Identification Of Sources Of Water Quality Degradation And Development Of Market Mechanisms For Improvements In A Sub-Basin Of The Rio Grande

An EPA Watershed Initiative Proposal from the Paso del Norte Watershed Council

Characteristics Of The Paso Del Norte Watershed

The Rio Grande is a desert river of limited quantity and increasing demands. The river is used, and reused, throughout its course from its headwaters in southern Colorado and northern New Mexico to its terminus. This use, and reuse, results in decreased quality downstream in some reaches. The river quality meets the New Mexico stream standards throughout the state (New Mexico Water Quality Control Commission, 2002), but fails to meet the Texas standards for Segment 2314 in Texas (303d List, Texas Council on Environmental Quality). As future demands on this limited resource increase quality concerns are likely to increase. To help deal with these issues this project will: 1) identify sources of salinity increases in the lower Mesilla Valley in New Mexico and provide new water quality information; 2) design market-based incentive mechanisms aimed at salinity source control; and 3) implement a pilot project that may provide mechanisms for water quality improvement. The overall project will be managed by the Paso del Norte Watershed Council, a coalition of water users and stakeholders in west Texas and southern New Mexico, whose mission is to promote and coordinate watershed restoration/enhancement, improve water quality, and ensure both ecosystem and economic sustainability in our region.

A. General Description

Physical. The Paso del Norte sub-basin of the Rio Grande is the watershed along the 180 river-miles from Elephant Butte Reservoir in New Mexico to Ft Quitman, Texas. The reach encompasses 9 percent of the total length of the Rio Grande, which has a drainage area of approximately 30,000 square miles (Figure1). The basin lies at relatively high elevations (1000+ m) within the Chihuahuan Desert of southern New Mexico, west Texas, and northern Mexico. The watershed is characterized by hot summers and cool

winters, and has an annual rainfall of 8 to 9 inches, 80 percent falling in a monsoonal pattern between April and October.

The Rio Grande drainage is essentially the only source of surface water in this basin. Other small drainages either end in closed basins, or flow only in summer months. Groundwater also provides for a significant portion of the water demands in the region, however, many of these aquifers are stressed where demand exceeds recharge and quality has deteriorated.

The predevelopment historic river hydrograph in the sub-basin was characterized by high springtime flows in response to snowmelt in the mountains of southern Colorado and northern New Mexico. In addition high flows often occurred in late summer in response to thunderstorms. The Rio Grande Project was developed in the early 1900's as a multi-purpose project that provided for the construction of Elephant Butte Dam and Caballo Dam. The storage behind these dams support an extensive system for irrigation of farmlands in New Mexico, Texas and Mexico. The Project also serves other purposes such as flood control, recreation, and community needs.

Biological. The Paso del Norte basin has the arid grasslands, desert shrublands, and remnant riparian areas characteristic of the Chihuahuan Desert. The riparian habitat along the river comprises less than 5 percent of the total area of the basin, but it is utilized by up to 80 percent of vertebrate species at some point in their life cycle. As elsewhere, the riparian habitat of the Rio Grande has been affected by man's control of aquatic resources. Historic accounts describe seep-willow, cottonwood, and willows forming the overstory along the river's edge with salt grass meadows, ponds, and marshy areas nearby. Today most of the historic native vegetation and the mosaic of habitats have been replaced by monocultures of non-native plants such as salt cedar, Russian olive, and Bermuda grass.

Social/cultural. Water in this Rio Grande sub-basin has been diverted for irrigation since the late 1600's with farming concentrated around the Spanish missions. Today, the waters of the Rio Grande are apportioned by a compact among Colorado, New Mexico, and Texas and a Treaty between the United States and Mexico. About 80% of the surface water is used for irrigated agriculture in the Rincon,

Mesilla, and El Paso Valleys, Hudspeth County, and Ciudad Juarez, Chihuahua, Mexico. The remaining water is used for municipal and industrial purposes. El Paso is 17th largest city in the nation and the populations of Las Cruces, El Paso, and Ciudad Juarez are now over 2 million. The regional population is predicted to double by 2020. The demands for municipal and industrial water in the region are projected to increase about 75% over the next two decades (from about 321,000 acre-feet in 2000 to over 565,000 acre-feet in 2020). Much of this increase in demand is expected to be met by conversion of surface (Rio Grande) water from irrigation to municipal and industrial uses, assuming water quality is satisfactory.

B. Problems and threats

Because water is so scarce in this region, it is used and reused, picking up and concentrating salinity as it moves downstream in the sub-basin. About one-half of the water that is diverted for irrigation and municipal uses is returned to the river for reuse. In some areas, groundwater of lower quality also contributes to tributary inflows. Historically, surface water releases occur only during the irrigation season (mid-February to mid-October). During the non-irrigation season the flows in the river are largely made up of shallow groundwater, agricultural return flows, and treated sewage effluents. Consequently, a primary water quality issue in the region is the increase in downstream total dissolved solids**.**

High TDS, especially related to low flow periods such as drought and the during the non-irrigation season (mid-October to mid-February), reduces the ability to use river water as a source for El Paso's drinking water for five months of the year when the salinity exceeds 1,000 mg/l TDS (Figure 2), and affects crop selection, crop yields and environmental conditions in the sub-basin.

C. Watershed plan

The applicant for this project is the Paso del Norte Watershed Council (Watershed Council) that was established to investigate, develop, and recommend options for planning and management on a watershed scale. The Council has representatives from federal agencies, state agencies, local municipal governments, environmental groups, a water utility company, academic institutions, and the general public. Some of the long-term goals of the Watershed Council are to explore how water-related resources can be managed and

sustained for the benefit of all watershed stakeholders. The Watershed Council promotes and coordinates restoration and enhancement activities, including the implementation of environmental enhancements and mitigations associated with the El Paso-Las Cruces Regional Sustainable Water Project. The Watershed Council fosters communication and collaboration to make best use of available resources, works to ensure both ecosystem and economic sustainability, promotes improvement of water quality in our region, improvement in source water protection, consolidation of water-related data, and restoration of riparian and aquatic ecosystems. This year the Watershed Council has initiated the development of a coordinated database and GIS for this watershed, including data on water quality, river flows, land use, and groundwater development from many different sources. The Council also has an ongoing educational program and is developing print and internet outreach materials in both English and Spanish.

Identification and prioritization of projects. The most important water quality issue in this region is the salinity of the river and its effects on stakeholders from farmers to city dwellers to the animals and plants living along the river. Several approaches are being explored to address salinity increases including interbasin transfers of water, desalination of brackish ground water, and management of agricultural, