDP) and its relevance to this project follow in the next sections. The Council hired Lisa LaRocque of Intercambios, to engage the stakeholders in the watershed to share their knowledge and viewpoints on the issues under study. Dr. Phil King was contracted to provide understanding of the existing data for depicting the watershed. The full reports by each contractor can be found in the attached appendices.

Biological Analysis

Analysis at the watershed scale is crucial to the structure and processes associated with streams and riparian systems (Briggs 1996). Riparian systems are directly affected by the connection with the adjacent ecosystems. Disturbances, even in small parts of the watershed, can create a disequilibrium that influences the condition of riparian systems for many years. Salwasser (1994) defined watershed integrity as "possessing a full set of natural parts and processes in good working order." Watershed integrity is synonymous with watershed condition or rangeland condition and includes factors other than pathogens and TMDLs. Many conservation activities are currently being pursued to ensure long-term system integrity that can affect the Rio Grande and surrounding tributaries New Mexico Department of Game and Fish 2005 (NMDGF).

Information for this assessment was based largely on *New Mexico's Comprehensive Wildlife Conservation Strategy* (NMCWCS) produced by NMDGF, and land cover, species-habitat models and land stewardship/ownership data provided by the Southwest Regional Gap Analysis Project [(SWReGAP) Prior-Magee et al. 2006]. Many species are present within the watershed, so focus is placed largely on habitat, rather than specific species. Species focus in cases is based around the NMDGF, Species of Greatest Conservation Need (SGCN), as identified within the NMCWCS and habitat associates provided by SWReGAP (Boykin et al 2006).

The study area is the 8-digit hydrologic unit code or HUC (13030102) with El Paso-Las Cruces, New Mexico, and Texas as the category name (Figure 1). The area encompasses areas with plant communities ranging from coniferous forests at the upper watershed to desert shrublands to riparian communities along the Rio Grande.

Population and abundance of wildlife is a difficult metric to measure and one that requires long-term datasets to allow meaningful interpretation. Coarse scale studies, such as SWReGAP, allow for regional perspective to be acknowledged but are limited in applicability at finer resolutions. Populations of wildlife vary depending on many factors related to the life history of the species. These populations can vary by orders of magnitude such as in amphibians. Watershed integrity plays a large role in populations by varying habitat, prey, and nesting or breeding sites. Only long term monitoring can filter noise caused by short term variability and allow cause and effect relationships to be identified.

There are multiple factors that affect the watershed and the lower Rio Grande. These factors can affect wildlife species by altering habitat or changing mortality rates or birth rates. Habitat changes can eliminate suitable habitat, breeding habitat, hibernacula, or prey. Factors can be of a short temporal scale that eliminates the entire population or can work at longer temporal scales that slowly reduce the population. These factors can be anthropogenic or natural and can include poor rangeland health, contamination, and changing flood regimes.

The entire watershed should be the focus of ecological integrity restoration. The USFWS (2001) suggested that a more year-round flow regime would be necessary before riverine ecosystems would effectively enhance habitat for aquatic species.

Data was obtained from multiple sources to provide the background necessary for further data analysis and implementation. This data is provided in shapefile, spreadsheet, and text files, as well as a HEC RAS model of the Rio Grande. Data are being imported to the Coordinated Database Project (CDP). A brief description of the data is given below in Table 2.

	Data Format			
Data Element	Hard-copy	Digital - Tabular	Digital - Geospatial	Other
Fecal coliform and *E. coli* sampling and analyses		√		
Land use				
a. Urban		√	√	
b. Hard surface		√	√	
c. Grazing		√	√	
d. Range condition and trend		√	√	
e. Farming		√	√	
f. CAFOs		√	√	
g. Research (University)				
h. Habitat characteristics				
i. Other land use		√	√	Proposed wilderness
Topography (DEM)			√	
Soil and associated hydrologic properties				
a. Soil series and descriptions		√	√	
b. Textural class		√	√	
c. Hydrologic group		√	√	
d. RUSLE parameters		√		
Watershed boundaries of Rio Grande surface water tributaries between Caballo Dam and Anthony		√	√	
Existing studies of vegetative cover, including remote sensing imagery analyses				
Channel morphology				
a. HEC-RAS data		√		
b. Sediment analyses				
c. Historical river channels				
Major drainage structures				
a. Storm drainage	√	√		FEMA FIRMs
b. Agricultural drainage		√	√	
c. Flood control dams		√	√	
d. Other drainage				
Wastewater treatment facilities and septic tank information, as available (entity, location, type, technology, loading, discharge)				
a. WWTP plants and discharge points		√	√	
b. Septic tanks and leach fields				
c. Other treatment systems		√	√	Permits
Other data sets encountered during the data inventory that may be relevant to the objectives of the WRAS or the broader objectives of the PdNWC.			√	Sub basin

Table 2: Data survey elements.

The Coordinated Database Project

The Rio Grande is the only major source of renewable water in the Paso del Norte region, which stretches from Elephant Butte Dam, New Mexico to Fort Quitman, Texas. The Coordinated Water Resources Database and Geographic Information System (GIS) Project (CDP) that is being developed by the Council has the objective of coordinating and compiling regional water resource data to provide timely, web-based access to information for scientists, water management organizations, and stakeholders within the Paso del Norte region of the Rio Grande. Several agencies are involved with river management and water resources research; the CDP focuses on the ability to coordinate access to water resources data among these stakeholders. There exists a long-term need for accessible, consistent water resource data; this need drove the development of this project. Independent water resource data measurements are collected by agencies according to each research or management goal. Prior to the CDP's efforts, there had been little or no compilation, coordination or convenient method to access data from these individual sources. The absence of collaborative access and sharing of historical and real-time data may lead to unnecessary duplication of efforts. This demonstrates the need to coordinate water resource data in order to efficiently manage resources.

The CDP provides water resource monitoring measurements on the river, canals, and drains. It provides data such as surface water flows, water reservoir storage, groundwater levels and well data, and water quality parameters collected and compiled by organizations like U.S. Bureau of Reclamation (USBR), U.S. Geological Service (USGS), USIBWC, EBID, City of Las Cruces Water Utility (CLCU), El Paso County Water Improvement District #1 (EPCWID#1), El Paso Water Utility (EPWU), University of Texas at El Paso (UTEP), New Mexico State University (NMSU), Texas A&M University – Texas Agricultural Experiment Station (TAMU-TAES), New Mexico Water Resources Research Institute (NMWRRI), University of Texas at El Paso (UTEP), and Universidad Autónoma de Ciudad Juárez (UACJ). Data collection networks contain instrumentation like stream gages and groundwater monitoring wells. Further, a range of physical resource data like land use and riparian cover is included in the database that can provide users with a geographical perspective of their region of interest. GIS layers within the project include irrigation networks, measurement stations, and archival water resource data; regional water and natural resource maps are also available. The coordination of water and natural resource data can provide an enhanced, comprehensive watershed-based representation of the Paso del Norte region.

NMWRRI serves as the internet host for this project through their web servers. The CDP can streamline the process of collecting and analyzing real-time water resource data within the Paso del Norte region, increase the knowledge base for water resource managers and researchers, and enhance regional watershed management efforts. An operational web site for the Paso del Norte Watershed Coordinated Water Resources Database with GIS interface has been created and may be accessed at http://river.nmsu.edu/website/PdNWC_website/. Reports on data sources, measurement parameters and monitoring locations have been prepared and are available through the NMWRRI webpage at http://wrri.nmsu.edu/.

Recent accomplishments of the CDP include:

- Development of a water resource database with GIS interface components
- Compilation and inclusion of new data sources
- Filling in of data gaps with installation and calibration of new monitoring stations
- Enhancement of sharing and access to real-time data
- Providing web-based help and query functions
- Implementation of feedback from web-based user survey responses
- Expansion of a library of technical reports

Ongoing work of the CDP includes:

- Creating digital records of historical data
- Expanding technical components to database and GIS components
- Linking to United States Army Corps of Engineer's Upper Rio Grande Water Operations Model (URGWOM – see http://www.spa.usace.army.mil/urgwom/default.asp for more information)
- Developing a user tutorial
- Continuing to fill existing and emerging data gaps
- Collaborating with Elephant Butte Irrigation District on linking new gauge data
- Providing stormwater runoff, land use, and best management practices data

Relevance of the CDP to the lower Rio Grande WRAS

Several areas of collaboration are evident whereby the outcomes and products of the CDP may contribute to the scope of work involved in the Council's 319(h) WRAS project, as outlined below:

How can the database utilize water quality data to provide a better understanding of impairments in the watershed?

Perhaps the most direct manner by which the CDP can assist in the work of the WRAS is by incorporating geo-spatial datasets of interest into the Web-based interface being served by NMWRRI. Specific datasets of interest include maps of the bacteriological data that are collected and shared by the USGS, USIBWC, and NMED; conveyance and return flow data associated with agricultural operations in the area; and sub-regions of the larger watershed that allow researchers to examine specific land use and water quality interactions. Such a linkage would allow greater access to the outcomes of the initial 319(h) grant WRAS project work.

How can we use the CDP and related GIS tools to design sampling and monitoring projects to examine land use and water quality interactions?

Through the use of GIS modeling routines, contributing watersheds can be delineated, and these sub-watersheds could be linked to specific sampling points on the main stem of the river (or on tributaries or drains) at which various water quality data are gathered (see Brown, Placchi, and Gersberg 1998 and Placchi 1998 for details of this framework). Using this analysis framework, researchers can examine the potential relationships that exist between certain land uses and downstream water quality. This framework can also be linked to source tracking to more specifically focus on areas of the watershed that are influencing water quality.

How can the CDP assist in prioritizing sub-basin locations for the implementation of BMPs?

The framework of sub-basin delineation that is discussed above can be expanded to include the incorporation of best management practices to the places where they are best suited. For example, if water clarity problems in the river are linked to areas of sediment generation and erosion, relevant BMPs such as sediment trapping and monitoring can be suggested for the land areas that are contributing the sediment to the river. These tools can also be used to map the overall set of BMPs that may be generated for the area of investigation. These map products can in turn be served by the CDP to reach a larger audience than the audience that would routinely read the WRAS document.

How can the combined activities of the CDP and WRAS that involve the use of GIS tools and geo-spatial data be best managed?

Given the interest in the use of GIS, the Web, and the increasing volume of geo-spatial data that the CDP and the WRAS are developing, the Clean Water Subcommittee suggests the proposal being developed for continuation of the WRAS work in the project area include funding for a GIS and geo-spatial database coordinator. This person would work with project partners and other water research and GIS experts in the region to further coordinate GIS activities and geo-spatial data that would be supportive of watershed management and restoration efforts in the project area.

Stakeholder Input and Process

The stakeholder contractor's charge was to assist the Council in expanding stakeholder involvement and to assess barriers to participation. In addition the contractor was to engage stakeholders in a process to understand the WRAS process and solicit meaningful input to the WRAS and participation in the Council.

The stakeholder participation strategy was developed by Intercambios , the contractor, with consideration of the limited understanding of probable sources of the bacterial impairments in the river from Percha Dam to the New Mexico - Texas state border; the need to maintain cooperative relationships with diverse stakeholders; and the timeline for probable action. The strategy included working with stakeholders specifically related to probable bacterial sources as well as general community members through listening sessions and group discussions. The role of the stakeholder outreach coordinator was to engage a broad network of stakeholders, gather information and perspectives of various stakeholders, and facilitate open dialog.

The stakeholder outreach contractor identified specific key informants who have a direct managerial capacity related to the probable sources of impairment in this section of the river. These key informants were interviewed to learn more about management issues, gain respect and trust from each stakeholder group, and provide a balanced narrative for other stakeholders to learn about each other. These key informants included representatives from the City of Las Cruces, Don Aña County, the United States Bureau of land Management, NMED, EBID, a local dairy owner, and a local rancher. Each key informant was interviewed and asked a series of questions were asked and summary information gathered from the interviews (a list of the stakeholders and interview questions can be found in Appendix IV and V).

Stakeholder Outreach Events

The stakeholder contractor facilitated meetings throughout the lower Rio Grande valley in order to capture a sense of how local stakeholders view the most effective way to fix the bacterial problems in the river. Two larger stakeholder events were held once the individual interviews were conducted and summarized. Stakeholders were presented with a synthesis of the water quality data analysis, a biological perspective of the watershed, and a summary of stakeholder's concerns. Stakeholders were asked to provide input to an approach for future investigations of water quality impairments, as well as for developing criteria for BMP options in the watershed.

On May 17, 2007, stakeholders attended a meeting at NMDA to attend a presentation by the water quality data consultant, Dr. Phil King, and discuss priorities for future research. Because of limited and/or inconsistent data sets and shifts in parameters from total coliform, to fecal coliform, to *E-coli*, stakeholders were left unsure about possible sources of contaminants, best strategies for future investigations and potential solutions to the problem. Although there were discussions about the value of a healthy living river that was swim-able, drinkable, and fishable, there was no firm commitment to more ambitious strategies for watershed restoration given the lack of firm data and many of the stakeholders' unfamiliarity with data analysis and its relationship to ecological health.

Figure 3: Participants of the PdNWC tour visit Mesilla Dam.

On June 19, 2007, stakeholders attended a meeting focusing on the biological characteristics of the watershed described by biologist, Dr. Ken Boykin; alternative BMP practices presented by water quality data consultant, Dr. Phil King; and community member concerns summarized by the stakeholder outreach contractor. Dr. King presented an overview from Tetra Tech's, *A Manual of Conservation Practices to Reduce Pollution Load Generated from Nonpoint Sources* that described potential criteria to use when evaluating BMPs.

Stakeholders were invited on a watershed tour on Saturday, May 5th, 2007, hosted by the World Wildlife Fund and NMDA. The tour was led by Dr. Phil King of New Mexico State University. The watershed tour presented stakeholders with a visual representation of water quality issues from Selden Canyon to the Gonzales Dairy in Vado, New Mexico. The issues discussed ranged from salt cedar removal to wild arroyos and to agricultural water infrastructure. Land management responsibilities, sediment transport, flooding, water monitoring, irrigation efficiencies, septic systems, and WWTPs were also topics of discussion as the group traveled southward through the watershed. Besides providing a concrete forum to view watershed issues, the tour strengthened stakeholder relationships as they recognized the value of everyone's input through scheduled commentaries throughout the tour.

A public stakeholder meeting was hosted by the Council on April 24, 2007. Clean Water Subcommittee members and regional stakeholders attended and were presented with information on the Council, the 319(h) grant, the WRAS process, and the role of NMED. Included in these discussions were regulatory issues, water uses within the watershed, water pollution including bacteria, and BMPs for improving water quality. Stakeholders were given advice on how to get involved in the Council, the WRAS process, and contact information.

Also provided by other agency stakeholders, in Appendices IX and X, is a catalog of current or planned future projects within the watershed that potentially complement the efforts of the Council in the development of this WRAS. Knowledge of such projects may provide additional incentives and impetus for WRAS implementation and networks to reach stakeholders, as these identified projects may have a positive impact on water quality, as well as other concerns. I

Neighborhood Conversations

The contractor also engaged additional stakeholders on a neighborhood basis to formulate a list of priority considerations to bacterial problems in the watershed. Numerous neighborhood associations throughout the project region that represent various socio-economic subgroups were approached to discuss such considerations. Residents in Del Cerro/Vado, near the Armijo Drain in Las Cruces, the West Mesa in Las Cruces, and Radium Springs were approached. This process facilitated communication with individual stakeholders at a different level and yielded valuable information concerning what is required to engage the public in the WRAS process and address their concerns. In summary, neighborhood residents wanted the problem to be strategically addressed, motivating others through health concerns, avoiding punitive actions, and by encouraging more grassroots approaches. The full report on neighborhood conversations can be found in Appendix VI.

IV. Best Management Practices (BMPs)

At this stage of the WRAS, a discussion of BMPs must first acknowledge the data gaps as currently identified by the Council and its contractors. Therefore what follows is a compilation of the Council's understanding of the limitations of the TMDL and data gaps as assessed to date for Phase I of the WRAS.

Limitations of the TMDL Study and Identification of Data Gaps

The impairment in the Rio Grande downstream of Percha Dam is clearly identified as *E. coli* in the SWQB's TMDL document. However, neither the 2004 study nor the interpretation method which led to the development of the TMDL was designed to identify sources of impairment other than in general terms. The interpretation method is limited in its ability to track individual source loadings or relative source contributions within the watershed. The TMDL document suggests alternate methods of interpreting the data and additional information gathering will be necessary to accurately characterize the sources of impairment. Both the general stakeholder community and the Council's Clean Water Subcommittee have identified the following data/information gaps that are critical to characterizing the sources of impairment in the watershed:

- There was concern that because 2004 was a drought year, and streamflow in the river was at a 30 year low, it was not a representative year for the watershed. While there was disagreement over this concern, it was agreed that no single year would have been representative. It was determined that a multi-year sampling effort would be necessary to develop a plan for mitigation and restoration.
- Prior studies examined bacterial concentrations primarily for fecal coliform, not *E. coli*. As a result, this information is inadequate to accurately determine sources.
- The complex nature of the watershed with respect to water diversions, irrigation return flows, drain return flows, storm water flows, and point source discharges was not represented well enough in the sampling design of the TMDL study to accurately characterize *E. coli* input from these sources, especially in the sub-watersheds. It was not possible to determine whether the source was urban, rural, rangeland, or some combination of the three. This hinders the specificity of possible BMPs.
- Precipitation and storm tracking capabilities for the watershed have been limited in the past. These events need to be characterized in greater detail to optimize a sampling plan targeting the sub-watersheds.
- Quantifying and mapping the vegetation and hydrology of the watershed, with emphasis on the sub-watersheds, is needed for the development of a comprehensive watershed plan.

- A greater understanding of the impact from point source discharges such as WWTPs, Confined Animal Feeding Operations (CAFO's), and possible un-permitted dischargers is needed to differentiate these impacts from non-point sources.
- There is a need to characterize to the best extent practicable the septic systems that potentially contribute to the *E. coli* problem. This is especially important in areas where homes are directly adjacent to the river such as in Selden Canyon.
- Quantifying, locating, and mapping all the flood control retention structures in the sub-watersheds is critical to understanding the hydrology of streamflow and eliminating potential storm water inputs.

BMPs for Pathogen Abatement

Since the data gaps indicate there is insufficient knowledge to identify contaminant sources at this juncture and without further study, the BMPs listed in the table provide a general starting point for consideration by the Council and stakeholders. In addition to the table below, Appendix VII discusses BMPs that can be used to abate nonpoint source pathogenic pollutants in a watershed. This information provides background and lists abatement strategies known to work in various circumstances. It is a list of promising strategies, but no strategies have been implemented in the watershed thus far.

As an initial exercise during a facilitated stakeholder meeting, stakeholders listed various BMP's and evaluated them. After the meeting, selected stakeholders and the stakeholder contractor further developed the criteria to provide a more specific ranking for each criterion. Table 3 reflects input from stakeholders following a presentation and discussion concerning possible BMPs for implementation to address pathogen abatement. Of great importance is the fact that several stakeholders felt it was premature to continue ranking BMP's until the data contractor could identify the most appropriate BMP's given geological and hydrological conditions.

Also of note, the CLC and EBID received funding to develop one of the City's major stormwater retention facilities, Burn Lake, into a regulating reservoir. The design contemplates inflows from stormwater and operational spills from the District's canals, and outflow through low head pumps into EBID's canal system or by gravity back to the Rio Grande.

BMP	Level of Effort Needed	Load reduction potential	Time for load reduction	TMDL sources	Other pollutants addressed	Treatment areas
Fencing	active management	high	immediate	disturbed areas, ag practices, stream erosion	sediments, nutrients, low DO, water temp	streamside, agricultural lands, developed lands
Filter strip	active management	high	up to 2 years	animal feeding, disturbed areas, ag practices, stream erosion	sediments, nutrients, salinity, heavy metals, pesticides, low DO	agricultural lands, developed lands
Detention basin	moderate engineering	high	immediate	animal feeding, disturbed areas, ag practices, mining practices	sediments, nutrients, salinity, heavy metals, pesticides	agricultural lands, developed lands
Cover crop	active management	medium	up to 2 years	disturbed areas, ag practices	sediments, salinity pesticides	agricultural lands
Seeding	active management	medium	up to 2 years	disturbed areas, stream erosion, ag practices, mining practices, natural sources	sediments, nutrients, salinity, heavy metals, pesticides, low DO, water temp	streamside, agricultural lands, developed lands
Constructed wetland	Intense engineering	medium	up to 2 years	animal feeding, industrial sources, ag practices	sediments, nutrients, salinity, water temp	streamside, agricultural lands, developed lands
Watering facility	mild engineering	medium	immediate	stream erosion, ag practices	sediments, nutrients, salinity, low DO, water temp	agricultural lands
Grazing management	passive management	medium	up to 2 years	disturbed areas, stream erosion, ag practices	sediments, nutrients, low DO, water temp	streamside, agricultural lands
Waste utilization	active management	low	immediate	animal feeding ops, ag practices	sediments, nutrients, pesticides	agricultural lands

Table 3: Summary of estimated load reductions and BMP effectiveness.

BMP Conclusions

For best management practices (BMPs) to effectively and efficiently target bacterial pollutants, they must be implemented in areas that are found to be contributors of pollutant loads. BMPs should address the specific impairment; therefore one must know where the impairment is. Due to the existing water quality data gaps, specific locations of the impairment are not known, therefore, actual sites for BMP implementation cannot be recommended at this time. However, based on physical and hydrological infrastructure and current land use practices, some logical regions may be strategically advantageous for BMP implementation.

V. Future Recommendations

After a review of the WRAS for Phase I, the Council concludes Phase II funding will be necessary in order to address all nine key criteria outlined earlier in this document. Phase II funding will be crucial to identify the sources of contamination using more robust methods for collecting and analyzing data. Stakeholder outreach efforts require additional effort to bring other key players to the table to assist with Phase II of the WRAS. Existing partnerships must be strengthened and new partnerships must be forged. A monitoring program must be established and implemented to evaluate progress toward achieving water quality goals. Specific BMPs must be identified, implemented, and evaluated in order to address water quality goals which includes establishment of interim, measurable milestones.

Future Biological Analysis

Biological and physical data, such as land cover, land form, and rangeland health should be analyzed to indicate overall hydrologic function and how it may have been altered over time with such human activities as fire prevention, cattle grazing, and dam construction. It may also be worthwhile to investigate the overall effects, both positive and negative, of land use practices that benefit wildlife such as constructed wetlands and filter strips. Wildlife attractants can enhance the quality of life in the watershed, but an increase in species such as waterfowl or white-winged doves may in fact increase the amount of fecal coliform contamination.

Monitoring

Possible sources of the impairment, *E. coli,* have already been acknowledged. The SWQB identifies some of the NPS as follows: impervious surfaces, municipal point source discharges, urbanized high density areas, on-site treatment systems, permitted run-off from CAFO's, rangeland grazing, pet waste, waterfowl, and other wildlife besides waterfowl.

While developing this WRAS document, the Clean Water Subcommittee compiled information about the physical characteristics of the watershed, including soils, land use, vegetation, and wildlife. Additional information about surface water, ground water and their interactions has been incorporated into a coordinated database developed by the technical committee of the Council. This information will support the design of a monitoring plan and analysis of results. These tools will also be in place to assist with any future problems and/or solutions.

One of the most important data gaps clearly identified in this study was the lack of long-term data on *E. coli* occurrence in the Rio Grande. A monitoring plan for the watershed will be developed to address this gap. While many of the details have yet to be worked out, the monitoring plan will include the following components:

1. Routine sampling and analysis of *E. coli* in the Rio Grande at fixed sites to be determined by hydrology and potential sources, and on a regular schedule. The objective is to characterize the levels of *E. coli* in the river (background levels).
2. Sampling and analysis of *E. coli* during rainfall-induced runoff events. The 2004 data suggest that episodic *E. coli* loading may be associated with runoff events, and sampling at the discharge points of flowing arroyos will help to test this hypothesis.

Both sampling components will help to characterize *E. coli* occurrence and behavior in the Rio Grande, and potentially direct selection and implementation of BMPs to reduce loading.

In the collection of monitoring data, it would be logical to break the study area into three assessment units instead of the current two: Percha Dam to Leasburg Dam (no change), Leasburg Dam to the River at Anthony (where the Rio Grande first crosses the Texas state line), and the River at Anthony to the southern-most New Mexico-Texas state line and the international boundary with Mexico.

Monitoring Program Objectives

Because this WRAS addresses a known impairment from unknown source(s), the monitoring goals focus are to design a study to identify sources of impairment versus WRAS and monitoring to determine BMP/mitigation effectiveness.

Broad Monitoring Goals: identification of sources of impairment

- determine sections of river where NPS pollution is likely to originate
- determine events and/or time periods where impairments occur or are likely to occur
- identify and better characterize non-point sources: rural, urban, rangeland
- identify and better characterize point sources (WWTP, CAFO's, Septic systems)
- characterize contribution of NPS from sub-watersheds
- characterize contribution of NPS from drain inflows, irrigation return flows, storm water flows
- characterize contribution from septic systems

Specific Monitoring Goals: identification of sources of impairment

1. Identify likely sources for NPS *E. coli* to achieve compliance to meet TMDL
2. Rate individual sources in terms of their relative contribution to annual loading
3. Identify strategies for reducing pollutant loading or to achieve compliance.

Designing a Water Quality Monitoring Program

The Council has done research with respect to the design for its future water quality monitoring program. It has found that according to the manual "Fundamentals of Urban Runoff Management" published by the North American Lake Management Society, the design of an aquatic monitoring program should include the following 5 steps:

1. Specify the monitoring program objectives
2. Determine the level of effort to devote to the analysis
3. Perform a systematic analysis appropriate to the problem and objectives
4. Use the analysis results to tentatively specify monitoring program elements
5. Evaluate the tentative monitoring program for cost-effectiveness and finalize according to evaluation results

Using this structure as a guide, the Council could begin to determine where to focus its attention and efforts. Specific elements of the monitoring effort will be developed in the future for Phase II funding.

BMPs – Future Recommendations

The Council has spent time analyzing first steps for the implementation of BMPs based on existing knowledge of the watershed. When observing the hydrologic inputs and physical structure in this watershed, one must look at the drainages that enter the main system. There are 52 flood control structures that restrict water flows; some of them are partially closed off to the main watershed and therefore would not contribute flows into the lower Rio Grande. BMPs that are directed toward capturing polluted water within a drainage system should be aimed at drainages that directly empty into the main watershed. The initial step for identifying the closed basin drainages is to isolate the USGS Hydrologic Unit Codes (HUC) and remove those from the potential locations for BMPs in the watershed.

Future implementation of BMP's will require a further understanding of the water quality impairment in the lower Rio Grande. Sampling, water quality monitoring, and analysis of newly emerging data will better assist in prioritizing appropriate BMP's and locations for implementation. Partnerships with NRCS, Resource Conservation and Development Councils (RC&D's) and local Soil & Water Conservation Districts (SWCD's) should be established to coordinate any existing parallel objectives and match funds. Restoration plans will need to be designed for specific implementation initiatives. A description of measurable milestones for BMP implementation will be completed in the future.

The USIBWC prepared an Environmental Impact Statement (EIS) for River Management Alternatives that addressed the need for flood control structure improvements and environmental enhancements. This process revealed potential locations within the lower Rio Grande watershed for implementation of BMPs that address bacterial pollutants and should be taken into consideration in the future. The Council may be able to use current knowledge from existing sources to take initial steps to address the *E. coli* problem. What follows, Table 4, identifies certain practices and the time to accomplish a load reduction once that practice is implemented. This table is not complete, but would be completed in the future for Phase II of this WRAS. The proposed funding source column in the table would be a starting place to address key criterion # 6 for the WRAS.

BMP Implementation with Stakeholder Support

The main objective is to implement the BMPs discussed in the Phase I WRAS. Successful implementation of BMPs hinges on the foundation created in the coming years. Without a commitment by additional stakeholders, without a deeper analysis of the data gathered in Phase I, and without a solid understanding of the sources of contamination, implementation of meaningful BMPs at the watershed level will be difficult. Further, implementation of BMPs can only proceed with funding and expertise from local, state and federal agencies. These entities are vital to success. The implementation strategy can only be developed once the process of stakeholder and agency engagement is well underway, and the Phase II analysis completed.

BMP	Time for load reduction	Cost Estimate	Maintenance Requirement	Maintenance Cost Estimate	Proposed Funding Source
Filter strip	up to 2 years	Phase II	low	Phase II	tbd
Detention basin	immediate	Phase II	high: regular cleaning needed	Phase II	tbd
Cover crop	up to 2 years	Phase II	medium	Phase II	tbd
Seeding	up to 2 years	Phase II	low	Phase II	tbd
Constructed wetland	up to 2 years	Phase II	low	Phase II	tbd
Watering facility	immediate	Phase II	low	Phase II	tbd
Grazing management	Up to 2 years	Phase II	low	Phase II	Tbd
Waste utilization	immediate	Phase II	medium	Phase II	tbd
Fencing	immediate	Phase II	medium: repairs as needed	Phase II	tbd

Table 4: Future BMPs.

Recommendations for Future Stakeholder Outreach / Public Education

The first phase of stakeholder outreach indicates a broad concern for water quality and a willingness to work toward improving the condition of the Rio Grande. Summaries of neighborhood association conversations (Appendix VI) lead us to believe that a broader campaign would be well-received throughout the watershed, as would implementation of certain BMP's by specific stakeholder groups.

A Water Quality Outreach Campaign

Based on previous outreach initiatives and comparing our progress with other watershed groups in the Rio Grande Basin, the Council will embark on an outreach campaign to increase awareness of the water quality in the lower Rio Grande of New Mexico.

The USEPA recommends that outreach campaigns be based on the following series of activities:

- Set a mission, goals, and objectives
- Identify and analyze target audience
- Create the message
- Package the message
- Deliver the message

The mission, goals, and objectives were initially created in the first phase of WRAS development. The mission of the Council is to investigate, develop, and recommend options for watershed planning and management and to explore how water-related resources can best be balanced to benefit the Rio Grande ecosystem and the interests of all watershed stakeholders. The goal in this 319(h) project is to reduce bacterial loading in the Rio Grande and the objective is to implement BMPs.

Create, package and deliver the message, however, several intermediary steps must be undertaken. First, the Council intends to establish a Citizen's Water Quality Monitoring Program that will serve the dual purpose of enhancing the understanding of sources of contamination and also engage a greater diversity of stakeholders, including students and the elderly.

The second step needed before the Council undertakes an outreach campaign is related to utilizing the data collected in the Citizen's Water Quality Monitoring Program in a more vigorous analysis of the watershed. Without a clearer idea of the sources of contamination, key audiences who could have the greatest impact on improving water quality cannot be targeted. Messages must be based on sound science and have measurable and achievable recommendations. Continuing analysis of the data collected should include:

- Identification of potential sources of contamination
- Identification of sites suitable for BMP's
- Recommended BMP's tailored to conditions in the lower Rio Grande watershed
- Estimates of costs associated with implementation of BMP's
- Sources of funding that will assist in implementation of BMP's
- Monitoring strategies to measure success

The third step necessary for a successful outreach campaign is the engagement of a broader array of local, state, and federal agencies that have responsibilities that intersect with water quality. The Council can be enhanced with the participation of several sectors not currently represented:

- U.S. Department of Agriculture-Natural Resource Conservation Service
- U.S. Department of Agriculture-Forest Service
- U.S. Department of Interior-Bureau of Land Management
- La Union Soil and Water Conservation District
- Caballo Soil and Water Conservation District
- Sierra County Soil and Water Conservation District
- New Mexico State Land Office
- New Mexico State Engineers Office
- New Mexico Health Department
- Dona Ana County
- Lower Rio Grande Water Users Organization
- Black Range RC&D

The short term strategy to interest some of these organizations is to host a nine month conversation series on water quality in the watershed. Personal invitations will be sent to invite representatives of these entities to attend any or all of the conversations. While funding is secured for Phase II of the WRAS development, educational opportunities will be provided for the community through this lecture series in a variety of locations along the lower Rio Grande of New Mexico. Table 5 that follows shows the target audience and possible topics for discussion. A timeline would be supplied for funding these activities in Phase II of the WRAS.

Site	Topic	Target Audience	Details
Fort Selden State Park	BMPs to reduce bacterial loading	Homeowners Ranchers	Rangeland and septic issues
City of Las Cruces City	BMPs for housing developments along arroyos	Developers Homeowners City and County Planners	Erosion control, construction techniques, policies
City of Las Cruces	How do Water Quality BMPs link to Vision 2040	City and County Planners, Open Space Activitists	Incorporating BMPs into the Vision 2040
Mesilla	Open space in other SW Cities	Open space activists,	Bring someone from PHX, Tucson to discuss how open space improves water quality
Sunland Park	The 319(h) process in Texas	Federal, state, City, County agencies	How Texas watersheds draining into the river impact NM Water quality
Anthony	Agricultural BMPs	Farmers & Resource Agencies	On-farm practices to reduce erosion and more
Hatch	Conservation Easements	Farmers & Agencies	State and federal opportunities for farmers
Mesquite	Wastewater BMPs	Towns, water utilities	Examples of wastewater treatment using wetlands and other techniques
Las Cruces	319(h) Campaigns	Watershed Council	Laura de la Garza from Arroyo Colorado

Table 5: Conversation series for public outreach.

Additional future plans for stakeholder engagement include convening larger stakeholder meetings to obtain a greater sense of overall community concerns, facilitate communication between stakeholders, and to form workgroups to address specific issues.

Outreach Recommendations at a Glance

1. Improve understanding of contamination by creating a Citizen's Water Quality Monitoring Program.
2. Provide recommendations for BMPs based on a more in-depth data analysis in Phase II.
3. Increase agency and stakeholder participation in the Council by hosting a series of lectures that would be useful to these targeted stakeholders.
4. Develop an outreach campaign based on the results of Phase II analysis and the enhanced participation in the Council.
5. Create a BMP implementation strategy after the completion of recommendations one through four.

Future Interim Measurable Milestones

The Council has developed two tables that follow to address the Phase II WRAS elements. Table 6 describes potential actions and participants to address progress toward meeting the nine key criteria of a WRAS. Table 7 describes measurable milestones and a timeline for meeting those. The Council will address the criteria to measure load reductions in Phase II. These tables provide a general guideline as to how the WRAS will be approached in Phase II.

Actions	Cost Estimate	Maintenance Cost Estimate	Potential Participants
Development of Monitoring Plan			
Refinement of water quality goals	Phase II	tbd	CWS, NMED
Devise sampling methodology	Phase II	tbd	CWS, NMED
Purchase equipment	Phase II	tbd	CWS
Collect water quality data	Phase II	tbd	CWS, SWEC, EBID
Re-evaluate after implementation of BMPs	Phase II	tbd	CWS
Stakeholder Outreach			
Develop outreach materials	Phase II	tbd	CWS
Maintain current stakeholder relationships	Phase II	tbd	CWS, Council
Develop new stakeholder relationships	Phase II	tbd	CWS, Council
Community projects	Phase II	tbd	CWS, SWEC, EBID
Public Education			
Expand educational capacity of Council	Phase II	tbd	CWS, Council
Reach stakeholders using various methods including media	Phase II	tbd	CWS, Council
Community projects	Phase II	tbd	CWS, SWEC, EBID
BMP Implementation			
Selection of appropriate BMP project	Phase II	tbd	CWS
Hire contractor, purchase equipment, organize stakeholders as appropriate	Phase II	tbd	CWS
Evaluation of effectiveness	Phase II	tbd	CWS
Human Resources			
Coordinator for Council	Phase II	tbd	CWS, Council
Additional contractors	Phase II	tbd	
Education resource person for Council	Phase II	tbd	CWS, Council
CWS = Clean Water Subcommittee NMED = New Mexico Environment Department SWEC = Southwest Environmental Center EBID = Elephant Butte Irrigation District Council = Paso del Norte Watershed Council BMP = Best Management Practice			

Table 6: Proposed Phase II actions and potential participants.

Actions	2008	2009	2010	2011
Secure Funding	x	x	x	x
Refinement of water quality goals	x	x		
Develop sampling methodology	x			
Purchase equipment	tbd	tbd	tbd	tbd
Collect water quality data, train volunteers if needed		x	x	x
Analyze water quality data		x	x	x
Re-evaluate after implementation of BMP's			x	x
Develop outreach materials	x	x	x	x
Maintain current stakeholder relationships	x	x	x	x
Develop new stakeholder relationships	x	x	x	x
Community projects		x	x	x
Expand educational capacity of Council	x	x	x	x
Reach public using various methods including media	x	x	x	x
Selection of appropriate BMP project		x		
Hire contractor, purchase equipment, organize stakeholders as appropriate	x	x	x	x
Evaluation of effectiveness			x	x
Coordinator for Council	x	x	x	x
Additional consultants	x	x	x	x
Education resource staff for Council	x	x	x	x

Table 7: Proposed Phase II WRAS measurable milestones implementation schedule.

Future Funding

A variety of funding programs that assist watershed groups in watershed protection and restoration were investigated. Information on each program is detailed to provide insight to specific funding opportunities for the Paso del Norte watershed in the lower Rio Grande. USEPA's Catalog of Federal Funding Sources for Watershed Protection provides an overview of potential federal and non-federal funding sources.

Nonpoint Source Implementation Grants

The Nonpoint Source Implementation Grants [319(h)] program provided the foundation of financial resources for the Council (Council) to address water quality issues in the Paso del Norte watershed. The 319(h) program funds projects and programs in concurrence with section 319(h) of the Clean Water Act (CWA) and are geared toward addressing nonpoint source (NPS) pollution. On average, $202 million dollars is administered in the U.S. for the 319(h) program. Projects like formation of a water quality monitoring plan, the design and implementation of Best Management Practices (BMP's), hiring watershed coordinators, and public outreach education programs are considered creditable for 319(h) funding. States are required to provide a 40% non-federal match for the entire grant in the form of financial and human resources. To date, the 319(h) program has funded a data, biological, and stakeholder analysis for the Council’s WRAS; this work has been ongoing since July 1, 2006. See the Catalog of Domestic Federal Assistance website, www.cfda.gov, for more information; search program number 66.460.

A request for proposals for 319(h) Phase II funding will be released in the fall or winter of 2007. Stream and river segments included in the NMED-SWQB 2004-2006 303(d) list will be eligible for this funding. The SWQB provides assistance to watershed groups in developing related documents needed for this program.

Environmental Quality Incentives Program

USDA’s Natural Resource Conservation Service (NRCS) supports the Environmental Quality Incentives Program (EQIP) financial assistance program. This voluntary program is targeted to agricultural producers for addressing local natural resource needs and goals. The major program goals are enhancing agricultural production and optimizing environmental benefits on lands that, for instance, are affected by problems with soil erosion, water quality and quantity, wetlands, or grazing lands, among others. EQIP contracts can extend the length of one year after project implementation to ten years maximum. A comprehensive plan of operations is developed by NRCS and the applicant to best identify and prioritize suitable conservation practices that would address specific resource goals. A typical match amount equals 25-50%; the local average of required match is ~35%. See www.nrcs.usda.gov/programs/eqip for more information.

Within the Paso del Norte watershed lie two Local Work Groups: the La Union and the Sierra Soil & Water Conservation Districts. These are the entities that approve all local operation plans and provide assistance with the management of EQIP funds. Eligible persons include land owners, landlords, operators, or tenants of eligible agricultural lands. Also, producers who face threats to their natural resources and those in need of assistance in complying with federal and state environmental law are encouraged to apply. Examples of projects include watershed management, restoration, monitoring, nonpoint source pollution control, best management practices, education/outreach, mitigation of ranching impacts, and water conservation efforts.

Targeted Watershed Grants Program

This grant is geared toward funding collaborative partnerships aimed at protecting and restoring water resources. Generally, grants are awarded for the use in on-the-ground implementation of watershed-based projects that contain a strong element of stakeholder collaboration for producing environmental changes. A technically sound watershed BMP implementation plan is necessary; this may present itself as a future funding option for the Council once such a plan is developed. A non-federal match of 25% is required. See www.epa.gov/owow/watershed/initiative/ for more information.

Small Watershed Rehabilitation Program

This program is aimed at the rehabilitation of aging dams that were originally constructed under the USDA Watershed Program in the last 50 years. The goal is to address public health and safety issues, including those associated with NPS pollution. Applications may be submitted year-found and a 35% match is required. See http://www.nrcs.usda.gov/programs/WSRehab/ for more information.

National Research Initiative Competitive Grants Program

USDA's Cooperative State Research, Education, and Extension Service support the Water and Watersheds Program which is aimed at protecting and enhancing natural resource bases and watershed environments. Specific goals include, but are not limited to, protecting food safety through clean irrigation and livestock drinking water supplies. Long-term goals for this program are reducing pathogens from watersheds and maintaining adequate water supplies for agricultural and livestock production, as well as rural water use water supplies.

FY 2008 project applications must address one of the two priorities: understanding the fate and transport of pathogens within a watershed (with a special emphasis on *E. coli*) or investigating agricultural and livestock producer behaviors aimed at water conservation. For a project spanning 2-4 years, proposed budgets must not exceed $200,000. Applications for FY 2008 funds are due by January 17, 2008 (5:00 P.M., ET). See http://www.csrees.usda.gov/funding/rfas/pdfs/08_nri.doc for more information.

Acronyms and Abbreviations

USACE	U. S. Army Corp of Engineers
USBLM	U. S. Bureau of Land Management
USBR	U.S. Bureau of Reclamation
BMP	Best Management Practice
CWA	Clean Water Act
Council	Paso del Norte Watershed Council
EPCWID#1	El Paso County Water Improvement District #1
EPWU	El Paso Water Utilities
EBID	Elephant Butte Irrigation District
USEPA	U. S. Environmental Protection Agency
FWS	Fish & Wildlife Service
USIBWC	U.S. Section, International Boundary and Water Commission
LRG	Lower Rio Grande
NGO	Non-governmental organization
NMED	New Mexico Environment Department
NMISC	New Mexico Interstate Stream Commission
NMSU	New Mexico State University
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
SWQB	Surface Water Quality Bureau
TAMU	Texas A&M University
TAES	Texas Agricultural Experiment Station
TMDL	Total Maximum Daily Load
USFS	U.S. Forest Service
USGS	U.S. Geological Service
UACD	Universidad Autonmas Cuidad Juarez
WRRI	Water Resources Research Institute
WRAS	Watershed Restoration Action Strategy
WWF	World Wildlife Fund

Appendix I - Paso Del Norte Watershed Council

Executive Committee

Kevin Bixby, Southwest Environmental Center

Hilary R. Brinegar, NM Department of Agriculture

Dr. Christopher Brown, Council chair, New Mexico State University

Juan Flores, Universidad Autónoma de Ciudad Juárez

Dr. Alfredo Granados, Universidad Autónoma de Ciudad Juárez

Inga Groff, League of Women Voters

Joe Groff, Chihuahuan Desert Wildlife Rescue

Brian Hanson, U.S. Fish & Wildlife Service

Dr. Conrad Keyes, Jr., Consultant to U.S. Army Corps of Engineers

Vanessa Lougheed, University of Texas at El Paso

Julie Maitland, NM Department of Agriculture

Dr. Ari M. Michelsen, Council treasurer, Texas A&M University

Jennifer Atchley Montoya, Council secretary, World Wildlife Fund

Dr. Zhuping Sheng, Texas Agricultural Experiment Station

Steve Smullen, U.S. International Boundary and Water Commission

Dr. Susan Watts, Council vice-chair, Texas Tech University

The Paso del Norte Watershed Council (Council)

The Council is an alliance of private citizens, non-governmental organizations, representatives of federal and state agencies, water utilities, municipal governments, and universities that partner and provide an integrated vision for watershed management in the Paso del Norte watershed region. Within the Council, diverse regional interests and interdisciplinary expertise provide specialized perspectives on watershed issues. The Council provides an open and inclusive forum for communication, collaboration, and innovative thinking concerning watershed issues for the benefit of agricultural, environmental, and municipal interests. The watershed lies within a bi-national, tri-state region that serves towns, municipalities, and irrigation districts. Its mission is as follows:

Paso del Norte Watershed Council Mission:

Investigate, develop, and recommend options for watershed planning and management and to explore how water-related resources can best be balanced to benefit the Rio Grande ecosystem and the interests of all watershed stakeholders. The Council's focus is the Paso del Norte Watershed, defined as the Rio Grande basin between Elephant Butte Dam/Reservoir in southern New Mexico and Fort Quitman, Hudspeth County, Texas. The Council provides an open forum for the encouragement and development of activities that lead to a healthy watershed.

The Council was initially established as an advisory body for the New Mexico-Texas Water Commission. Since 2000, the Council has met an average of seven times per year as it strives to promote a variety of projects to improve water quality and quantity, ecosystem integrity, quality of life, and economic sustainability in the Paso del Norte region. Membership to the Council is open to anyone, and extensive efforts have been made to solicit maximum participation by stakeholders throughout the watershed.

The Council has built collaborative relationships among a broad base of stakeholders. It also recognizes the continued need to expand stakeholder participation among key groups in the farming and ranching community, conservation interest groups, local, state, and federal entities including the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS).

The Council has previous experience providing comprehensive recommendations for restoration projects in this region. Its initial objective was to advise the New Mexico-Texas Water Commission in their development of a 50-year water supply plan for the border region. This project was named the El Paso-Las Cruces Regional Sustainable Water Project and the Council was formed because of the need for recommendations on environmental mitigation and river enhancement projects. Efforts over the years vary from technical support and development of internet-based research tools to investigation of water quality and water quantity issues to recommending and supporting restoration projects. Recommendations contained in this WRAS come from a collaboration of experienced and diverse stakeholders with a wealth of expertise and perspectives. The overall goals of the Council are to:

- Promote and implement watershed planning and management.
- Support restoration and enhancement projects in the watershed.
- Facilitate communication, education, and outreach among stakeholders and within the Council.
- Seek and evaluate funding methods to attain the objectives.

Since the 319(h) grant was awarded in July 2006, the Council has convened eight times to facilitate/provide input in development of this WRAS and to discuss related issues such as the Coordinated Database Project, the USBR 2025 Grant, Rio Grande Project Reservoir Operations, the Paso del Norte Water Task Force, the New Mexico-Texas Water Commission's Management Advisory Committee (MAC), pertinent upcoming legislation, restoration efforts, water quality issues, and the 319(h) grant progress, among other topics.

Appendix II - Clean Water Subcommittee

Kevin Bixby	Southwest Environmental Center
Hilary Brinegar	New Mexico Department of Agriculture
Chris Brown	New Mexico State University
Fernando Cadena	New Mexico State University
Chris Canavan	New Mexico Environment Department
Anne Coleman	New Mexico Department of Agriculture
Brian Hanson	U.S. Fish & Wildlife Service
Julie Maitland	New Mexico Department of Agriculture
Jennifer Atchley Montoya	World Wildlife Fund
Susan Watts	Texas Tech University

Appendix III - Biological Analysis

Habitat and Land cover

SWReGAP mapped land cover based on ecological systems over a broad region including the watershed (Lowery et al 2006). Ecological systems are defined by Comer et al. (2003) as "groups of plant communities and sparsely vegetated habitats unified by similar ecological processes, substrates, and/or environmental gradients." SWReGAP mapped 52 land cover types within the watershed with 40 types mapped at less than 1% of the land area. Many of these land cover types are likely on the periphery of their range or found in small isolated patches within the watershed. Twelve land cover types (Table 2) were mapped with more than 1% of the watershed including Chihuahuan Mixed Desert and Thorn Scrub, Apacherian-Chihuahuan Semi-Desert Grassland and Steppe, Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub, and Apacherian-Chihuahuan Mesquite Upland Scrub. Irrigated agriculture was mapped on 6.7 % of the watershed and urban areas including low, medium, and high density development were mapped on 3.4%.

There are several key habitats within the watershed as identified by the New Mexico Department of Game and Fish in New Mexico's Comprehensive Wildlife Conservation Strategy (NMDGF 2005). These include the terrestrial habitats of Chihuahuan Semi-Desert Grasslands, Madrean Encinal, and Madrean Pine-Oak /Conifer-Oak, riparian habitats, and aquatic habitats including Marsh/ Cienega/ Spring/ Seep, 1st and 2nd Order Streams, and 5th Order Streams (Rio Grande). Below, in Table 8, we discuss land cover types considered either dominant within the watershed or in or adjacent to streams. Information on habitat condition, factors affecting these habitats, information gaps, research needs, and conservation actions for those land cover types identified as key habitats to species (NMCWCS 2005).

Code	Description	Hectares	%
S062	Chihuahuan Mixed Desert and Thorn Scrub	200,840	33.4
S077*	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe	113,393	18.9
S068	Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub	91,947	15.3
S058	Apacherian-Chihuahuan Mesquite Upland Scrub	57,153	9.5
N80	Agriculture	40,174	6.7
S112*	Madrean Pinyon-Juniper Woodland	15,183	2.5
S018	North American Warm Desert Active and Stabilized Dune	13,036	2.2
N22	Developed, Medium - High Intensity	11,258	1.9
N21	Developed, Open Space - Low Intensity	8,896	1.5
S116	Chihuahuan Mixed Salt Desert Scrub	8,131	1.4
S019	North American Warm Desert Volcanic Rockland	6,783	1.1
S051*	Madrean Encinal	6,202	1.0
*Key habitats as defined by the New Mexico Department of Game and Fish			

Table 8: Key habitats as defined by the New Mexico Department of Game and Fish.

Upland Habitats

Of the five predominant terrestrial land cover types, only the Chihuahuan semi-desert grasslands were identified as a key habitat by NMDGF. This land cover type is an aggregation of semi-desert grasslands including the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe ecological system. The other three land cover types (Chihuahuan Mixed Desert and Thorn Scrub, Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub, Apacherian-Chihuahuan Mesquite Upland Scrub) were not considered key and were not treated as extensively as the Chihuahuan semi-desert grasslands.

Chihuahuan Semi-Desert Grasslands

In the Paso del Norte watershed, the predominant ecological system within the Chihuahuan Semi-Desert Grasslands is the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (Figure 2). This ecological system is broadly defined as a desert grassland, mixed shrub-succulent, or xeromorphic tree savanna (Comer et al 2003, see Appendix C). It occurs in the Borderlands of Arizona, New Mexico and northern Mexico. It occurs on gently sloping bajadas that supported frequent fire throughout and steeper piedmont and foothill slopes in the Chihuahuan Desert. Species present include perennial grasses such as black grama (*Bouteloua eriopoda),* hairy grama *(Bouteloua hirsute),* sideoats grama *(Bouteloua curtipendula),* blue grama *(Bouteloua gracilis),* plains lovegrass *(Eragrostis intermedia),* bush muhly *(Muhlenbergia porter),* curlyleaf muhly *(Muhlenbergia setifolia),* tobosagrass *(Pleuraphis mutica)*, and alkali sacaton (*Sporobolus airoides).* Succulent species include of *Agave, sotol (Dasylirion),* and *Yucca.* Tall-shrub/short-tree species include mesquite (*Prosopis* *spp.)* and various oaks including gray oak (*Quercus grisea)* and Arizona white oak *(Quercus arizonica*)(Comer et al 2003).

Figure 4: Representative site of Chihuahuan Sandy Plains Semi-Desert Grassland as an ecological system grouped into the Chihuahuan Semi-Desert Grasslands land cover type. Photo courtesy of SWReGAP.

These semi-desert grasslands are found throughout the watershed. This grassland habitat type has recently shifted from perennial grassland to shrub-dominated desert scrubland (Barnes 1936, Buffington and Herbel 1965, Branson 1985, Archer 1989). Fredrickson et al. (1998) suggested the reasons for this shift include improper livestock grazing, climatic change, and fire suppression. Conversion of grassland and human development have caused increased runoff and erosion, decreased biological diversity, shifts in avian species assemblages, increased invasion by non-native species, and decreased livestock and wildlife forage (Branson 1985, Saunders et al. 1991, Vickery et al. 1999, Desmond et al. 2005).

Species of Greatest Conservation Need associated within this habitat type include two amphibians, the Great Plains narrowmouth toad and tiger salamander (NMDGF 2005). Bird SGCN include Aplomado falcon, Baird's sparrow, bald eagle, Bendire's thrasher, Botteri's sparrow, burrowing owl, common ground-dove, ferruginous hawk, golden eagle, grasshopper sparrow, gray vireo, hooded oriole, loggerhead shrike, Montezuma quail, mourning dove, northern harrier, sage thrasher, sandhill crane, scaled quail, Sprague's pipit, and varied bunting. Mammal SGCN associated with this habitat type include Arizona Myotis bat, black-tailed prairie dog, Coues' white-tailed deer, desert bighorn sheep, lesser long-nosed bat, Mexican long-tongued bat, mule deer, northern pygmy mouse, pocketed free-tailed bat, swift fox, white-sided jack rabbit, and yellow-nosed cotton rat. Reptiles associated with this habitat include bunch grass lizard, collared lizard, desert massasauga, gray-banded kingsnake, gray-checkered whiptail, milk snake, ornate box turtle, Texas banded gecko, and the western diamondback rattlesnake.

Several mollusc SGCN are also associated with this habitat and include distorted Metastoma snail, Dona Ana talussnail, Franklin Mountain talussnail, New Mexico ramshorn snail, northern treeband snail, Organ Mountain talussnail, San Luis Mountains talussnail, three-toothed column snail, whitewashed radabotus snail, and a woodlandsnail species.

Chihuahuan Mixed Desert and Thorn Scrub

The Chihuahuan Mixed Desert and Thorn Scrub is comprised of two ecological systems including the Chihuahuan Creosotebush Xeric Basin Desert Scrub and the Chihuahuan Mixed Desert and Thorn Scrub (Comer et al. 2003) (Figure 3). These land cover types include xeric creosotebush shrublands and mixed desert scrub in foothill transition zones and extending up to lower montane woodlands (Appendix C). Species include creosote bush (*Larrea tridentata*) singly or mixed with thornscrub and other desert scrubs such as lechuguilla (*Agave lechuguilla*), Wright's bee brush (*Aloysia wrightii*), ocotillo *(Fouquieria splendens),* sotol *(Dasylirion leiophyllum),* tarbush *(Flourensia cernua),* Big Bend barometerbush *(Leucophyllum minus),* catclaw mimosa *(Mimosa aculeaticarpa* var. *biuncifera)*, Texas prickly pear (*Opuntia engelmannii),* mariola (*Parthenium incanum),* honey mesquite *(Prosopis glandulosa),* and plumed crinklemat *(Tiquilia greggii)*.

Figure 5: Representative site of Chihuahuan Mixed Desert and Thorn Scrub ecological system mapped by the Southwestern Regional Gap Analysis Project. Photo courtesy of SWReGAP.

There are 173 terrestrial vertebrates species associated with this habitat type (Appendix G). Amphibians within this habitat include green toad, red-spotted toad, Woodhouse's toad, Couch's spadefoot, and plains spadefoot. Birds associated with this land cover type include black-chinned hummingbird, burrowing owl, scaled quail, cactus wren, Chihuahuan raven, Aplomado falcon, greater roadrunner, bald eagle, phainopepla, ladder-backed woodpecker, Bendire's thrasher, and Lucy's warbler. Mammals associated with this habitat include ringtail, Townsend's big-eared bat, Merriam's kangaroo rat, banner-tailed kangaroo rat, black-tailed jack rabbit, mule deer, collared peccary, hispid cotton rat, badger, gray fox, and kit fox. Reptiles found in the habitat include glossy snake, trans-Pecos rat snake, Chihuahuan spotted whiptail, Texas banded gecko, western diamondback rattlesnake, collared lizard, Texas horned lizard, round-tailed horned lizard, massasauga and ornate box turtle.

Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub

This ecological system includes open shrublands of vegetated coppice dunes dominated by honey mesquite (Comer et al. 2003)(Figure 4). It can include four-wing saltbush (Atriplex *canescens)*, Torrey's ephedra (*Ephedra torreyana)*, longleaf jointfir (*Ephedra trifurca)*, frosted mint (*Poliomintha incana)*, and littleleaf sumac (*Rhus microphylla)* coppice sand scrub with 10-30% total vegetation cover. Soaptree yucca (*Yucca elata)*, snakeweed (*Gutierrezia sarothrae)*, and mesa dropseed (*Sporobolus flexuosus)* are also commonly present.

Figure 6: Representative site of Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub mapped by the Southwestern Regional Gap Analysis Project. Photo courtesy of SWReGAP.

There are 63 terrestrial vertebrates associated with this land cover type (Appendix G). Amphibians found within Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub include red-spotted toad and Woodhouse's toad. Birds they may be found within this habitat include burrowing owl, great horned owl, lesser nighthawk, greater roadrunner, bald eagle, Scott's oriole, loggerhead shrike, ash-throated flycatcher, sage thrasher, phainopepla, Bendire's thrasher, western kingbird, and mourning dove. Mammals associated with this habitat include Merriam's kangaroo rat, Ord's kangaroo rat, desert pocket gopher, striped skunk, Arizona myotis, southern plains woodrat, big free-tailed bat, mule deer, northern grasshopper mouse, southern grasshopper mouse, silky pocket mouse, mountain lion, gray fox, and kit fox. Reptiles associated with this habitat include glossy snake, Trans-Pecos rat snake, New Mexico whiptail, checkered whiptail, western diamondback rattlesnake, long-nosed leopard lizard, common kingsnake, Texas blind snake, Texas horned lizard, massasauga, ground snake, and ornate box turtle

Apacherian-Chihuahuan Mesquite Upland Scrub

This ecological system occurs in the uplands as shrublands or as the grassland-shrubland transition in foothills and piedmont in the Chihuahuan Desert (Figure 5). Plant species are dominated by honey mesquite and succulents. Other desert scrub that may be dominant or codominant include viscid acacia (*Acacia neovernicosa)*, whitethorn acacia (*Acacia constricta)*, one-seed juniper (*Juniperus monosperma)*, or redberry juniper (J*uniperus coahuilensis)*. Grass cover is typically low. The area occupied by this system has increased through conversion of desert grasslands as a result of drought, improper grazing, and/or decreases in fire frequency.

Figure 7: Representative site of Apacherian-Chihuahuan Mesquite Upland Scrub mapped by the Southwestern Regional Gap Analysis Project. Photo courtesy of SWReGAP.

There are 198 terrestrial vertebrate species associated with this land cover type. Amphibians found in this habitat include green toad, red-spotted toad, Woodhouse's toad and Couch's spadefoot. Bird species associated with this habitat include black-chinned hummingbird, burrowing owl, great horned owl, zone-tailed hawk, scaled quail, killdeer, lesser nighthawk, common nighthawk, common raven, Chihuahuan raven, peregrine falcon, American kestrel, greater roadrunner, bald eagle, Scott's oriole, loggerhead shrike, ash-throated flycatcher, western screech-owl, painted bunting, phainopepla, ladder-backed woodpecker, green-tailed towhee, vermilion flycatcher, Bendire's thrasher, Lucy's warbler, Bell's vireo, gray vireo, and mourning dove. Mammals associated with this habitat include porcupine, desert pocket gopher, hoary bat, black-tailed jack rabbit, bobcat, striped skunk, Arizona myotis, long-legged myotis, southern plains woodrat, desert shrew, mule deer, northern grasshopper mouse, collared peccary, silky pocket mouse, raccoon, mountain lion, tawny-bellied cotton rat, hispid cotton rat, spotted ground squirrel, desert cottontail, badger, gray fox, kit fox and red fox. Reptiles associated with this type include glossy snake, Trans-Pecos rat snake, Chihuahuan spotted whiptail, New Mexico whiptail, Texas banded gecko, racer, western diamondback rattlesnake, rock rattlesnake, collared lizard, ring-necked snake, many-lined skink, great plains skink, long-nosed leopard lizard, western hook-nosed snake, Gila monster, western hog-nosed snake, common kingsnake, Texas blind snake, Texas horned lizard, round-tailed horned lizard, western patch-nosed snake, Southwestern black-headed snake, plains black-headed snake, ornate box turtle, western terrestrial garter snake, and western lyre snake.

Riparian Habitats

Riparian habitats are assemblages of plant communities associated with stream-induced or related factors (Kauffman and Krueger 1984). Riparian systems can range from mesic vegetation communities associated with perennial water such as the Rio Grande River to xeric communities with highly ephemeral waters associated with the many arroyos within the watershed. All riparian habitats were considered key habitats within the NMCWCS. Sixteen ecological systems mapped by SWReGAP were aggregated. In the Paso del Norte watershed, six ecological system were mapped including North American Warm Desert Wash, North American Warm Desert Playa, North American Warm Desert Lower Montane Riparian Woodland and Shrubland, North American Warm Desert Riparian Woodland and Shrubland, North American Warm Desert Riparian Mesquite Bosque and North American Arid West Emergent Marsh (See Lowery et al 2006 for descriptions). Watts (1998) identified finer scale vegetation communities specifically for the watershed. Dominant tree and shrub species included ash (*Fraxinus* spp.), cottonwood (*Populus* spp.), saltcedar (*Tamarix* spp.), willow (*Salix* spp.), seepwillow (*Baccharis* sp.), and mesquite (*Prosopis* sp.). Herbaceous species include alkali sacaton (*Sporobolus airoides),* Bermudagrass *(Cynodon dactylon),* and saltgrass *(Distichlis spicata)*.

Riparian habitats support greater diversity of plants and animals than upland habitats. A large number of wildlife in the Southwest use riparian habitats (Thomas et al. 1979, Johnson et al. 1977) and approximately 80% of sensitive and specially classified vertebrate species in New Mexico depend upon riparian habitat for some portion of their life cycle (New Mexico Department of Game and Fish 2000). It is estimated that wetlands and riparian ecosystems comprise less than 1% of New Mexico (Dahl 1990, Henrickson and Johnston 1986, Allen and Marlow 1992).

Dahl (1990) estimated that 33% of the wetlands once existing in New Mexico have been lost. Hink and Ohmart (1984) identified an 87% decrease in wetland acreage along the main stem of the Rio Grande from 1918 to 1982. Riparian systems have been the subject of alteration and fragmentation because they occur in the valley floor were human have settled for agricultural reasons. Fullerton and Batts (2003) suggested the largest stressors were regulated river flows, channelization, and invasive species. Historically, floods caused multiple channels and sandbars, washed away stands of trees, and created wetlands resulting in an heterogeneous mosaic of vegetation communities and age classes. Construction of dams has decreased flood frequency and intensity. Additionally, the water table decreased, river channels were straightened and bermed, banks were stabilized, and the natural shifting of channels halted. At some locations, the river channel is narrowing and deepening and vegetation is stabilizing the riverbank.

The condition of xeric riparian (arroyos) communities is largely unknown. These communities occur throughout the watershed along ephemeral drainages. These communities can be highly fragmented due to natural and anthropogenic sources. Few studies have focused on these riparian communities and standard riparian monitoring methods are not applicable to these vegetation types. Xeric riparian communities are thought to be important for species and support unique species compared to adjacent upland habitats (Meyer 1995).

Riparian habitats host up to 216 terrestrial vertebrates within the watershed (Appendix F). Amphibian species found within this habitat type include amphibians such as great plains toad, green toad, red-spotted toad, Woodhouse's toad, plains leopard frog, Chiricahua leopard frog, northern leopard frog, and Couch's spadefoot. Birds associated with this habitat type include northern goshawk, sharp-shinned hawk, wood duck, black-throated sparrow, northern pintail, black-chinned hummingbird, common black-hawk, yellow-billed cuckoo, Chihuahuan raven, Aplomado falcon, peregrine falcon, sandhill crane, blue grosbeak, bald eagle, dark-eyed junco, phainopepla, ladder-backed woodpecker, vermilion flycatcher, Bendire's thrasher, orange-crowned warbler, Lucy's warbler, Bell's vireo, gray vireo, and mourning dove. Mammals found within this habitat type include pallid bat, beaver, hispid pocket mouse, hog-nosed skunk, Merriam's kangaroo rat, banner-tailed kangaroo rat, porcupine, spotted bat, bobcat, striped skunk, mule deer, muskrat, Mearns' grasshopper mouse, collared peccary, raccoon, mountain lion, badger, gray fox, and red fox. The reptiles associated with the habitat type include spiny softshell turtle, glossy snake, Trans-Pecos rat snake, snapping turtle, New Mexico whiptail, western diamondback rattlesnake, black-tailed rattlesnake, collared lizard, ring-necked snake, Madrean alligator lizard, yellow mud turtle, Sonoran mountain kingsnake, Big Bend slider, and common slider

In xeric riparian communities there are up to 108 terrestrial vertebrates associated with these communities riparian communities (Appendix G). Amphibians found within this habitat type include green toad, red-spotted toad, Woodhouse's toad, and plains spadefoot. Birds associated with this habitat type include black-chinned hummingbird, burrowing owl, verdin, zone-tailed hawk, ferruginous hawk, Gambel's quail, lesser nighthawk, peregrine falcon, greater roadrunner, phainopepla, vermilion flycatcher, Bendire's thrasher, Lucy's warbler, and mourning dove. Mammals associated with xeric riparian communities include Merriam's kangaroo rat, banner-tailed kangaroo rat, porcupine, spotted bat, desert pocket gopher, western red bat, bobcat, striped skunk, mule deer, collared peccary, silky pocket mouse, cactus mouse, raccoon, western spotted skunk, desert cottontail, Brazilian free-tailed bat, Botta's pocket gopher, gray fox, and kit fox. Reptiles that are associated with this land cover include glossy snake, Trans-Pecos rat snake, New Mexico whiptail, western diamondback rattlesnake, Great Plains skink, common kingsnake, western blind snake, Texas horned lizard, ornate box turtle, and western terrestrial garter snake.

Aquatic Habitats

The NMCWCS identified three key aquatic habitats that can occur within the Paso del Norte watershed. These include Perennial Marsh/Cienega/Spring/Seep, Perennial 1st and 2nd Order Stream, and Perennial 5th Order Stream. Each aquatic habitat was treated within the CWCS.

Perennial Marsh/Cienega/Spring/Seep

Perennial marsh/cienegas/Springs/Seeps occur as geographically isolated wet depressions or seeps that are products of seasonal discharge of shallow groundwater aquifers and precipitation events. These areas collect and hold water that commonly supports hydrophilic plants (e.g., obligate and facultative wetland plants) and wildlife. Flooding provided the majority of the habitat along the Rio Grande until channelization and water control activities reduced these events. Perennial spring-fed marshes and cienegas discharge to localized aquatic systems that contribute surface flows to perennial tributaries of the Rio Grande.

Within Perennial Marsh/Cienega/Spring/Seep there are 34 identified SGCN for the entire Rio Grande (Appendix H). Invertebrates associated with this land cover type include crustaceans such as sideswimmers/scuds, Socorro isopod, and mollusks such as the Alamosa springsnail, blunt ambersnail, Chupadera pyrg snail, ovate vertigo snail, and Socorro pyrg snail. Fish species within these habitats include the Rio Grande Silvery Minnow, although not likely within the watershed. Amphibians that can be associated with this habitat include Chiricahua leopard frog, northern leopard frog, plains leopard frog, tiger salamander, and western chorus frog. Birds associated with this habitat include American bittern, bald eagle, common black-hawk, eared grebe, Lucy's warbler, northern harrier, northern pintail, peregrine falcon, sandhill crane, southwestern willow flycatcher, white-faced ibis, and yellow warbler. Mammal species that are associated with this habitat include Allen's big-eared bat, American beaver, New Mexico meadow jumping mouse, spotted bat, and western red bat. A reptile SGCN that is associated with this habitat type is the New Mexico garter snake.

Perennial 1st and 2nd Order Stream

Perennial 1st and 2nd ordered streams consist of headwater streams. These streams are limited within the watershed and likely only occur in the higher elevations of the Black Range Mountains or Organ Mountains. These streams are least impacted by human activity. Limited channelization and dewatering occurs within these streams. At lower elevations in the watershed, 1st and 2nd order streams are ephemeral unless associated with springs.

Within Perennial 1st/2nd order streams, there are 14 identified SGCN for the entire Rio Grande (Appendix H). Invertebrates associated with this habitat type include crustaceans (e.g. Sideswimmers / Scuds) and mollusks (e.g. Alamosa springsnail and wrinkled marshsnail). Fish species associated with this habitat type are Rio Grande chub, Rio Grande cutthroat trout and the Rio Grande sucker. Amphibians associated with this aquatic system include Chiricahua leopard frog, northern leopard frog, and western chorus frog. Bird species that are associated with this habitat include common black-hawk and yellow warbler. Only one mammal (American beaver) and one reptile (New Mexico garter snake) are associated with this habitat.

Perennial 5th Order Stream

The Rio Grande is the only 5th order streams in the watershed. There is a decreasing gradient for the Rio Grande until it reaches the state border. In the Mesilla valley the historic floodplain was wide and diverse. Crawford et al (1996) suggested that the channel morphology was complex including meanders, oxbows, and braiding. Frequent over-bank flows generate off-river ponds and marshes.

Within Perennial 5th order streams there are 31 identified SGCN for the entire Rio Grande (Appendix H). Invertebrates that inhabit these systems include sideswimmers / scuds and the creeping Ancylid snail. Fish found within these streams include blue catfish, Rio Grande chub, Rio Grande sucker, and smallmouth buffalo. Amphibian species found within 5th order streams include Chiricahua leopard frog, northern leopard frog and the plains leopard frog. Birds that are associated with these systems include bald eagle, bank swallow, Bell's vireo, common black-hawk, eared grebe, interior least tern, Lucy's warbler, northern pintail, osprey, painted bunting, peregrine falcon, Southwestern willow flycatcher, and yellow warbler. The American beaver is the only mammal SGCN that is associated with this habitat and there are three reptiles including Big Bend slider, New Mexico garter snake, and western painted turtle.

Wildlife Distributions

Distribution models for terrestrial and aquatic vertebrate species were produced by the Southwest Regional Gap Analysis Project (http://fws-nmcfwru.nmsu.edu/SWReGAP/) and the NMDGF CWCS (http://fws-nmcfwru.nmsu.edu/cwcs/). These efforts provided extensive literature review to identify species, habitats, and range for these species (NMDGF 2005, Boykin et al 2006).

Distribution and Abundance of Vertebrates

Geographical Distributions and Abundance of Terrestrial Vertebrates

Our knowledge of distribution and abundance of vertebrates varies by taxa group. Many abundance estimates are site based or small parcel based. Breeding bird counts and Christmas bird counts provide estimates of trends and abundance by species, but recent data is currently in interim format (Breeding Bird Atlas Explorer 2007). Data for trend and abundance are listed in Appendix A. There are two possible sampling sites for Christmas Bird Counts within the watershed providing a limited dataset for use (http://www.audubon.org/bird/cbc/pdf/AmBird106-pp93-98.pdf). We identified available bat data from Bat Conservation International which includes polygon distribution information for 20 species.

Museum records databases are available from various online museum data sources including Mammal Networked Information System (MaNIS; http://manisnet.org/), Ornithological Networked Information System (OrNIS; http://olla.berkeley.edu/ornisnet/), and Herpnet (http://www.herpnet.org/)(Appendix A). Also, records are available from the Institute of Natural Resource Analysis and Management (INRAM) biodiversity section (http://biodiversity.inram.org/).

Southwest Regional Gap Analysis Project (Prior-Magee 2006) completed habitat modeling for the Southwest United States (Boykin et al. 2006). SWReGAP identified the predicted suitable habitat for species. For each modeled, a total of 431 terrestrial vertebrates were predicted to occur within the Paso del Norte watershed (Table 9). These include 13 amphibians, 265 birds, 89 mammals, and 64 reptiles. SWReGAP data was restricted to species level so no subspecies models were available. Within this watershed there are 11 federally listed and 9 New Mexico State listed species. For more information on Southwest Regional Gap Analysis Project refer to http://fws-nmcfwru.nmsu.edu/SWReGAP/ and for information for the NMDGF CWCS refer to http://wildlife.state.nm.us/conservation/comp_wildlife_cons_strategy/index.htm.

Stotz (2000) identified 8 native amphibian species within the watershed, with one probable species and one introduced species (bullfrog). There were 49 reptiles identified by Stotz (2000), with one introduced species (Mediterranean gecko), and one introduced species extirpated (lined snake). For mammals, Stotz (2000) identified up to 36 species within the watershed, with 4 introduced species and one extirpated species. Stotz (2000) provides factors that have led to extirpation as well as population trends and habitat preference within developed species accounts (see Stotz 2000 for further detail).

Taxa Group	Number of Species
Birds	265
Mammals	89
Reptiles	64
Amphibians	13
Total	431

Table 9: Number of terrestrial vertebrate species that may be found within the watershed as mapped by the Southwest Regional Gap Analysis Project (Boykin et al. 2006).

The number of terrestrial vertebrate species by habitat association within the watershed varies from a low of 27 species in the North American Warm Desert Volcanic Rockland ecological system to a high of 246 species in the North American Warm Desert Riparian Woodland and Shrubland (Table 10). Most ecological systems within the watershed have more than 100 species associated with them. These species may use the habitat year-round, during migration, during the winter or during breeding. This is highly variable depending on the individual life history of the species. Species associations as derived from SWReGAP are provided in Appendix G.

The dominant key habitats identified by the NMCWCS in the watershed were the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe. This ecological system was mapped on 18.9% of the watershed and has 228 species of terrestrial vertebrates associated with it. The Chihuahuan Mixed Desert and Thorn Scrub ecological system has 173 species associated with that system, which accounts for 33.4% of the watershed. The Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub was mapped on 15.3% of the watershed and has 63 associated species, Apacherian-Chihuahuan Mesquite Upland Scrub occurs on 9.5% of the watershed and has 198 species associated with this ecological system. Agriculture has 171 species associated with it and was mapped on 6.7% of the watershed. The two other key habitats as identified by the NMCWCS were the Madrean Pinyon-Juniper Woodland mapped on 2.5% of the watershed and the Madrean Encinal mapped on 1.0%. These ecological systems had 220 and 155 species respectively associated with them.

The riparian systems (Table 10) vary in total species associations. The mesic riparians ecological systems including North American Arid West Emergent Marsh, North American Warm Desert Lower Montane Riparian Woodland and Shrubland, North American Warm Desert Riparian Mesquite Bosque North American Warm Desert Riparian Woodland and Shrubland have near or over 200 species associated with each. The two xeric or arroyo ecological systems within the watershed are well below this number of species. The North American Warm Desert Playa ecological system has 45 species associated and the North American Warm Desert Wash ecological system has 108 species.

General Type	SWReGAP Land Cover Type	Number of Species
	Agriculture	171
	Apacherian-Chihuahuan Mesquite Upland Scrub	198
Semi-Desert Grasslands	Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe	228
	Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub	173
	Chihuahuan Mixed Salt Desert Scrub	130
Semi-Desert Grasslands	Chihuahuan Sandy Plains Semi-Desert Grassland	100
	Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub	63
	Developed, Medium - High Intensity	63
	Developed, Open Space - Low Intensity	123
	Madrean Encinal	155
	Madrean Pinyon-Juniper Woodland	220
Riparian	North American Arid West Emergent Marsh	205
	North American Warm Desert Active and Stabilized Dune	64
Riparian	North American Warm Desert Lower Montane Riparian Woodland and Shrubland	241
Riparian	North American Warm Desert Playa	45
Riparian	North American Warm Desert Riparian Mesquite Bosque	199
Riparian	North American Warm Desert Riparian Woodland and Shrubland	246
	North American Warm Desert Volcanic Rockland	27
Riparian	North American Warm Desert Wash	108
	Open Water	133

Table 10: Number of terrestrial vertebrate species that may be found within the watershed as mapped by the Southwest Regional Gap Analysis Project (Boykin et al. 2006).

Geographical Distributions and Abundance of Aquatic Vertebrates

The geographic distribution of fish within the watershed was mapped for species of Greatest Conservation Need by the NMDGF (http://fws-nmcfwru.nmsu.edu/cwcs/). There were 15 species of fish identified as occurring within the specific HUC (Table 11). Abundance of aquatic vertebrates is often difficult to obtain over large areas such as the watershed. NMDGF does conduct periodic surveys of sport fish and native species.

Stotz (2000) provided background on historical accounts of the aquatic vertebrates along the river. Historic accounts of eels and large fish were reported common near El Paso. Catfish and soft-shell turtles were mentioned along the northernmost reaches. According to Stotz (2000), 10 native fish species have been extirpated within the watershed, eleven native species remain, and 15 species have been introduced.

Common Name	Species Name
Trout, Cutthroat, Rio Grande (NM)	*Oncorhynchus clarki virginalis*
Trout, Rainbow	*Oncorhynchus mykiss*
Chub, Chihuahua	*Gila nigrescens*
Chub, Rio Grande	*Gila pandora*
Sucker, Rio Grande	*Catostomus plebeius*
Buffalo, Smallmouth	*Ictiobus bubalus*
Catfish, Channel	*Ictalurus punctatus*
Catfish, Flathead	*Pylodictis olivaris*
Bass, White	*Morone chrysops*
Bluegill	*Lepomis macrochirus*
Sunfish, Longear	*Lepomis megalotis*
Bass, Smallmouth	*Micropterus dolomieui*
Bass, Spotted	*Micropterus punctulatus*
Bass, Largemouth (NM)	*Micropterus salmoides salmoides*
Crappie, White	*Pomoxis annularis*

Table 11: List of fish species identified within the PdN HUC by NMDGF (2005).

Distribution and Abundance of Invertebrates

The distribution and abundance of many of the invertebrates is limited or unknown. This is particularly the case with distributions of aquatic invertebrates in smaller streams and springs. A list of species identified within the NMCWCS is provided in Table 12.

Common Name	Scientific Name
tadpole shrimp	*Triops sp.*
Beavertail fairy shrimp	*Thamnocepahlus platyurus*
clam shrimp	*Cyzicus sp. (mexicanus?)*
clam shrimp	*Isaura compleximanus (Leptestheria compleximanus)*
clam shrimp	*Eulimnadia cylindrova*
clam shrimp	*Eulimnadia texana*
Mexican beavertail fairy shrimp	*Thamnocepahlus mexicanus*
Moore's fairy shrimp	*Streptocephalus moorei*

Table 12: List of Crustaceans species identified within the PdN HUC by NMCWCS (2005).

Wildlife Borne Infectious Diseases

A number of wildlife borne infectious diseases are having been or have potential to be present within the watershed. These diseases include avian influenza, West Nile Virus, Cryptosporidium, and Avian Botulism. Another purpose of this effort was to analyze existing data including historic, current or potential incidences of wildlife borne infectious diseases that could be potential human pathogens based on wildlife populations within the watershed. These diseases cycle between vertebrates and invertebrates.

Avian influenza

Avian influenza is an infection caused the influenza viruses. These viruses occur naturally in birds, where the virus is found in their intestine. Typically, the birds are not affected by the virus (CDC 2006a). Avian influenza is very contagious and can be transmitted to domesticated birds (CDC 2006a). Infected birds can transmit the virus through their saliva, saliva, and nasal secretions. The risk to human from avian influenza is low; however there are confirmed cases of human infections (CDC 2006a). These confirmed cases have been associated with infected poultry (CDC 2006a). Currently, there have been no cases of avian influenza within the United States.

West Nile Virus

West Nile Virus is a virus that can cause human meningitis or encephalitis (CDC 2007). It was first detected in Egypt in the 1950s and first appeared in North America in 1999. Mosquitos are the vectors for this virus generally from bird reservoir hosts. Though some bird species can die (e.g. crows and jays), most infected birds survive (CDC 2007). Mammals, including humans, are considered incidental or “dead-end” hosts. DeMinna et al. (2006) describe the emergence of West Nile Virus (family *Flaviviridae*, genus *Flavivirus*, WNV) along the Rio Grande Valley in New Mexico. Introduction appears to have occurred in late summer of 2002 with a period of transmission cycles between avian hosts and mosquitoes. Many municipalities currently have mosquito abatement programs in place in an effort to reduce mosquito populations. Multiple cases of West Nile Virus have been identified within humans in Dona Ana County (Dona Ana County 2007).

Spatial data regarding the number of cases in wild birds or just in crows is identified in Appendix A. This data was obtained from the National Atlas.

Cryptosporidium

Cryptosporidium is an enteric parasite that can affect both birds and mammals (Kuhn et al. 2002). The parasite can be found in drinking water and recreational water in every region of the United States. The parasite can, which is protected by an outer shell, can survive outside of the body for long periods of time. Thus, the parasite can be found in soil, food, and water. Kuhn et al. (2002) identified the presence of both *Cryptosporidium* and *Giardia* in wild ducks within the Rio Grand River Valley.

Avian Botulism

Avian botulism is defined as “a paralytic disease caused by ingestion of a toxin produced by the bacteria, Clostridium botulism” by the National Wildlife Health Center (http://www.nwhc.usgs.gov/disease_information/avian_botulism/). This widespread bacterium is found in soils. The bacteria require warm temperatures, a protein source, and an anaerobic environment to produce toxin. These warm temperatures coupled with decomposing vegetation and invertebrates provide ideal conditions for the bacteria to activate and produce toxin. Several types of toxins are produced by strains of this bacterium and birds are more commonly affected by type C than type E. Birds either ingest the toxin directly or eat toxin containing invertebrates (e.g. chironomids). The invertebrates are not affected by the toxin and store the toxin. A cyclical pattern develops during an outbreak with fly larvae feeding on animal carcasses and ingesting the toxin. Ducks that consume these maggots can develop botulism after ingesting as few as 3 or 4 maggots. Diagnosis is made through serum or tissue samples. Waterfowl, shorebirds, and colonial waterbirds are the main host for Type C toxin. Gulls and loons are host to Type E. The toxin affects the bird nervous system and affected birds are unable to use muscles in the wings, legs, neck. Death results in water deprivation, electrolyte imbalance, respiratory failure, or predation.

Avian botulism outbreaks can occur throughout the United States with outbreaks generally occurring from July through September. Control includes removal and disposal of carcasses. It is suggested that altering water depth by flooding or drawing down water levels during hot weather should be avoided as this can increase mortality in invertebrate and fish. Affected birds should be provided with fresh water, shade, and protection from predators for recovery. Birds are not known to develop Immunity after surviving a botulism outbreak.

We have identified spatial data regarding the incidence of avian botulism in the United States. This data is listed in Appendix A.

Factors Affecting Habitat and Conservation Actions

Chihuahuan Semi-Desert Grasslands

Factors that affect this habitat or those species associated with this habitat include fragmentation, condition and restoration, grazing practices, fire regimes, development, off-road vehicles, non-native species, and diseases and pathogens (NMDGF 2005). Little is known about the intensity, scale, extent, and causes of grassland fragmentation in the Chihuahuan Desert particularly regarding the effects of fragmentation on SGCN and other wildlife. Pidgeon et al. (2001) suggested that the movement from grasslands to desert shrub has caused a major turnover in the avian community. Gutzwiller and Barrow (2002) suggested that landscape patchiness was species specific and could affect bird community structure. Additionally more information is needed about the extent that land use activities (e.g. livestock grazing; human development; off-road vehicle use; and exotic species invasions) fragment and alter habitats. More information is also needed to identify the effect of land management practices on grazing regimes, invasive species, and shrub encroachment. More information is needed on all aspects of vertebrate and invertebrate species including habitat association, life histories, ecological relationships, and population trends within grasslands. Interception, transpiration, infiltration, and runoff processes within Chihuahuan semi-desert grasslands need to be better understood.

Condition of the grasslands is an important factor and identifying ways to determine degradation is necessary. Conditions of the habitat types are necessary before restoration can occur to restore the natural ecological processes of these areas. Shrub encroachment is a significant factor within these grasslands and has direct effects on hydrology. It is important to know the environmental conditions and thresholds needed by wildlife species including the SGCN.

Livestock grazing effects on wildlife in the Chihuahuan Desert are dependent on the grazing management practices. Grazing by domestic livestock or wildlife may lead to loss of grassland cover, mortality of plant species, and increased erosion (Wilson and MacLeod 1991). Infrastructure development and improper grazing practices can lead to habitat fragmentation and loss by promoting conditions favorable for shrub encroachment (Dinerstein et al. 2000). Grazing management practices that produce sustainable levels, composition, and structure of native grasses need further research.

Fire regimes have been altered from fire suppression and removal of fine fuels, which can promote woody vegetation establishment and introduced non-native species. Historically, fire occurrence in desert grasslands varied and was related to seasonal and annual rainfall and physiographic variables (Archer 1994). Fires in desert grasslands were likely limited due to low biomass and a lack of fine fuels (Hastings and Turner 1965, York and Dick-Peddie 1969).

Increased urbanization in the Chihuahuan desert leads to the loss and fragmentation of native vegetation and increased erosion. Off-road vehicle use has increased in these grasslands. While the affects of these activities are not well understood, increased off-road vehicle use can negatively impact wildlife by destroying or fragmenting habitat, cause wildlife mortality, or alter wildlife behavior (Busack and Bury 1974, Brattstrom and Bondello 1983). Little is known about the extent to which off-road vehicle use is impacting Chihuahuan semi-desert grasslands and specifically SGCN wildlife populations. Though the effects are likely similar to those previously discussed by Pidgeon et al. (2001), Gutzwiller and Barrow (2002), and Desmond (2004).

Invasive species can displace native plant and animal species, disrupt nutrient and fire cycles, and promote further invasions (Cox 1999, Deloach et al. 2000, Zavaleta et al. 2001, Osborn et al. 2002). The extent of invasive species in Chihuahuan semi-desert grasslands is unknown as is the effects on wildlife species.

Riparian Habitats

Factors that are affecting wildlife species and wildlife habitat within riparian areas include alteration of natural flow regime, habitat conversion, invasive species, restoration practices, grazing practices, fire management, and disease (NMDGF 2005). Natural flow regimes are important for a river's natural ecosystem function and riparian biodiversity (Stanford et al. 1996, Poff et al. 1997, Richter et al. 1997). Flow regimes affect riparian communities by creating variable environmental conditions which drive patch dynamics and influence organisms' movements (Poff et al. 1997).

Habitat conversion can be a type conversion or more subtle such as changing dominant plant densities or changing plant strata composition. Concentrated flow of surface runoff from dairy farms or agricultural chemicals may limit the capability of riparian buffers to remove or absorb this runoff (Davis et al. 1999). Roads can redirect water, sediment, and nutrients between streams and their riparian ecosystems (Trombulak and Frissell 2000). Roads can create habitat fragmentation which can change species territories, creating patches too small for viable populations, or becoming barriers to species movement. Development also creates habitat conversion or fragmentation. Riparian habitats along the Rio Grande downstream of Caballo Dam have experienced considerable change and fragmentation (Fullerton and Batts 2003). River channelization, agriculture, urbanization, changes in flow regime, and landscape vegetation have all altered native vegetation composition in favor of invasive species or different plant communities (Fullerton and Batts 2003).

Invasive species can influence the integrity of riparian areas by disrupting the structure and stability of native plant communities and degrading native wildlife habitat by successfully competing with and replacing native plant species. Along the entire Rio Grande in New Mexico, exotic species represent more than 25% of herbaceous plant species and more than 40% of tree species (Muldavin et al. 2000). The Rio Grande Canalization Project Environmental Impact Statement identified invasive species being prevalent throughout the corridor with complete eradication not feasible (Parsons 2003). Non-native species can alter riparian and aquatic biodiversity, ecosystem processes, and landscape structure (Crawford et al. 1996).

Historically, restoration projects have been unsuccessful, despite availability of detailed site evaluations and intensive management (Briggs 1992). Current restoration practices focus on natural processes and self-sustainability when assessing restoration site potential (Rood et al. 2003). Native riparian vegetative communities have been successfully restored using natural flooding processes or artificial seeding and planting (Taylor and McDaniel 2003, Taylor and McDaniel 2004). Developments within the floodplain, such as levees, urban, agriculture, and water or transportation infrastructures, can constrain restoration of floodplain connectivity and dynamic geomorphic channel processes like bank erosion, lateral migration, and avulsion.

Improper grazing practices have been identified as a factor that negatively affects riparian systems in New Mexico (Carothers 1977, Kennedy 1977, Szaro 1989, Durkin et al. 1996). Wilson and Macleod (1991) defined improper grazing practices as those grazing practices that reduce long-term plant and animal productivity. Improper grazing practices that alter infiltration and runoff patterns in upland areas may ultimately influences river flow regimes by increasing frequency and intensity of floods (Wallace 1992). Ecological effects from improper grazing (both livestock and wildlife) include invasion by exotics species (Sivinski et al. 1990, Busch and Scott 1995, Medina 1996), an increase in soil compaction, reduced vegetative cover, changes in species composition (Kauffman and Krueger 1984, Szaro 1989), stream bank erosion, changes in channel morphologies, increased sediment transport, and the lowering of the surrounding water tables (Clary and Webster 1990, Krueper 1996). Suggestions that minimize the adverse effects of livestock and wildlife grazing in riparian areas include: 1) improving grazing practices, 2) herding or fencing cattle away from streams, 3) reducing livestock numbers, 4) increasing the period of rest from grazing, 4) changing the kind or class of grazing animals, 5) managing riparian zones as “special use pastures”, 6) installing in-stream structures, and 7) range improvement practices such as salting, providing alternative water sources, fencing, and range riders (Kauffman and Krueger 1984, Vallentine 1989, Armour et al. 1994, Elmore and Kauffman 1994, Belsky et al. 1999, Holechek et al. 2001). Restoration of degrading channel systems may only require exclusion of grazing (domestic animals and wildlife) for a few years (Medina 1996). Lucas et al. (2004) argue that the scientific literature has not adequately addressed the effects of livestock grazing on riparian areas in New Mexico. They argue that most available information is observational, anecdotal, based on un-replicated experiments, or compares heavily grazed areas to areas from which livestock have been completely excluded.

Forest fires in riparian systems of the southwest have been increasing in number and severity, due to increased litter-layer fuel accumulations from reduced flooding events, and more frequent natural and anthropogenic ignition events (Molles et al. 1995, Ellis et al. 1998, Bess et al. 2002). As a result of enhanced fuel loads, the severity of fire has changed from relatively cool, slow-moving ground fires, to extremely hot, rapidly moving stand-replacement fires, which often leave only dead standing trees and a surface layer of mineral ash (Steuver 1997, Steuver et al. 1997). This was exemplified when the Mesilla Valley Bosque State Park, near Radium Springs burned 40 acres of saltcedar (D. Boykin, personal communication 2007).

Numerous studies have been conducted in riparian habitats, yet many information gaps remain (NMDGF 2005). Currently, the amount of riparian habitat is only estimated and we have limited knowledge of the condition of these habitats. Likewise we have limited knowledge on the temporal change and fragmentation of these habitats though Watts (1998) provided a comparison of species diversity between 1977 and 1998. Further, the effect that these changes have had on wildlife species and specifically SGCN is largely unknown. In general, we have little abundance and trend information for many of the SGCNs and the habitat needs of the obligate riparian SGCN are poorly understood. Additionally, the response of SGCN to human disturbance is poorly understood.

Hydrological models can facilitate research on human-induced alterations to the flow regimes, but there is largely no quantitative estimates of the flow parameters that are necessary to sustain native species and natural ecosystem functions. The role and ecological function of small streams within larger watersheds are not fully understood. The effects of regulated flows on riparian systems from stabilization of flows and systems established by seasonal flooding needs further study. An understanding is needed of the magnitude, frequency, timing, duration, and rate of change of flow and those affects and hydrologic alterations on riparian systems. A need exists to determine flow requirements for habitats and SGCN. The Fish and Wildlife Coordination Act Report (2001) for the El Paso regional water projects provides a list of recommendations for the floodplains.

Restoration efforts need to have research that develops methodological approaches to restoring ecosystem-level processes and functions. These methods need to incorporate monitoring to determine outcomes of the effects on habitat and wildlife (Block et al. 2001). Knowledge of riparian habitat condition is necessary for restoration projects and management. Research is needed to identify the specific conditions and thresholds that affect all wildlife species, which to date is largely unknown. Quantification of the current condition provides the ability to begin to identify indicators of degradation and provide restoration goals for that habitat. There are some current efforts in place to do just this. Incorporating indicators of biological integrity may also provide information regarding the amount of riparian fragmentation. Other factors affecting condition include current land use practices including agricultural use, urban development, off-road vehicle use, and recreation. The interactions of invasive species with natural processes and native species requires additional research particularly to see how these species have altered riparian habitats and wildlife distribution and abundances.

Better understanding of the effects of fire including frequency, severity, behavior, and extent on riparian communities and species that inhabit these areas is needed (Ellis 2001, Bisson et al. 2003, Dwire and Kauffman 2003). Wildfire studies not in the Southwest have shown that fire effects riparian forests by creating erosion from denuded catchments and that fires have long-term affects on the community structure in lotic systems (Molles 1982, Minshall et al. 1989, Minshall et al. 2001, Earl and Blinn 2003, McKenzie et al. 2004). Additionally the impact on amphibians to fire and fuel reduction practices in riparian areas is unknown (Pilliod et al. 2003).

Perennial Marsh/Cienega/Spring/Seep

Wildlife and wildlife habitat are affected by dewatering and habitat conversion (NMDGF 2005). Water table lowering has caused perennial cienegas and marshes to become either ephemeral or non-existent. This habitat loss has resulted in a decline of some species (western painted turtles, leopard frogs, and New Mexico garter snakes).

Information gaps for the perennial marshes/cienegas/springs/seeps in the Rio Grande Watershed include comprehensive data on the distribution and abundance of fish, invertebrates, and amphibians and the location and condition of marsh/cienega/spring/seep habitats, and knowledge regarding the extent to which habitat conversion alters perennial marsh/cienega/spring/seep habitats (NMDGF 2005). Research was identified to assess potential threats to these habitats and to increase the mapping effort of these sites. Further research on species that use these habitats is necessary to provide for better understanding and management. Fragmentation that alters these habitats must also be studied.

Prioritized conservation actions identified include 1) protecting habitat; 2) implementing an aquatic nuisance species management plan; 2) identify methods to track increases and decreases in perennial marsh/cienega/spring/seep habitats; 4) monitor habitats to assess adverse effects caused by introduced species; 5) promote saltcedar management that does not affect endemic communities; 6) conduct studies that provide information about SGCN within the habitat.

Perennial 1st and 2nd Order Stream

The NMCWCS (2005) suggested that sedimentation resulting from improper grazing or logging and associated infrastructure presented the most serious potential adverse effect to these streams. Native species that occur within these streams (e.g. Rio Grande sucker and Rio Grande chub) are negatively affected by the presence of non-native salmonids through competition, or predation. The Chiricahua leopard frog can be found in these streams and frog populations are known to be declining largely as a result of Chytrid fungus (*Batrachochytrium dendrobatidis*).

Five Information gaps for 1st and 2nd order stream habitats have been identified in the entire Rio Grande Watershed (NMDGF 2005). These include 1) unknown effect of fragmentation on the viability and genetic diversity of Rio Grande cutthroat trout, though possible distribution within the watershed is limited; 2) unknown population information for non-game species such as the Rio Grande sucker; 3) little known about invertebrates in perennial 1st and 2nd order stream habitats; 4) limited SGCN life history and habitat use in perennial 1st and 2nd order stream habitats; and 5)limited knowledge about the intensity, scale, and extent of different land use activities degrading these habitats and their effects on populations of SGCN.

The NMDGF conducts periodic surveys of 1st and 2nd order streams to assess sport fish and native species populations. However additional research and surveys needed include 1) comprehensive population data for Rio Grande sucker and Rio Grande chub; 2) identifying the distribution of the Chiricahua leopard frog and identifying methods for minimizing non-native fish species impacts, and determining how to reduce Chytrid fungus spread; 3) Assess current stocking of non-native fish species and minimize potential conflicts with SGCN; 4) study habitat use patterns of all SGCN that are perennial 1st and 2nd order stream obligates; 5)study and monitor invertebrate species since little is known of their distribution, biology; and 6) Characterize population dynamics and species interactions in these habitats.

NMDGF Conservation actions, in order of priority, include: 1) Include non-game species in NMDGF fish survey analysis to improve baseline information regarding distribution and status of SGCN; 2) Increasing connectivity for fish species should benefit other wildlife species within this habitat type; 3) Work with land managers to develop methods that reduce the adverse effects of non-native aquatic species on native SGCN; and 4) Work with US Fish and Wildlife Service and other federal agencies to implement the Chiricahua Leopard Frog Recovery Plan and develop and implement strategies to reduce the spread of Chytrid fungus.

Perennial 5th Order Stream

Factors that affect this habitat or associated species were identified by the NMDGF (2005). This includes modification of natural processes. The Rio Grande has been affected by anthropogenic activity. Diversion and dewatering may be the largest impact to fish occupying this habitat, though other habitat stressors exist. Agricultural return flows alter water chemistry and sediment load. Channelization has reduced channel diversity and eliminated over-bank flow for most of the system.

Within the watershed a number of fish species (e.g. bluntnose shiner, gray redhorse, blue sucker, and Rio Grande shiner) have been extirpated. Non-native predators and disease likely caused the extirpation of the northern leopard frog. Big Bend sliders are now mostly confined to perennial reservoirs due to water diversion and alteration of the river channel.

Four information gaps for the Rio Grande have been identified (NMDGF 2005). These include 1) unknown long-term effects of habitat fragmentation on population viability and genetic diversity of wildlife species; 2) unknown effects of habitat modification on aquatic nuisance species expansion; and 3) Incomplete information on the effects of chemical and physical efforts of saltcedar removal on biological communities, particularly invertebrates and amphibians.

Six conservation actions have previously been identified (NMDGF 2005). These include: 1) Investigate the role of irrigation supply and return ditches as refugia for SGCN and the biological connectivity of large reservoirs to 5th order stream habitats; 2) develop and implement an aquatic nuisance species management program; 3) monitor Rio Grande plant and animal communities to assess problems posed by introduced species and eliminate threats where possible: 4) investigate habitat modification strategies; 5) minimize impacts of water management in the Rio Grande Watershed and avoid dewatered conditions; and 6) reduce sedimentation and promote water conservation activities such as lining irrigation supply and return ditches.

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Appendix IV - Lower Rio Grande Stakeholders

	Name	Organization	Email	Phone
IMPERVIOUS SURFACES, RUNOFF AND FLOODING	Paul Dugie	Office of the Flood Commissioner, Dona Ana County	pauld@donaanacounty.org	505-647-7256
	Mark Dubbin	Public Works Department, City of Las Cruces	MDubbin@las-cruces.org	505-521-3168
	Peter Bennett	Public Works Department, City of Las Cruces	pbennett@las-cruces.org	505-528-3075
	David Mercer	NM Environment Department	n/a	n/a
	Cathy Mathews	Parks and Facilities, Landscape Architect	cmathews@las-cruces.org	505-541-2592
MUNICIPAL URBANIZED AREAS	Chuck McMahon	DAC Community Planning and Economics, Director	chuckm@donaanacounty.org	505-647-7350
	Mike Gallagher	DAC Community Planning and Economic Development Dept	michaelg@donaanacounty.org	505-525-6120
	Carol McCall	Planning Department, City of Las Cruces	cmccall@las-cruces.org	505-528-3209
	Josh Rosenblatt	Water Conservation Officer, City of Las Cruces	jrosenblatt@las-cruces.org	505-528-3549
	Susan Krueger	Open Space Task Force, Town of Mesilla	skrueger_tom@comcast.net	505-524-3262
	Michelle Marshall	Las Cruces Home Builders Association	m_marshall@lchba.com	505-526-6126
	Judd Singer	Developer, Villa Custom Homes	jsinger027@msn.com	505-523-8900
	Cindy Rhodes	Las Cruces Home Builders Association	n/a	n/a
	Ray Bowers	Open Space Task Force	rsbowers@zianet.com	505-541-1877
ON-SITE TREATMENT AND HEALTH ISSUES	Paul Dulin	NM Border Health Office	Paul.Dulin@state.nm.us	505-528-5154
	Jagan Butler	Southern Area Health Education Center	jabutler@nmsu.edu	505-646-3441
	Tom Ruiz	NM Environment Department, former Border Health Office	thomas.ruiz@state.nm.us	505-647-7976
	Frank Fiore	NM Environment Department	frank.fiore@state.nm.us	505-524-6300
	Diana Bustamante	Colonia Development Council	dbustamante@zianet.com	505-647-2744
	Kiki Suggs	Johnny Septic	coues@zianet.com	505-526-5442
	Adrian Hanson	NMSU, Civil and Geological Engineering	n/a	505-646-3032
DAIRIES - CONFINED AREA FEEDING OPERATIONS (CAFOS)	Joe Gonzalez	Gonzalez Dairy and Dairy Producers of NM	jolugo@swwn.net	505-233-4801
	Reddy Ganta	Glorieta Geoscience	ganta@glorietageo.com	505-983-5446, ext. 107
RANGELAND GRAZING	Leticia Lester	Bureau of Land Management	leticia_lister@nm.blm.gov	505-525-4328
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	Jeanette Thurston-	USDA-ARS	jthursto@unlnotes.unl.edu	n/a

	Enriquez			
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	Mary Sanchez	Natural Resources Conservation Service, Las Cruces	Mary.Sanchez@nm.usda.gov	505-522-8775
	Tom Mobley	Sierra Alta Ranch	tommobley@fastwave.biz	505-526-2112
WASTE FROM PETS	Mark Johnston	Parks and Facilities, City of Las Cruces	mjohnston@las-cruces.org	505-541-2550
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WATERFOWL AND WILDLIFE	Beth Bardwell	World Wildlife Fund	bethbardwell@zianet.com	505-525-9537
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MUNICIPAL POINT SOURCE DISCHARGES	Kurt Moffatt	Water Utilities, Dona Ana County	kurtm@donaanacounty.org	505-525-6192
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NEIGHBOR-HOOD ASSOCIATIONS	Jamie Michael	DAC Health and Human Services	jamiem@donaanacounty.org	505-525-5872
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	Sandy Geiger	West Mesa Neighborhood	sgeiger@math.nmsu.edu	505-526-5972
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	Tim McKimmey	Armijo Lateral, LC	tim@nmsu.edu	n/a
	Veronica Carmona	Colonia Development Council	carmonav@zianet.com	505-647-2744
	Lorena Saenz	Del Cerro Community Center	n/a	505-233-3686
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GENERAL WATERSHED MANAGEMENT	Gary Esslinger	Elephant Butte Irrigation District	gesslinger@ebid-nm.org	505-526-6671
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DATA AND WRAS PROCESS	Geoff Smith	NMSU, Microbiology	n/a	505-646-6080
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Table 13: Lower Rio Grande stakeholders by interest area.

Appendix V - Stakeholder Interviews

- Can you describe the general management practices and guidelines used in your work related to watershed protection? What is the geographic scope?

- What are some of the management practices that have been most effective?

- What are some of your constraints?

- How is information communicated within your area? What are sources of information for you?

- Who is involved in this process?

- Do you have any write ups on this project? Or a website?

- Is GIS and data part of the scope of your work?

- How can our work best complement yours? Are there any considerations that are important to you that we include in writing the WRAS?

- Who do you feel might best represent your interests in creating a stakeholder committee that develops criteria for next steps and recommended BMPs?

Municipal Point Source Discharges

The following is drawn from interviews given and approved by Dona Ana County Municipal Services, Anthony Water and Sanitation District, New Mexico State University, EPA and Texas A&M University (TAMU) epidemiologists.

There are a total of seven active permits for waste water treatment plants to discharge effluents into the Rio Grande along in the impaired assessment area. These include:

WWTP	Design Capacity	Treatment Method	Effluent Limits	Number of Hookups
Leasburg to Percha Dam				
Village of Salem	0.2 MGD	Secondary biological, UV disinfection	200 cu/100 ml 30-day average; 400 cu/100 ml 7-day maximum	200
Village of Hatch	0.3 MGD	Chlorine disinfection	500 cu/100 ml 30-day average; 500 cu/100 ml 7-day maximum; also has to report E.coli results for 30-day average and 7-day.	700 +
Texas Border to Leasburg Dam				
City of Las Cruces	8.9 MGD		200 cu/100 ml 30-day average; 400 cu/100 ml 7-day maximum	
Gadsden Independent School District	0.088 MGD	Chlorination disinfection	200 cu/100 ml 30-day average; 400 cu/100 ml 7-day maximum	3700 individuals at GISD MS and HS
South Central Regional/Dona Ana County	1.5 MGD	Secondary biological, UV disinfection	200 cu/100 ml 30-day average; 400 cu/100 ml 7-day maximum	2000
Anthony Water and Sanitation District	0.9 MGD	Activated sludge, UV disinfection	500 cu/100 ml 30-day average; 500 cu/100 ml 7-day maximum	2500
City of Sunland Park	0.53 MGD	589-3470 or 1234	500 cu/100 ml 30-day average; 500 cu/100 ml 7-day maximum	

Table 14: Study area waste water treatment plants.

In an effort to address public health concerns in the colonias, Dona Aña County received funding in 2003 to build the Salem WWTP, with 200 connections in the north valley and the South Central Regional WWTP serving Chamberino, La Mesa, Vado, Berino, Las Palmeras, Montana Vista for communities south of Las Cruces with a total of 2000 connections. At present, the South Central Plant is at 30% capacity and was situated with the goal of reaching the majority of densely clustered homes. According to the county, at least 90% of the homes within 300 feet of the connection lines are hooked up. The mandatory hookup cost is $1300, (although rural development offers financial support for low income residents).

Sewage bills are paid to the county, while water utilities are paid to various municipal suppliers.

Anthony Water and Sanitation district is a government entity with elected members and authorities to construct and manage roads, parks, and almost all utilities. Unlike the county, their sanitation service boundaries are well defined and growth is controlled. The district supplies both water and sewage services and has leverage to cut off water supplies when payments are delinquent, guaranteeing a continued revenue for updating infrastructure. The district has had to shut down two wells because of nitrate contamination in groundwater wells. Several years ago the district commissioned a study to measure the quality of effluent water. Studies of this nature run $15,000 and are a drain on the District's financial resources.

Mesquite's waste water is treated through a wetland system. Other plants such as Dona Ana and La Union also have treatment facilities, but do not discharge into the Rio Grande. In addition, there are small treatment facilities, known as package plants for trailer parks and other small residential areas that discharge into groundwater in the valley. WWTP's must all measure for the same parameters set forth by EPA, although small operations have reporting requirements monthly, while larger facilities report daily. Discharge Monitoring Reports (DMR's) describing water quality are generated by each plant and sent in to NMED; duplicate monitoring is not required.

Pathogen levels may be affected by drought conditions, especially for rivers that receive wastewater treatment plant effluents. According to research undertaken by Dr. George D. Di Giovanni of TAMU in El Paso, (2004)[1] there are large seasonal differences in levels of Cryptosporidium and Giardia in the Rio Grande with higher levels in the non-irrigation season (November through April), when the river water is dominated by wastewater effluent, than during the irrigation season. Di Giovanni explains:

> *Traditional microbial indicators of fecal pollution, such as fecal coliform, E. coli and bacteriophages (viruses of bacteria), used to monitor for the potential presence of waterborne pathogens are not good indicators of the levels of Cryptosporidium or Giardia. For example, chlorination used in conventional water treatment easily kills indicator organisms such as fecal coliform bacteria, but not Cryptosporidium or Giardia. Therefore effluent may test negative for indicators but still contain high levels of potentially infectious Cryptosporidium or Giardia. Conventional wastewater treatment plant procedures remove about 99 to 99.9 percent of the Cryptosporidium or Giardia form sewage before the effluent is discharged into surface water, However, sewage contains tens of thousands of Cryptosporidium or Giardia per liter, so effluents may contain ten to hundreds per liter.*

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[1] Di Giovanni, G. D. *Drought May Concentrate Pathogens in Surface Water, Southwest Hydrology, V3/No. 6, Nov./Dec. 2004.*

> *Livestock and wildlife also have been shown to be significant sources of surface water contamination with Cryptosporidium or Giardia.*
>
> *DiGiovanni, 2004 p. 25*

Di Giovanni goes on to explain that upgrading conventional wastewater treatment plants with technologies such as ultraviolet (UV) disinfection and advanced filtration methods could help further decrease pathogens in effluents. However, globalization, the rapid development of confined animal feeding operations, and current technologies also impact abilities to address the risk of pathogens.

<u>Summary</u>

There are several waste water treatment plants serving county residents. All plants are required to provide Discharge Monitoring Reports to NMED. Epidemiologists are concerned that current monitoring practices for microbial indicators may not be capturing other pathogens present in the water.

Urbanized High Density Areas

This summary is drawn for interviews given and approved by the City of Las Cruces Public Works, Community Development, Facilities and Utilities Departments, and the Las Cruces Home Builders Association.

Storm Water Management

The largest urbanized high density area in this region is the City of Las Cruces (CLC). There are numerous CLC departments linked with dimensions of watershed management including Public Works, (e.g. storm management and engineering); Community Development, (e.g. planning and outreach); Facilities, (e.g. parks and landscape); Utilities, Public Service, Law Enforcement and Fire.

At a macro level, the CLC through the Public Works Department is required by the EPA, to develop and enforce a Storm Water Management Plan according to National Pollutant Discharge Elimination System (NPDES). Cities with population sizes of less than 100,000 residents follows guidelines for a Phase II program, which has less rigorous requirements than the Phase I program used for cities with larger populations (100,000-249,999). The Storm Water Management Phase II Plans address municipal activity and construction; (Phase I plans include these former areas and industry). Currently, the CLC has developed its own Phase II Plan, which is detailed below.

CLC's current plan outlines six minimum control measures, (required by the NPDES guidelines), that are designed to result in "significant reductions in pollutants by the City".[2] The common water quality pollutants of concern are fecal coliform, yard waste, restaurant grease, oil, suspended solids, and sediment. The Best Management Practices, (BMP's), are regulatory (through enforcement and ordinances), structural, and educational.

[2] City of Las Cruces, Storm Water Management Plan for City Department

The regulatory BMP's focusing on illicit discharge detection involves municipal staff, (Codes Enforcement, Storm Sewer Maintenance, and Fire), and local citizens. The CLC catalogs data pertinent to the NPDES program. The CLC's goal is to have 100% of outfall mapping completed and 70% of illicit discharges eliminated within the city limits by December, 2007. Currently only minor infractions occur with a few residents dumping oil, grassing limits, or draining pools.

The City has adopted a Storm Water Pollution Prevention Ordinance requiring an approved Erosion Control Plan for land disturbances of one or more acres for construction and post-construction runoff for all development including residential. It requires developers to submit a plan that contains measures to reduce soil erosion and practices to control sediments that have already eroded. The subdivision codes and design standards require the developer to install and maintain those specified measures and practices agreed to in the plan. In addition, the CLC has instituted area-wide measures to reduce impervious cover and Smart Growth Initiatives to promote open space and native landscaping according to the plan.

According to the plan, post-construction runoff measures are being addressed with structural and non-structural BMP's. The CLC is planning on increasing natural land set-asides for conservation and using pervious areas for more effective storm water management including regional ponding and parks in new subdivisions. Parks will be managed privately or by the CLC Park Division or Public Works Street Systems Section. The plan also assigns the Community Development staff to encourage stream buffers recommending that riparian areas are restored with native vegetation and that buffer zones, (including the 100 year flood plain), extend from 100 to 150 feet wide on both sides of the bank.

In terms of educational BMP's, the CLC piggy backs on many existing programs to disseminate its message including the Industrial Pollution Prevention (IPP) program, the Household Hazardous Waste (HHW) program, recycling programs, and Keep Las Cruces Beautiful.

It is also interesting to note the current and predicted changes in storm water management planning. As of 2007, cities and town with populations of 10,000 to 50,000 are also required to develop Storm Water Management Plans with the assistance of models plans developed by EPA. In the 2010 census, CLC staff anticipates that the growth in population will require it to develop the more stringent Phase 1 plans. The CLC commissioned Bohannon-Huston, Inc. in 2006 to develop a 20-year Master Drainage Analysis assessing current and projected capacity needs of the city.

The recommended BMP's for many of the 17 current storm water retention areas in the above analysis are grass or natural vegetation and ported risers for dry ponds. The latter BMP is as a concrete riser that serves to exclude floating debris from impoundments. Dry ponds allow the majority of storm water to percolates into the ground. These BMP's although not directly addressing bacteria loading, will minimize the amount of water that enters the river in the majority of two year storm events.

Parks and Open Space

The fast pace of development has put a heavy work load on CLC staff. The engineering department reviewed and approved over 350 new commercial and subdivision development plans and onsite construction storm water management permits last year. The CLC's parks and landscape department is slated to develop three storm drain retention ponds for public use including the 34-acre Burns Lake and a new adjoining Esslinger Park as well as other open spaces, trails, and parks[3]. Developers also donate park land adjacent to new subdivisions to the City for design and maintenance furthering the list of queued projects. Although very supportive of watershed protection, limited staff and resources often preclude the CLC from exploring alternative BMP's such as wetland filtration.

The Las Cruces 5-Year Strategic Plan[4] has set goals to improve policies and design standards for drainage; create a regional open space authority; and, encourage the preservation of major arroyos and open space within the city limits. The Strategic Plan also refers to several other CLC documents such as the draft City of Las Cruces Parks and Recreation Master Plan and the Rio Grande Ecological Corridor Project Comprehensive Plan (Corridor Plan) that offer a blueprint and guide for potential corridor and arroyo development. The Corridor Plan identifies and prioritizes several sites for potential wetland restoration project and makes recommendations about how to improve habitats along the river including the development of the Alamo Drain Wetland.

<u>Summary</u>
Municipal areas are guided by regulatory procedures and plans that address storm water management and development. There are several CLC documents that detail plans such as the Storm Water Management Plan for City Department, the Storm Water Pollution Prevention Ordinance, the Bohannon-Huston 2006 Master Drainage Analysis, the Las Cruces 5-Year Strategic Plan, CLC Parks and Recreation Master Plan, Recreation Master Plan and the Corridor Plan. Clearly, limited staff, budgets, and competing needs make it difficult for the CLC to take a proactive role in watershed restoration.

[3] There are currently 88 parks within the city.

[4] City of Las Cruces' Publications: http://www.las-cruces.org/pio/publications/default.shtm

On-Site Treatment Systems

This summary is drawn for interviews given and approved by the NMED, Dona Ana County Planning Office, the NM Border Health Office, the Colonia Development Council, and local septic system business

Addressing septic and similar decentralized system issues has been a health and regulatory priority for the past decade. Dona Ana County (DAC) requires that septic systems meet codes as a condition for receiving any new mobile home or building permits. In September 2005, the Liquid Wastes Disposal and Treatment regulations were also updated requiring that any property changing hands must have a septic system up to code before transfer. Permit requirements start at $100 and come from NMED which checks the site against ground water depth and soil type. NMED also has a legislative mandate to inspect at least 80% of all newly installed permitted systems.

Systems that were installed before DAC's building permits can still receive permits if the septic tanks installation date and functionality are evident. Many of the older domestic systems have been switched over to municipal systems thanks to the county's interventions in addressing health concerns.

Local septic tank businesses suggest that tanks be pumped every 1-5 years depending on the number or residents and activity of a family. Without regular maintenance a system can back up sending a clear message to residents that pumping or repair is imperative. The cost for pumping is $155 plus tax which is less than a city sewer service averaging $300 annually.

Beginning July 2007, liquid waste disposal operators must be certified, creating another check and balance in the system. Training will address septic system efficiency to discourage operators from draining only one of the two tanks and leaving solid wastes in the tank. Illegal dumping and disposal costs will also be covered. Currently, dumpers must carry sewage to the special liquid waste facilities paying $60 for an 8,000 gallon discharge (the volume of one tank).

With increasing costs for infrastructure, maintenance and repair, several public health organizations, (Southern Area Health Education Center, The Colonia Development Council, DAC, Paso del Norte Health Foundation) have taken steps to assist colonia residents to improve septic systems and consequently lower health risks over the past decade. Health promoters have stepped colonia residents through permitting processes recognizing that language barriers, (whether it is English, written Spanish, or technical or analytical questions), and the fear of immigration issues remain obstacles for residents. The DAC has created a Master Plan to address many of the infrastructure needs by building small waste water treatment plants connecting all residents within 300 feet of the septic lines. Over 2,500 homes were connected and were concentrated in areas that did not have septic system.

By 1990, the DAC had become urbanized, with a population of 135,510. Population growth is expected to continue at a rapid pace over the next 20 years. The average annual rate is projected to be in the 4-6% range. This translates to a 2015 population of more than 300,000 people. The primary areas of growth will be in the Las Cruces metropolitan area and the southern part of DAC.

Providing basic infrastructure, maintenance and protection is a priority for the DAC. However, the continued reality is that development is out pacing many of the efforts made. More growth is occurring in areas where there are not waste water systems than in areas where the infrastructure exists. (NMED issued over 2500 septic tank permits last year.) The concern remains that those still not served by the new waste water treatment plants may not have systems up to code such as with residents with lot sizes of less than 0.25 acres and/or cess pools. In order to identify these problem areas the DAC will need to overlay GIS systems with census tracts, septic permits, and waster water treatment connections to determine which sites remain problematic. Currently, the DAC Planning Office is analyzing current challenges as well as projected growth to determine incentives and disincentives for development.

<u>Summary</u>
Despite new regulations, assistance from various health organizations, and continued vigilance and planning from local agencies, inadequate and malfunctioning septic systems and illegal dumping continue to be a challenge for stakeholders in this area. This problem needs to address socio-economic issues in order to be effective.

Permitted Runoff from Confined Animal Feeding Operations

This summary is drawn for interviews given and approved by Glorieta Geoscience Consultants, USDA Agricultural Resource Service and a local CAFO Dairyman.

Confined Area Feedlot Operations (CAFO's) are under the inspection of many departments in the NMED, the EPA and the USDA-NRCS. Large dairy producers are responsible for following several regulations and monitoring parameters from weather conditions to nitrate levels. The New Mexico Dairy Producer's Association has hired Glorieta Geoscience Consultants to assist with compliance issues, monitoring, and management of operations.

In terms of protecting the watershed, CAFO's are required to keep all operation water and rainfall on their property. Lagoons are lined and designed to store 60-days worth of operation water. The perimeter is bermed to contain all water. Stored water is used to irrigate crops; this demonstrates improved quality of the stored water. The majority of large dairy operations in the Mesquite area are located two miles from the river and a half mile from major irrigation canals.

Although large CAFO operations are strictly regulated, economic constraints as well as “acts of nature” can limit an operation’s ability to always protect the environment. A lagoon is designed to hold water for a 24-hour, 25-year storm event; should storms exceed this scale and/or duration, flooding may occur. Off-site flooding from large storm events or excessive runoff from impervious surfaces that enters over a CAFO area’s berm can have an impact on an operation’s ability to contain water. Drift from strong winds, may also carry bacteria[5]. Small operations (less than 200 head) are not held to the same regulatory standard as large operations. In all cases, NPDES requirements do not ask for bacterial monitoring, therefore there is no specific collection of data in CAFO’s related to the river’s bacterial impairment found from the Percha Dam to the state border.

The USDA Agricultural Research Service scientist, Jeanette Thurston-Enriquez, has detailed the natural conditions that limit pathogen fate and transport in educational webcasts. According to Dr. Thurston-Enriquez, factors such as high temperatures; time, (e.g. manure applications where pathogens life cycles end before a runoff event); sunlight, (e.g. desiccation and UV light as long as pathogens are directly exposed to light); and desiccation make pathogens inactive.

Dairy Operators learn about best management practices through fellow operators, the extension service, and journals. Many of the proposed BMP’s are thought to be cost prohibitive or untested for the Chihuahuan desert climatic conditions. Since dairy prices are regulated and fluctuate within a season, producers, although supportive of new technologies, would need financial assistance to go beyond regulatory BMP’s.

Summary
Dairy operations of over 200 head are strictly regulated. As with other sectors, economics, “acts of nature”, and limited technologies applicable to the region limit one’s ability to protect the environment under all conditions. Dairy operations of less than 200 have lesser regulatory processes and vigilance than larger operations.

Rangeland Grazing

This summary is drawn for interviews given and approved by the Bureau of Land Management, the Natural Resource Conservation Service, the NM State Land Office and a local rancher.

[5] Thurston-Enriquez, Jeanette. (Forthcoming). USDA Agricultural Research Service Monograph.

Federal Management

Grazing activities are found on federal, state and private land and make up 82 percent of the land use activities within the watershed of the impaired stretch of the river under investigation. Approximately 35 percent of these grazing operations are located on federally managed BLM lands. Grazing allotments are located both adjacent to the river and in the uplands. BLM authorizes grazing activities through permits.

On any ground disturbing activity, (such as well drilling, fence building, or brush control), BLM is required to follow the National Environmental Policy Act, (NEPA), to write an EIS[6]. NEPA requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach and prepare detailed statements assessing the environmental impact of and alternatives to federal actions affecting the environment. The *New Mexico Standards for Public Land Health and Guidelines for Livestock Grazing Management* is used to help guide the development of the environmental documents. Ranchers will not receive permits for “range improvements” that do not protect riparian and hydrologically sensitive areas. BMP’s, such as season of use and duration, intensity, and frequency of grazing are examples of some of the practices promoted.

Improvements to the land are often financed through a cooperative agreement where BLM provides materials and ranchers do the labor; some projects are fully funded by the BLM, but most are completed cooperatively. Cooperation may come not only between the rancher and BLM, but in many cases it may also include NRCS, especially if the projects are partially funded through the EQIP. The various grazing allotments have been ranked as Improve, (I), (those that could benefit from intervention); Maintain (M) (those allotments where we could maintain or improve the existing situation); or Custodial, (C), (those allotments with little hope for improvement because of soil condition, etc.). The allotments next to the river range from 80 acres to over 58,000 acres. On the northern end of the watershed, the allotments are predominately smaller in acreage and mostly categorized in the I and M management categories. On the southern end of the watershed, the allotments are predominately larger in acreage and have been designated as Custodial because sandy soil conditions and the mesquite/creosote vegetation limit the possibility for improvements. A large block of public lands in the Jornada Draw, which is within the watershed and is north of the Jornada Experimental Range, has been sprayed for brush control over the past several years and set to rest for 5 years. Jornada Draw water runs south eventually flowing into Isaac’s Lake, a playa with interconnected ground and surface water.

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[6] The EIS’s are posted on the BLM website for public comment and review. (http://www.nm.blm.gov/planning_nepa/planning_nepa_home.html)

The BLM Las Cruces District has seven rangeland management specialists and two technicians which administer over 600 allotments ranging in size from 30 to over 100,000 acres. The specialists use a collaborative approach with ranchers to develop mutually agreed upon plans. When conflicts arise, the Range Improvement Task Force based out of NMSU helps to informally arbitrate policy and management decisions. NMDA also can be asked to assist with this process through Section 8 consultations.

State Management

The New Mexico State Land Office, (SLO), manages 12 percent of land in this part of the watershed. SLO's mission is to generate revenue for schools and believes that conservation and preservation strengthen their investments. There is one Range Conservationist, Conservation Biologist, Environmental Engineer, Environmental Specialists and Forester on staff for the state. In addition there is one district resource manager for this area. SLO leases land for 5 years, with the option of renewal, and holds the lessee responsible for managerial decisions. The value of the lease is determined through a formula based on carrying capacity and market value. Leases run from 0.5 sections[7] to 10-12 sections in size. If a lessee makes improvements, the value of the land holding is increased. If a lessee gives up his lease, the new lessee must pay for improvements made at fair market value to the former lessee.

SLO encourages good management practices through its Range Stewardship Incentive Program. If a lessee pays for an assessment (drawing from a list of pre-approved assessors) and qualifies as maintaining their lease with good or excellent health with a stable or improving trend, SLO will drop grazing fees by 25 percent. Because of the cost of this assessment, only large lessees usually take advantage of this program. Currently, there are 325,000 acres from this state participating in the incentive program

SLO also works with BLM and offers programs to support ranchers. The Rangeland Ecological Services Program and Candidate Species Conservations Program are designed for the smaller lessee and addresses erosion control, wildlife habitat, and other ecological/productivity concerns. With these programs, SLO provides funds (from 0 to 100 percent), expertise, and labor and will often try to involve school groups in the process. SLO is interested in increasing its support and hopes to leverage support through BLM programs, NRCS's EQIP program, 319(h) funds, and other sources.

The areas of management concern and support include, but are not limited to, erosion control, riparian restoration, brush control and reseeding. Often times demonstration projects will be created and serve as a learning lab for ranchers in the region. Socorro County has created a wetland demonstration plot; predatory

[7] One section is equal to 640 acres. SLO usually manages 4 sections per township. Each township holds 36 sections.

exclosures for quail were created in this region. Usually the district managers suggest projects, and collectively there are between 10 to 20 projects occurring throughout the state, often taking over a year to complete. SLO sees the value of also evaluating these projects to promote BMP's given the unique conditions in a semi arid region. SLO draws its information from practitioners in the field, research, professional societies, GIS data basis and the Jornada Experimental Range. SLO feels that interaction and communication with lessees will further disseminate new practices.

Private Management

From a rancher' perspective, a ranch is managed as one overall unit whether private deeded land, a BLM grazing allotment, or a SLO lease. Through the ownership of water rights on acquired deeded land or leased state trust lands, or as a result of acquired authorized tanks and wells on federal lands, ranchers maintain a strong proprietary position toward public lands including forage.

Each allotment has an established grazing preference, which means the total number of animal unit months (AUM's) on public lands are apportioned and attached to the base property. An AUM is the forage required to sustain one cow and one calf for a period of one month. The grazing preference is reflected on the 10-year term grazing permit and any changes to the grazing preference is only completed after analysis of monitoring data indicates that a change is necessary to meet the management objectives. From this analysis, BLM determines the total AU rating for the grazing allotment that includes federal, state, and privately owned land. Given ranchers' interest in making a profit on their land and cattle investment on a sustainable basis, they consider BLM's grazing permit to be a maximum stocking rate, but they make stewardship decisions independently looking at rainfall and available forage to reduce stocking rates when range conditions indicate the necessity to do so. Ranchers work hand-in-hand with BLM range specialists, but feel that regulatory and paper work requirements limit the time the specialists can spend in the field and thus limits their effectiveness

According to one rancher, cows distribute themselves fairly evenly around an allotment to take advantage of forage, but concentrations of numbers occur near water sources. Given the normal eight months of dry weather, much of the accumulations of manure near those locations would dry and decompose before being moved into the drainage system. It would be unlikely that significant bacteria would travel to the river given the distances from the river for most grazing allotments. From a rancher's perspective, once an improvement or intervention has been permitted, it would be difficult to modify practices unless there was definitive proof of the source of bacteria, and compensation for any changes and remediation.

Ranchers feel confined and sometimes overburdened with regulations. The granting of permits can take up to six months to complete, sometimes requiring an environmental study. After a permit has been granted, ranchers want to feel confident that there will be few regulatory problems remaining. The New Mexico Cattle Growers Association serves as the primary support organization to ranchers in New Mexico, providing resources on a spectrum of issues including water quality, health, and taxes. However, like other organizations, they are understaffed and with limited budget.

<u>Summary</u>

Federal and state agencies take a partnership approach when providing oversight and assistance to ranchers. Federal NEPA requirements and the *New Mexico Standards for Public Land Health and Guidelines for Livestock Grazing Management* guide BLM management decisions. The NRCS offers technical advice and assistance most often through the EQIP program. The state uses the Range Stewardship Incentive Program, Rangeland Ecological Services Program and Candidate Species Conservations Program to encourage best management practices. Ranchers are most receptive to incentive programs that provide financial assistance, but will most likely participate when there is a clear benefit to the property and cattle.

Waste from Pets

This summary is drawn for interviews given and approved by Dona Ana County's Animal Control, Dona Ana County Humane Society, and the Las Cruces Park Department.

Nationally, pet waste has been found to be a major source of fecal coliform and pathogens in many urban watersheds, due to their population, daily defecation rate, and bacteria/pathogen production. In 1993 the U.S. EPA wrote, **"**It has been estimated that for watersheds of up to twenty-square miles draining to small coastal bays, two to three days of droppings from a population of about 100 dogs would contribute enough bacteria and nutrients to temporarily close a bay to swimming and shellfishing." [8]

When looking at dog populations alone, national averages estimate that there are 0.17 pet dogs per capita. Using this statistic, the estimated population of pet dogs in DAC would be over 32,000. When combining the stray population – DAC's Animal Control alone captured 11,000 strays last year –the number of dogs could potentially reach 43,000.

Average dog feces are 0.3 pounds or around 135 grams. One gram of dog feces contains an average of 23 million fecal coliform bacteria, some of which are

[8] United States Environmental Protection Agency (US EPA). 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. US EPA, Office of Water. Washington, DC.

pathogenic (Van Der Wel, B. 1995).[9] High concentrations of these bacteria can make water unsafe for drinking and recreational use.

Despite the apparent threat that dog feces pose to water quality, many people are unaware of the significance. Control of animal waste as a pollution source in the United States has been moderately successful in some areas, such as establishing designated areas in which dogs are allowed to defecate and requiring dog owners to pick up their pets' refuse or face fines. These laws are hard to enforce, and annoy pet owners, who claim that they are being targeted unfairly

The CLC Parks Department is addressing pet defection problems by providing free *mutt mitts* to facilitate waste pick up. In high traffic areas like the Traviz pathway, the city provides over 100 bags per mile to the trail weekly. In low traffic areas like La Llorana Park, visitor rates and use of mitts may drop to 10% of this figure. Even using these conservative figures for less trafficked areas like La Llorana where leash use and pet waste pick up is less, the cost for mitts and maintenance escalates rapidly when one considers the miles of arroyos and ditch banks in the watershed with no managing authority to cover these costs.

In terms of behavior, the biggest limitation to controlling pet waste is reluctance to handle dog waste. According to a Chesapeake Bay survey, 44% of dog walkers who do not pick up indicated they would still refuse to pick up, even if confronted by complaints from neighbors, threatened with fines, or provided with more sanitary and convenient options for retrieving and disposing of dog waste. [10]

<u>Summary</u>
At this point, the impact of pet wastes is an unknown, but could be a potential contributor given the number of pets and strays in DAC. The Middle Rio Grande, similarly with bacterial impairments in the river, has found that pets are the second largest contributor of bacteria in the river next to wildlife.

Wildlife Other Than Waterfowl

Waterfowl and wildlife are considered part of the natural background conditions of the water quality and are therefore not addressed as a stakeholder concern. Recently NMED created a Total Maximum Daily Loads (TMDL's) for this section of the river. A TMDL is a pollution reduction plan that accounts for all pollutant sources to the water and determines how much each source is allowed to contribute. The basic premise is that if existing pollutant inputs (loads) from all sources are reduced to a specified level (the maximum daily load) and the margin of safety is added, then water quality goals will be achieved. Load allocations include non-point sources and natural background; waste load

[9] Van Der Wel, B. 1995. Dog pollution. The Magazine of the Hydrological Society of South Australia 2(1).

[10] www.esb.utexas.edu/nrm2001/dogdoo/waterquality

allocations make up all point sources. A TMDL is equal to the load allocations plus waste water allocations and margin of safety.

Appendix VI - Outreach Neighborhood Conversations

During the neighborhood conversations, local residents listened to a 20-minute presentation that provided an overview of the issues, followed by a short question and answer session. Through a facilitation process, participants were asked to create a ranking of responses for each of the questions below. Responses were provided to expedite the process, although participants were free to add responses or clarify their interpretation of responses. A summary of rankings and comments are described below:

1. How ambitiously should we attack this problem?
   - *Make a long term prioritized plan and do a little each year*
   - *Do a thorough scientific tracking of bacteria to positively determine sources*
   - *Jump right in and encourage people to change their habits*

Comments from neighborhood groups related to how we should attack problem included:

- *People are not alarmed that it is a big or risky problem so there is not a sense of urgency. Yet people want the river clean for health and ecological reasons;*
- *People really don't listen to messages about changing their habits, especially if there is no proof that it is the cause. It is important for them to at least hear the message and know the rules and consequences;*
- *It is important to know more, but is it actually necessary to know the specific source?*
- *We feel a lot of regulatory decisions are capricious and we would like decisions backed up with facts;*
- *It is very disillusioning when studies are made and then put on the shelf and never used;*
- *They all need to be done at the same time because it takes along time to change peoples habits;*
- *Changing habits may be the cheapest approach of all*

2. How can we motivate people to be concerned about these issues?
   - *Improve health*
   - *Fix the problems ourselves without waiting for the government*
   - *Avoid fines/punish those that don't comply*
   - *Improve the environment*
   - *Preserve the historic and cultural value of the river*
   - *Assure that future generations have resources*

Comments from neighborhood groups related to motivation included:

- *Everyone is concerned about their own health. Not everyone is concerned about the environment.*
- *If it could be dangerous to swim, why aren't there signs posted? Why isn't there more information about it? That would raise awareness and stop people from getting sick.*
- *Many of our wells are shallow and we have all had problems with sediments and even bacteria especially after a rain. We even had to treat our water for a while.*
- *It was suggested that high amounts of bacteria are probably associated with concentrated activities where antibiotics or other chemicals are used that could exacerbate or mask even bigger problems;*
- *It is important to see if there are regulations in place to take care of the problem and to encourage/enforce compliance of these regulations (especially with respect to businesses and industries); For those that are poor, we need more assistance without punishment.*
- *Enforcement seems to be uneven. Big businesses like the greenhouse seem to be able to do all sorts of things. The rest of us always seem to be hassled.*
- *There are lots of innovative things that we could try and want to try if we got funding to do it. Gray water systems, alternative waste treatment, planting native vegetation. There doesn't seem to be any programs that support that.*

3. What sorts of management practices should we promote?
   - *Practices that are aligned with nature and ecology*
   - *Methods that have a dual purpose, such as cleaning the river and serving as open space*
   - *Community campaigns where everyone is involved*
   - *Methods that help those that are interested without fines or punishments*
   - *Things that won't increase our taxes*
   - *Better application of the laws and regulations*
   - *Big engineering projects that don't involve people*

Comments from neighborhood groups related to management practices included:

- *Our past experiences have shown us that one group tries to fix something and then another part of the environment gets messed up. The management practices need to look at the whole hydrological system, the ecology of the area, not just one part;*
- *We need to get everyone together face to face to solve all of these related problems like flooding, bacteria and open space;*
- *You can accomplish more with more expertise when you address several problems. Everything is connected;*

- *Need to show a progress, a type of report card where the measurable improvements work for multiple stakeholders. We need similar measures of success;*
- *We only need government to help us get grants and loans. We can do the rest;*
- *We would really be interested in trying out small scale cottage industry projects like gray water;*
- *We need to make sure people know about the regulations*
- *We are not confident that regulations will be followed equally by everyone. There always seems to be variances and exceptions.*

In summary, neighborhood residents wanted this problem to be strategically addressed, motivating others through health concerns, avoiding punitive actions, and by encouraging more grassroots approaches.

Appendix VII – Best Management Practices (BMP's)

"A Manual of Conservation Practices to Reduce Pollution Loads Generated from Nonpoint Sources" by TetraTech is a useful BMP implementation guide for landowners, natural resource managers and technicians. It identifies BMPs that can be used to abate nonpoint source pathogenic pollutants in a watershed. Each BMP has multiple benefits that span beyond controlling pathogenic pollutants and also include controls for issues such as sedimentation and erosion, as well as others. Management levels, projected load reduction potentials, targeted sources, and treatment areas are just some of the types of information provided by this guide. Cost estimates and detailed BMP implementation schedules are unknown pending the identification of specific locations where BMPs can be effectively implemented for pollution control in the affected region. Funding issues need to be address in the planning stage of BMP design. Generally, the manual suggests that these practices be implemented in areas immediately adjacent to the stream channel or water body, as well as in upland areas. It also advises that multiples practices be implemented in chorus to maximize the effectiveness of pollution control. While data gaps still exist, there is sufficient information available to recommend BMPs to address some of the potential sources which have already been identified. As further information is compiled, placement and specific design features of these practices can be optimized.

Filter Strip

A filter strip is an area of planted herbaceous vegetation that is located between agricultural, grazing, or disturbed lands and environmental sensitive areas. It helps to abate pathogenic contaminants, among others, from entering bodies of water by interrupting runoff and removing the pollutant before it enters water bodies. Filter strips can also serve as buffers between agricultural lands and water bodies to prevent any applied pesticides or chemicals from entering the water. These provide a buffer strip which increases filtration and reduces surface flow into the waterbody. Filter strips target the following potential Total Maximum Daily Load (TMDL) sources: animal feeding operations, disturbed areas, stream erosion, and agricultural practices. They have a high load reduction potential that can occur between a few months and two years. They are best utilized on agricultural and developed lands and may require a low level of maintenance.

There is a potential for additional benefits with the implementation of filter strips: reduced sedimentation of water bodies, reduced runoff, increased infiltration, groundwater recharge, and improved wildlife habitat. Strategic planning and placement of filter strips is suggested to capture maximum benefits. For instance, using vegetation that is tolerant to herbicides that are used in proximity will prolong the life and functionality of filter strips. The abatement of other pollutants may be successful using filter strips; contamination by sediment, salinity, pesticides, nutrients & organics, heavy metals, and low dissolved oxygen may also be addressed with filter strips.

Detention Basin

There are about 50 retention basins in the lower Rio Grande watershed that were originally constructed for the purposes of flood control. These structures range from the federally-funded PL 566 dams constructed in the 1960's, to dams designed and constructed by individual landowners. Many of these structures are heavily silted in or have reached their intended design lifespan and need to be maintained or upgraded. Loss of these structures would likely have a negative impact on the *E. coli* impairment, sediment transport, and flooding.

A retention basin is an engineered structure designed to capture and temporarily store water and associated debris and sediment. They are considered a temporary practice aimed at protecting reservoirs and other water bodies by preventing the deposition of sediments, waste products, and other waterborne materials. Detention basins can filter pollutants from the following potential TMDL sources: animal feeding operations, disturbed areas, agricultural, and mining practices. They have a high load reduction potential that can occur immediately following implementation and also provide groundwater recharge. They are best utilized on agricultural and developed lands. Detention basins require a high level of maintenance; regular cleaning of the basin is required for full functionality. If basin construction occurs in a stream channel or wetland, Section 404 and 401 permits are required through the Army Corps of Engineers (ACE).

Engineering of detention basins must occur with careful design in order to match the regional hydrology of the watershed. These structures should be evaluated for their efficacy and provided with upgrades and any necessary maintenance throughout time. Other planning considerations need to be made in terms of desired water quality and water quantity effects.

Elephant Butte Irrigation District is evaluating the 33 dams that they own and maintain. Their goal is to rehabilitate and upgrade these dams to provide appropriate protection for the dams' current hazard ratings, but also to provide retention for longer than the current standard of 96 hours. The District's aim is to regulate the release flow to meet downstream water demands and to enhance the infiltration and associated aquifer recharge while water is retained behind the dams. This strategy is primarily intended to offset the anticipated long-term reduction in snowmelt runoff associated with climate change by more effectively utilizing monsoonal rainfall as a water supply source. A secondary benefit will be improved control of *E. coli* in the mainstem of the Rio Grande.

Grazing Management

Grazing management in the watershed falls into two general categories; upland grazing, and riparian grazing. Improving upland grazing management in the watershed presents a variety of challenges. Part of the rangeland in the watershed is in poor condition with poor herbaceous ground cover. This condition increases erosion and stormwater flow, decreases infiltration, and can promote livestock and wildlife concentration into areas with adequate forage and water. When these areas are impacted by storm events the waste from these animals is transported downstream. Rest and rotation practices should be utilized to maximize desired forage health to increase productivity and reduce the impacts associated with erosion. Reducing the impacts from riparian grazing can have an immediate and direct impact on animal waste entering the river. Two areas of concern were identified by the watershed group. There are places along the river where grazing is still permitted between the flood control levies. Additional areas have also been identified in un-levied sections of the river where livestock is grazing directly adjacent to the river. Livestock not only have access to the floodplain, but to the river itself where waste can easily enter the river. These management practices need to be modified. Removing livestock from the floodplain and the river also has the added benefit of reducing erosion, improving bank stabilization, and by increasing streamside vegetation, providing a filter strip and increasing groundwater infiltration.

Improved Stormwater Management of Unpermitted CAFOs

There are numerous small CAFOs in the watershed which are not regulated under the NPDES program. Many of these operations do not have stormwater plans or BMP's of any kind to control stormwater from flowing off site. Suggested management practices include providing stormwater basins, providing protective berms to keep stormwater on-site, removing livestock pens from the active floodplain or channel, and proper waste disposal.

Improvements to Municipal Stormwater Management

The City of Las Cruces has a complex stormwater management strategy described in their MS4 plan. This plan is further along in its development than the WRAS, as the City has invested much time, expertise, and financial resources into its development. Future work in the development and implementation of the WRAS will include integration of the City's MS4 plan into the BMP planning for the rest of the watershed.

Waste Disposal and/or Utilization

This BMP addresses the waste generated by CAFOs. Disposal of waste by land application as fertilizers is a common and accepted practice. Waste can also be utilized as part of a composting process to improve compost quality. Stockpiling of waste in the vicinity of waterways should be discouraged and proper disposal through land application or as part of a composting process should be encouraged.

Replanting and Seeding of Disturbed Areas

Areas which have been disturbed by stream erosion, land development, agricultural practices, and construction riparian areas can be planted with native vegetation with transplants or seeds. Each site should be evaluated for appropriateness of mulching, broadcast seeding, hydroseeding, pole planting or transplanting. These practices not only reduce erosion, and provide for increased filtration, but address a variety of other pollutants including salinity and nutrients.

Watering Facility

Upland watering facilities can be provided to reduce utilization of the stream as a watersource. This is often used in conjunction with fencing that removes livestock from riparian areas to reduce the impacts from their activities. Livestock may also utilize the riparian areas to cool down and for shade. Alternate shade sources should also be considered if livestock are excluded from the riparian areas. This will decrease the likelihood livestock will damage fencing to gain access to the riparian area. By decreasing the damage to the riparian area this also has the added benefit of reducing bank erosion and reducing the addressing the same pollutants as replanting and seeding.

Domestic Pet Waste Management

There is no domestic pet waste management program promoted by any of the municipalities or the counties at this time. As in many areas, it is a common practice throughout the watershed to walk dogs for recreation and exercise. The waste from these animals may contribute a substantial amount of the non-point source load of *E. coli* to the watershed. Particular areas of concern are recreation areas along the river, and the network of irrigation ditches, which are both favorite spots to walk dogs. An outreach program should be initiated in the watershed to educate the public on the problems associated with domestic pet waste, the E.coli impairment, and proper waste disposal.

Cover Crop

Cover crop provides seasonal protection and soil improvements by growing grasses, small grains, or legumes. Benefits to soil quality are numerous: decreased erosion, increased fertility, addition of organic material, improved soil tilth, increased infiltration and aeration. Further, crop covers can reduce the effects of wind, rill, and water erosion. Crop covers target potential TMDL sources such as disturbed areas and agricultural practices. They have a medium load reduction potential that can occur between a few months and two years following implementation. They are best utilized on agricultural lands and require medium levels of maintenance. Some planning considerations include planting deep-rooted species to achieve maximum nutrient recovery and avoidance of species that can attract damaging insects. Grasses use more soil nitrogen and legumes use both nitrogen and phosphorus – these should be considerations for implementation of this BMP. Crop covers can also address sedimentation, salinity, and pesticide pollution.

Constructed Wetland

Constructed wetlands have been utilized in a wide variety of environmental conditions to filter domestic and livestock wastewater, stormwater, and agricultural returns. The arid environment of the watershed and water rights issues within the watershed make implementing this BMP a challenge. However, a pilot project is underway which will be implemented by the EBID to construct several small wetlands in select agricultural return drains. As the watershed continues to experience residential growth, and waste treatment needs expand, there is potential to add constructed wetlands to WWTP design as part of the waste treatment process. This would require stakeholder involvement and community support to make this a part of the planning process. This practice has the added potential of filtering other pollutants, providing wildlife habitat, possible opportunities for wildlife viewing, and community outreach in the form of a park.

Constructed wetlands can filter and clean wastewater from domestic or livestock operations and agricultural irrigation returns. Biological processes occur in wetlands that can improve water quality. Once solids and pathogens are removed from water, wetlands can be used as a final cleaning process in wastewater treatment. Constructed wetlands target the following potential TMDL sources: animal feeding operations, industrial sources, and agricultural practices. They have a medium load reduction potential that can occur between a few months and two years following implementation. They are best utilized in streamside areas, and on agricultural and developed lands. Low levels of maintenance are expected.

Planning considerations for constructed wetlands include the choice of appropriate vegetation types and the design of flow velocities. Water quality objectives should be developed, water quantity capacity should be considered, and a monitoring program should be established for the engineering of this best management practice. Wetlands can also be used to address pollution from sediment, salinity, nutrients and organics, and water temperature.

Appendix VIII - Future Stakeholder Outreach / Public Education Recommendations

Maintaining stakeholder engagement through the process of water quality data collection and analyses, interviews should be conducted to gather concerns related to a specific geographic area in order to better understand stakeholders' decision making priorities and information channels used. This type of information will aid in the development of outreach campaigns and foster greater community support. Sub-basin tours should be offered to stakeholders so that they may better understand how topography, soil and hydrology affect the sub-basin's ability to absorb human impacts. The focus should be on ecosystem and watershed health rather than on bad management practices.

If feasible, stakeholders within each sub-basin should be trained to collect water quality data. Ideally, this data collection would be linked to community centers and Youth Conservation Coups (YCC) programs that could better involve residents and provide job opportunities to youth in rural areas. This strategy will demonstrate the Council's concern for meeting multiple needs within the community.

Engaging stakeholders during the BMP implementation stage should involve linking up with neighborhood associations, community centers, and civic organizations to invite participation. This could mean "adopting" restoration wetland and buffer strip sites by making seed balls, doing plantings, weeding and general maintenance. Agencies and organizations with expertise and experience, such as the Soil and Water Conservation Districts, RC&D Council, the Natural Resource Conservation Service, and other local professionals , in developing BMP's that improve impairments should be promoted to stakeholders and supported collegially and if possible, financially.

The Council should develop a relationship with agencies and organizations involved in BMP's that have an impact on river health such as those working on floodplain management, planning, parks, public works, irrigation, dairy, and grazing. Open space, recreation, and conservation initiatives should be created. The overarching goal to be met for future stakeholder engagement is to encourage compatible, cooperative, and ecologically restorative practices within the watershed.

Educational outreach pertaining to water quality analyses and BMP implementation in the Paso del Norte watershed would foster increased stakeholder ownership and participation in watershed management ideas. Water quality data collection and analyses on specific sub-basins should be coupled with stakeholder education regarding why and how it will be conducted. It is important that stakeholders understand that new data may support or refute previous information.

Stakeholders should also be educated about the array of suitable BMP’s available to address the identified water quality impairments. This should be accompanied with an explanation of the advantages and disadvantages of each (e.g. effectiveness in addressing impairments, supporting ecological health as well as promoting economic and social viability). Feedback from stakeholders should be sought about their preferences and concerns about specific BMP’s.

Appendix IX - Data Analysis

The data sets referenced here are included in digital (Excel spreadsheets) as part of the digital data set being submitted with this report and available through the Coordinated Database Project.

U.S. Geological Survey (USGS)

The U.S. Geological Survey (USGS) has maintained a flow measurement station at the El Paso Narrows above American Dam. The USGS station 08364000, The Rio Grande at El Paso, is also locally called Courchesne Bridge. Bacteriological data were kept for the site from January 1978 through at least August of 2005, with a gap from May 1995 through November of 2003. Samples were taken at intervals ranging from about one to three months. Fecal coliform was measured the entire period of record. Total coliform was measured from October 1979 through October 1980. Fecal streptococcus was measured from January 1978 through May 1995. *E. coli* was measured from November 2003 through August 2005. A graph of the USGS data is shown below in Figure 8.

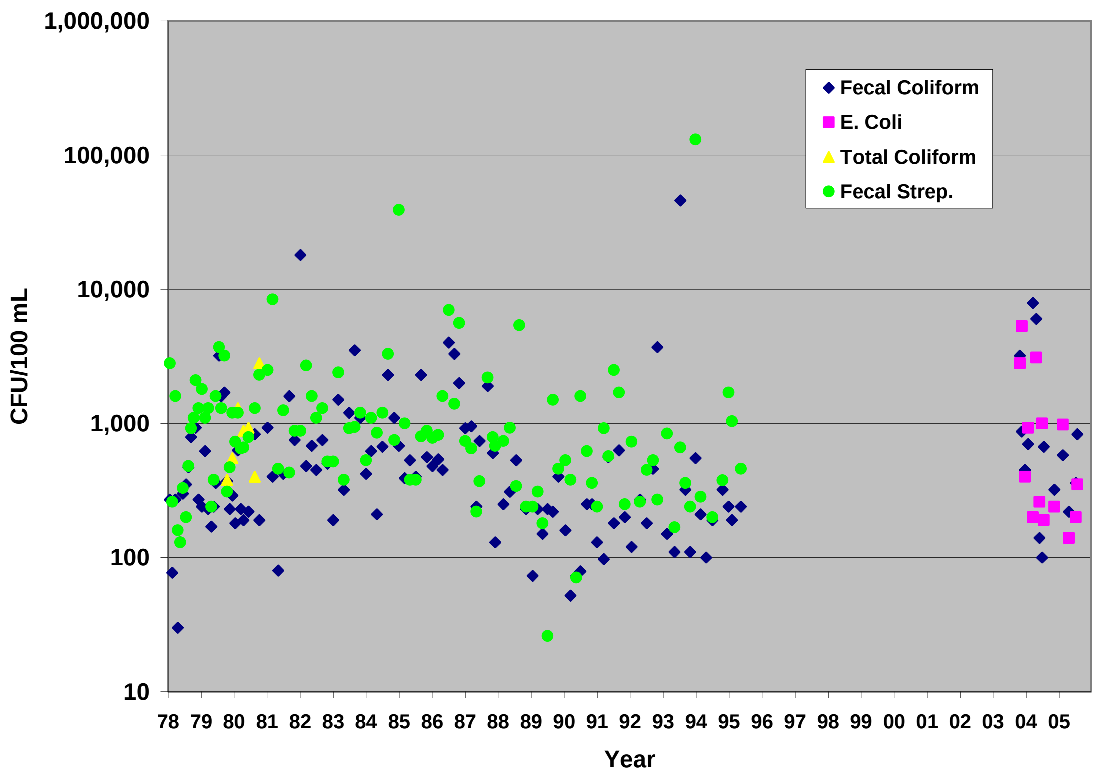

Figure 8: USGS bacteriological data from the Rio Grande at El Paso (Courchesne Bridge), 1978-2005.

The *E. coli* data show exceedance of the regulatory limit of 410 CFU/100 mL in six of the 14 samples, or 42 percent of the samples which were analyzed for *E. coli*. Four of these exceedances occurred between November 2003 and May

2004, the early season issues identified by the SWQB data presented in the Identification of Causes and Sources of Impairments in section III. Another exceedance, in July 2004, could be related to rainfall-induced runoff as discussed in section III. The last exceedance, in March 2005, is outside of the time span of the SWQB sampling, and its origin is uncertain.

While the USGS do provide a relatively long term record of fecal coliform and fecal streptococcus, and some coverage of *E. coli*, the fact that the samples are taken from the same point on the Rio Grande makes it impossible to characterize the sources based on spatial distribution. It can be concluded for certain that the sources producing exceedances occur above Chourchesne Bridge, but that covers the entire study area.

U.S. International Boundary and Water Commission (USIBWC)

The U.S. section of the International Boundary and Water Commission (USIBWC) reports bacteriological data from three sites: above the confluence of the East Drain and the Rio Grande near the New Mexico-Texas state line, at Anapra downstream of Sunland Park, and at Courchesne Bridge. This data set provides a bit of both spatial and temporal coverage, and it appears from the data set, shown graphically below in Figure 9, that *E. coli* sources exist between the upstream sampling point above the East Drain to Courchesne Bridge. This supports the findings of the SWQB analysis discussed in section III.

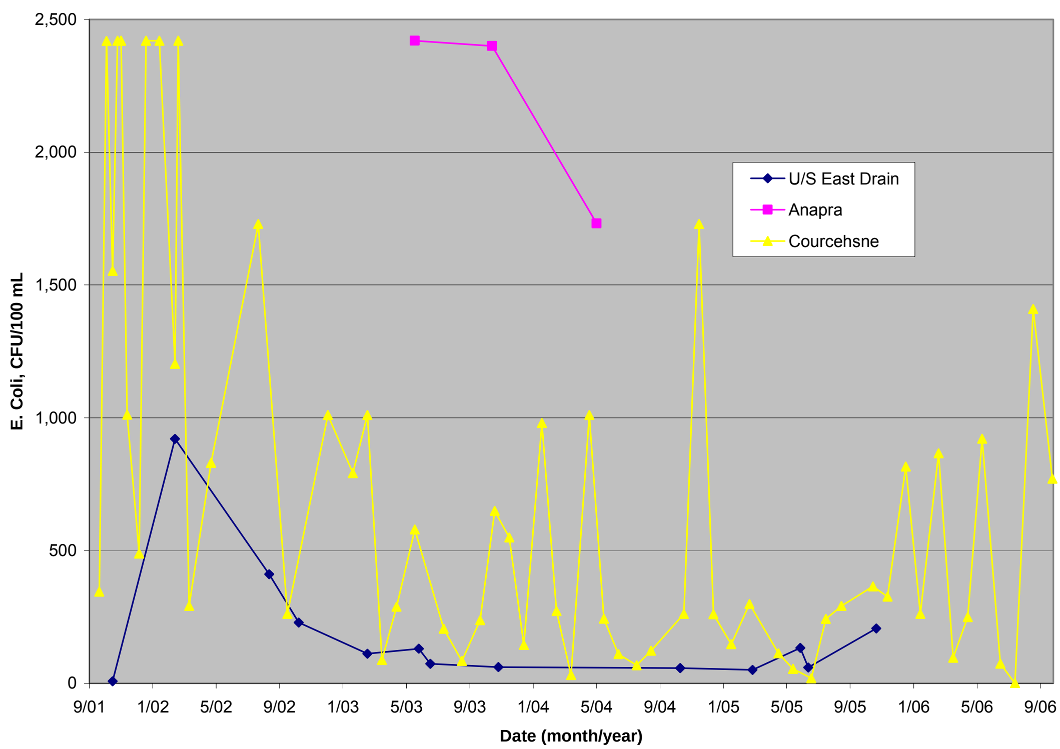

Figure 9: USIBWC *E. coli* data for the Rio Grande above the confluence with the East Drain, at Anapra, and Courchesne Bridge. The maximum reporting level is 2,420 CFU/100 mL.

The USIBWC data are at irregular time intervals, and the samples from one site do not necessarily correspond in time to samples from other sites. Still, it is clear that the *E. coli* level at Courchesne Bridge is highly variable.

One interesting aspect of the data sets is that the *E. coli* and fecal coliform show a very counterintuitive lack of relationship, making the long history of fecal coliform of little use as a surrogate for *E. coli*. This is true for the USGS and USIBWC data sets that included simultaneous sampling and analysis for *E. coli* and fecal coliform. The relationship is shown graphically below in Figure 10. The correlation between *E. coli* and fecal coliform for this composite data set is 0.329. This is particularly surprising since *E. coli* is a subset of fecal coliform, but it is also illustrative of why *E. coli* is being adopted as a regulatory standard rather than fecal coliform.

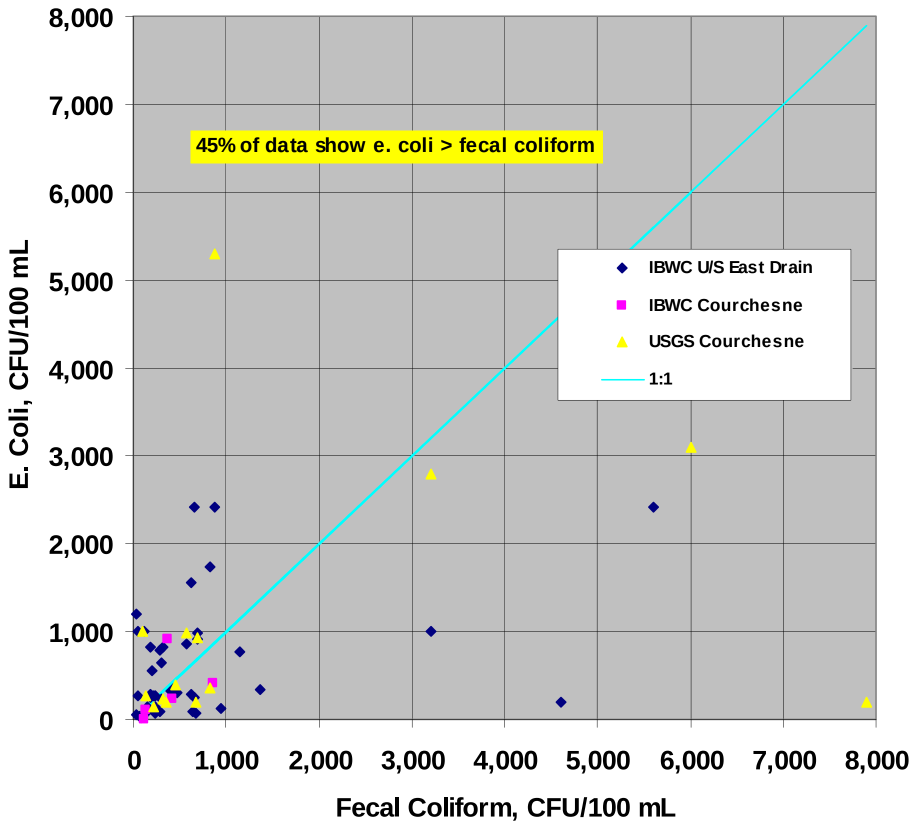

Figure 10: *E. coli* versus fecal coliform for USIBWC and USGS data sets.

New Mexico Environment Department Surface Water Quality Bureau (SWQB)

The data collected by the Surface Water Quality Bureau of NMED showed exceedances of the regulatory limit as discussed in section III.

In general, the data for the Rincon Valley reach, shown graphically in Figure 11, showed low levels in the early months of the year, with exceedances particularly downstream of Derry during the monsoon season from the end of June through September. Nearly all of these exceedances are associated with precipitation events in the Rincon Valley and surrounding watershed, suggesting storm flows are a likely contributing nonpoint source of *E. coli*.

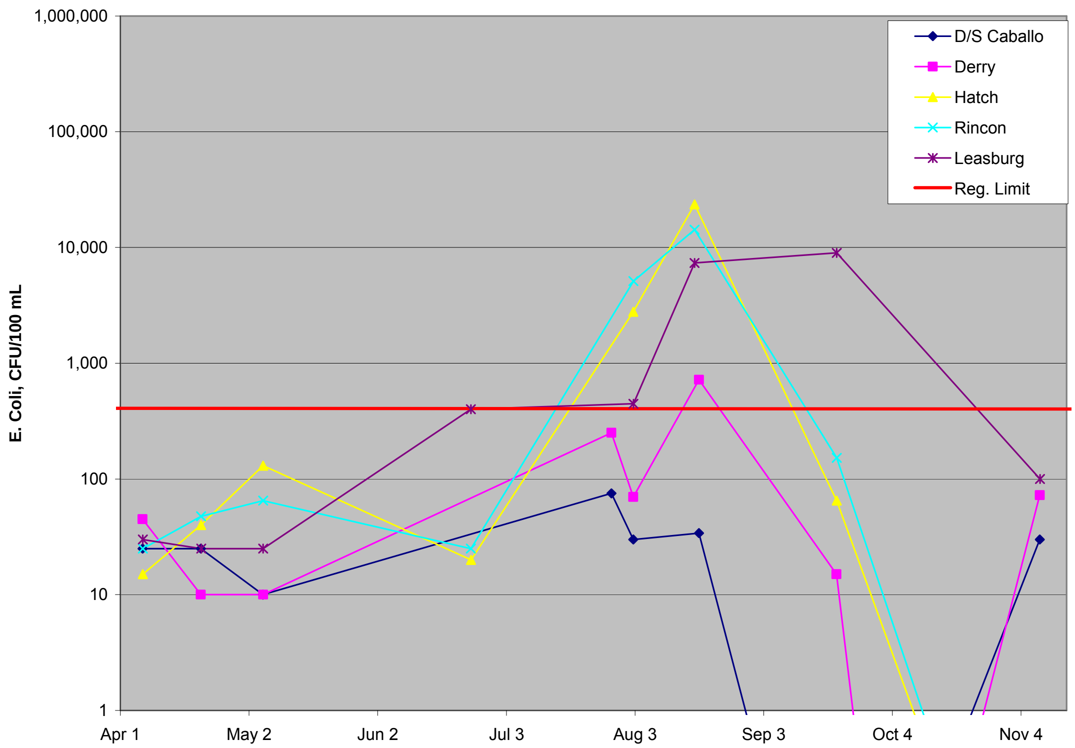

Figure 11: SWQB *E. coli* data for 2004 from below Caballo to Leasburg.

For the Mesilla Valley reach from Leasburg to Sunland Park, there is a similar trend to that of the Rincon Valley reach with the notable exception of the downstream-most sampling point below Sunland Park. The highest levels of *E. coli* of the entire study were detected there, and appear to be associated with malfunctioning wastewater treatment facilities in the Sunland Park area. The peak value, which runs off the graph in Figure 12, shows an *E. coli* level of about 2,000,000 CFU/100 mL.

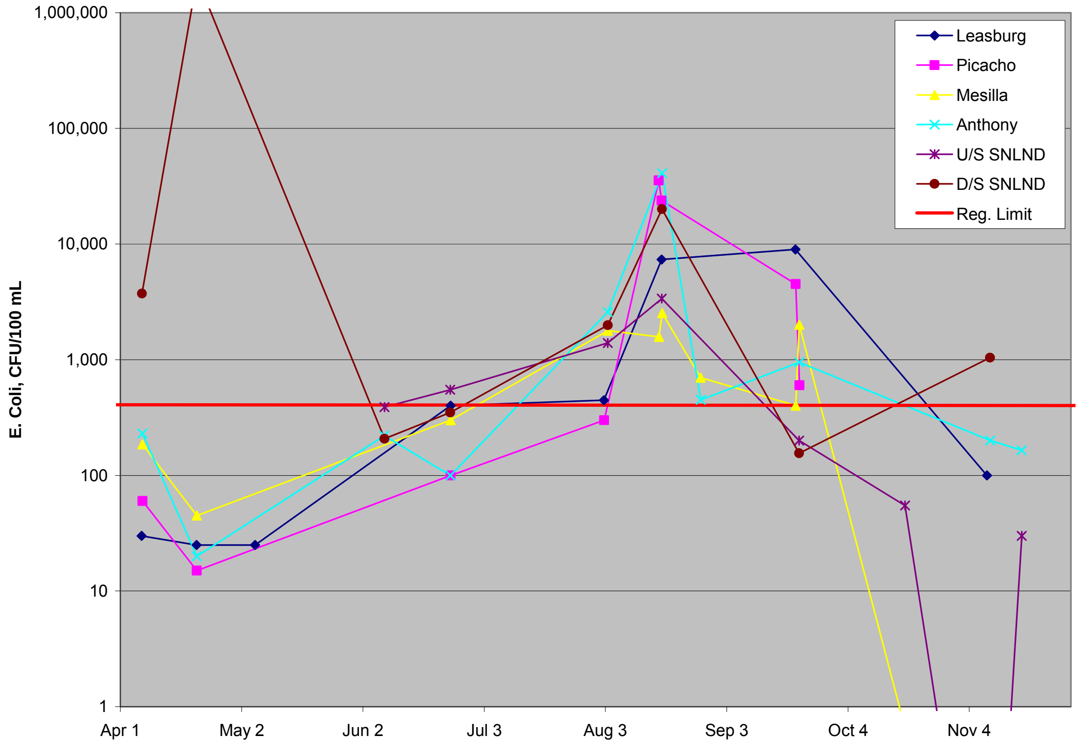

Figure 12: SWQB *E. coli* data for 2004 from Leasburg to below Sunland Park (D/S SNLND).

Appendix X - Paso del Norte Watershed Restoration Activities Potentially Complementary to the Watershed Restoration Action Strategy

U.S. International Boundary and Water Commission

The U.S. International Boundary and Water Commission (USIBWC) is currently in discussion with a stakeholder group (Collaborative) regarding IBWC's River Management Plan for the Rio Grande Canalization Project (RGCP), a 105-mile river reach from Percha Dam, New Mexico to the American Dam, Texas. The plan has been presented as part of an EIS and holds great potential for furthering the goals of the WRAS because of the focus of the work and its partners.

The EIS, describes plans that carryout USIBWC's mission to provide protection of life and lands along the RGCP from floods and provide irrigation and water deliveries to users in the U.S. and Mexico. However, there are also several proposed measures to mitigate the environmental impacts that may occur as a part of the management scheme. At this time, the Collaborative is still in a discussion phase and has neither recommended sites nor mitigation measures.

The meetings with various stakeholders are being sponsored by the Elephant Butte Irrigation District (EBID), the World Wildlife Fund (WWF), and Environmental Defense. The meetings provide for information and input for 25 stakeholders. In addition to the above process, the USIBWC is presently involved in levee work to protect against flooding.

World Wildlife Fund

Through the Collaborative described above, WWF has identified the restoration of up to 1000 acres of riparian habitat, dense shrub, and grasslands as well as the cessation of grazing leases on USIBWC right-of-way as BMP's for restoring the watershed.

Elephant Butte Irrigation District

EBID has been awarded funds from NMED to develop restoration projects in the area along their drain systems that will require USIBWC collaboration. Proposed actions for the project include establishing riparian habitat in the EBID drain, channel widening, and construction of structures to promote diverse flow conditions.

The U.S. Army Corp of Engineers

The U.S. Army Corp of Engineers (USACE), Albuquerque District has a long standing cooperative working relationship with the USIBWC. Currently, the USACE and the USIBWC are engaged in a watershed initiate on the Rio Grande below Elephant Butte Reservoir. USACE's scope of work includes hydrology and hydraulics, an environmental analysis, plan formulation, workshops and informational meetings, report preparation, technical review and project/study management.

Southwest Environmental Center

The Southwest Environmental Center (SWEC), another member of the Collaborative, continues its efforts in the restoration of aquatic and riparian habitats along the Rio Grande. SWEC collaborated in the development of the Picacho Wetlands in the newly established Mesilla Valley Bosque State Park (MVBSP) and is continuing its approach of wetland "pearls along the river" with the La Mancha property.

The La Mancha property is located on the west side of the river, adjacent to the federal right-of-way, less than one mile upstream from the MVBSP. It is nearly three acres of land along the Rio Grande with accompanying surface water rights. The New Mexico Legislature has appropriated $90,000 to DAC to develop a wetland at this site.

This newest project holds great potential. The availability of water rights opens many options for restoration. The proximity to MVSBP provides an opportunity for comparative analysis of desert aquatic ecosystems. The site's closeness to the population center of Las Cruces offers potential for nature-based education and recreation, and provides another opportunity to raise public understanding and appreciation for the Rio Grande ecosystem.

The New Mexico State Parks Division

The New Mexico State Parks Division (NMSPD) manages three developed parks as well as a few adjacent undeveloped parcels near the stretch of the river between Percha Dam and the state line. The developed areas include Percha Dam, Leasburg Dam, and Mesilla Valley Bosque Parks. NMSPD manages these sites primarily for recreation and natural resource protection, which can include wildlife enhancement, and/or restoration of native areas. NMSPD owns some water rights and is working to use this resource to restore and enhance wetlands for the benefit of wildlife, water quality and visitor experiences. NMSPD is currently working with the EBID in management of drain areas in the MVBSP. In addition, the NMSPD has established a small wetland area at Percha Dam State Park and has received funding to restore a larger wetland site below the dam at Caballo Lake State Park. Although the Caballo Lake State Park is just north of the WRAS area being studied, the wetland could provide a positive impact on water quality and an important study site. The NMSPD wetland restoration projects routinely include salt cedar control and incorporated mimicking the flood regime where possible.

U.S. Fish and Wildlife Service (USFWS)

According to the Ecological Services Field Office (ESFO), there are currently no USFWS activities in the area downstream of Elephant Butte Reservoir.

New Mexico Department of Game and Fish

According to the Las Cruces Field Office, there are currently no New Mexico Department of Game and Fish activities in this area.

U.S. Bureau of Land Management (BLM)

The Restore New Mexico Initiative of the BLM has allowed for federal dollars to be matched with contributions of other state and federal agencies, private organizations, individuals, and companies. Using this approach, BLM is looking at landscape projects and making an impact on large areas. BLM is looking beyond allotment boundaries, but must still work with the individual ranchers on individual projects to ensure they have the flexibility to allow required rest, especially on brush control projects. The greatest emphasis on the initiative is to restore shrub dominated communities back to grasslands. Of course, this requires careful planning and evaluating of individual sites to ensure the sites have the potential to recover. Not only has the BLM been using their own experiences from the last 20 years, but they are also using satellite imagery in conjunction with the ecological site descriptions to look at those areas that have the greatest potential for recovery. For the past several years, the BLM has been working on this technology with Jornada Agricultural Research Station.

The projects listed below are projects that BLM is currently working on, at least within the lower Rio Grande watershed and continues to look for opportunities as they complete their determinations on public land health.

Natural Resource Conservation Service

The Natural Resource Conservation Service (NRCS) provides conservation planning, technical assistance, collaboration with other agencies and organizations on special projects. Participants develop and implement plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) and to address their social and economic interests. The NRCS links groups and provides technical advice and programs when working in collaboration with such diverse groups like IBWC, BLM, EPA, SLO, NMED, NMDA, SWCD's, and many non-profit organizations.

The NRCS is a leading organization in the development of technical guides specifically adapted to geographic areas by field staff. In Dona Ana and Sierra counties, NRCS staff supports agricultural producers on Irrigation Water Management (IWM), as well as pest, nutrient and soil management programs. In addition to technical support, the NRCS offers financial assistance and incentives to foster natural resource conservation. NRCS's infrastructure and resources are an important asset in furthering restoration efforts on a watershed basis.

Project Description	Location	Schedule	Funding Sources	Partners	Notes
Construction of water developments, erosion control structures, and fencing	Blue Canyon Allotment No. 16057	2006-2008	Rancher BLM	BLM Rancher NMSLO	These are planned range improvements to assist in the overall management of the allotment. Additional projects may be planned in the future.
Control of noxious weeds	Home Ranch Allotment No. 03002	2007-2009	BLM NMSLO	BLM Rancher NMSLO	This is an ongoing effort to spray an African Rue infestation on this allotment.
Construction of fencing	Sierra Kemado Allotment No. 03043 Hersey Arroyo Allotment No. 03014 Rock Canyon Allotment No. 03007	2006-2008	Rancher	BLM Rancher	This is an ongoing effort for the construction/ maintenance of allotment boundary fences to aide in livestock control and resolve grazing trespass issues.
Construction of fencing	Altamira Allotment No. 03040	2007-2008	Rancher	BLM Rancher	This is an ongoing effort for the construction/ maintenance of allotment boundary fences to aide in livestock control and to keep them off of the Rio Grande.
Construction of fencing, water developments, erosion control, and brush control projects	Upham Allotment No. 03068 Thorn Well Allotment No. 03063 Rincon Allotment No. 03067 Apache Gap Allotment No. 16018 Alamo Basin Allotment No. 03015	2007-2009	Rancher BLM NRCS NMSLO NMACD	BLM Rancher NRCS NMSLO NMACD	These are planned projects on that are all part of the Restore NM Initiative. Additional similar projects may be completed on these allotments in the future.
Construction of water developments (pipeline, storage, and drinkers)	Percha Creek Allotment No. 16085	2007-2009	Rancher	BLM Rancher	This is an ongoing project for the construction of a livestock water pipeline to aide in livestock management on the allotment.
Completion of permit renewal EAs and Determination on the Standards for Public Land Health	All allotments within the lower Rio Grande Watershed (HUC 1303012).	1999-2011	BLM	BLM RancherU SFWS NMDGF	This is an ongoing effort to complete the NEPA documentation for the renewal of grazing permit/leases continue on the allotments along the lower Rio Grande watershed. In addition, the BLM is working on the Determinations on the Standards for Public Land Health.

Table 15: Bureau of Land Management projects in the lower Rio Grande.

Dona Ana Flood Commission

According to the Dona Ana Flood Commission, at this time Dona Ana County does not have any project ongoing or planned that address water quality impairments. However, other agencies, such as IBWC, are raising the levees in that reach of the river to comply with the Federal Emergency Management Agency (FEMA) requirements. This is not a BMP project, but construction traffic project will affect any projects along that route.

Dona Ana Planning Department

The Dona Ana County Planning Department does not have projects specific to addressing water quality impairments in the river between Percha & the NM-TX state line. However, the Planning Department does engage in related activities that may contribute to the abatement of water quality problems. It works closely with the NMED and the DAC Sheriff to resolve identified code violations and health hazards that may be related to pathogens in the water.

The Planning Department reviews all land development applications to ensure compliance with county ordinances and compatibility with the county comprehensive land-use plan. Several agencies are requested to review proposed subdivision and land development projects to ensure a complete review. These agencies include NM Office of the State Engineer, EBID, Water & Soil Conservation District, NM Environmental Department, Dona Ana County Codes Enforcement, and the International Water Boundary Commission. The responses from the reviewer agencies assist the Planning Department in determining recommendations to the applicable planning board(s) for land development projects.

The City of Las Cruces Public Works Department

Project Description	Location	Schedule	Funding Sources	Partners	Notes
El Molino Drainage & Roadway Improvements	Burn Lake site, Burn Lake Rd	N/A	The City of Las Cruces, Willa Dean Esslinger	Willa Dean Esslinger-donated land.	Flood control/ conservation. Acts as staging and filtration.
View Court Pond	Off View Ct (Telshor Area)	Presently working on.	The City of Las Cruces		This pond will eliminate excess sediments from entering the storm drain system.
General-Ponds	Throughout the City of Las Cruces	Existing, in progress, and scheduled.	The City of Las Cruces		46 ponds that primarily serve as flood control and also reduce sediment and pollutant loads that eventually end up in the lower Rio Grande.

Table 16: City of Las Cruces Public Works Department projects.

Appendix XI - Watershed Restoration Efforts in New Mexico

A Framework for a Restoration Vision for the Rio Grande, Hope for a Living River

The purpose of the document is to embrace a system-wide view of the restoration of hundreds of miles of the Rio Grande from the headwaters in Colorado to Candelaria, Texas. This approach is needed since the river ecosystem has been highly modified, and many important functions and values are greatly impaired. A growing population along the Rio Grande is placing demands upon the limited water resource. The document outlines the key biologic, hydrologic, and geomorphologic processes of the Rio Grande in this stretch. Restoration opportunities are identified.

As part of the report, the World Wildlife Fund and the Alliance for the Rio Grande Heritage hosted a workshop (March 2002) to develop a restoration vision from a variety of diverse agencies and groups. The final agreed upon vision is:

We envision a Rio Grande that sustainably supports both the ecology and biota of the river, and the needs of human inhabitants of the region. To sustain the Rio Grande ecosystem and its native aquatic and riparian biodiversity, we need to promote flows that more closely resemble the historic hydrograph; re-establish geomorphic processes and other characteristics that maintain the river's channel, floodplain and riparian corridor; control invasive species; and encourage land use and water resource management that promotes and maintains such a system.

The plan can be obtained from www.savetherio.org.

New Mexico Forest and Watershed Health Plan an Integrated Collaborative Approach to Ecological Restoration

This Plan was created to address the increasingly unhealthy condition of the state's ecosystems. The Plan was developed through a stakeholder process and created by a planning committee of government, industry and environmental representatives.

The Plan establishes an integrated ecological restoration strategy to guide all of New Mexico to our goal of healthy landscapes. The Plan contains 20 action items that are intended to transform the way ecological restoration is accomplished. The action items focus on state-level support of project efforts, planning, coordination, management and administration. The Plan calls for the establishment of a state office dedicated to forest and watershed management.

The plan can be obtained from www.emnrd.state.nm.us/FD/FWHPlanMain.htm.

New Mexico Non-native Phreatophyte/Watershed Management Plan

The purpose of this plan is to provide guidance for control of non-native phreatophytes and to further identify the necessary templates and protocols for monitoring revegetation, rehabilitation, and long-term watershed activities. The vision that was developed through a work group was:

New Mexico will become the national model for conservation and restoration of healthy functions to its ecosystems and watersheds through landscape-scale-management of its watersheds, including invasive plant species.

The plan can be obtained from www.nmda.nmsu.edu/animal-and-plant-protection/tamarisk-salt-cedar/2005-nmnpwmp.pdf.

New Mexico State Water Plan

This Plan is a blueprint to move the State forward into the 21st century with 21st century techniques and technology applied to conserve and to increase the supply of water. Because of drought and man-made issues – from endangered species matters to interstate water conflicts – water supplies are dwindling. The plan is an outcome of months of work by the Interstate Stream Commission, State Engineer and Water Trust Board, with input from a broad spectrum of New Mexico's citizens and institutions.

This plan is a strategic management tool for the purposes of:
(1) promoting stewardship of the State's water resources; (2) protecting and maintaining water rights and their priority status; (3) protecting the diverse customs, culture, environment and economic stability of the State; (4) protecting both the water supply and water quality; (5) promoting cooperative strategies, based on concern for meeting the basic needs of all New Mexicans; (6) meeting the State's interstate compact obligations; (7) providing a basis for prioritizing infrastructure investment; and (8) providing statewide continuity of policy and management relative to our water resources.

The plan can be obtained from www.ose.state.nm.us/water-info/NMWaterPlanning/2003StateWaterPlan.pdf.

Restore New Mexico, U.S. Bureau of Land Management

Restore New Mexico is an aggressive partnership to restore woodlands, grasslands and riparian areas to a healthy and productive condition. The environments is threatened with the expansion of invasive plants over the past 140 years, and degraded water quality due to erosion, and an increased threat from catastrophic wildfires to wildlife habitat and communities bordering public lands. The Bureau of Land Management is working with partners on all land ownership types – state, private and federal – and involving communities, agencies, industry, organizations, and private citizens. The focus is on large-scale restoration efforts, dealing primarily with invasive and exotic brush species, including mesquite, juniper, creosote and salt cedar.

Further information can be obtained from www.blm.gov/nm/st/en/prog/restore_new_mexico.html.

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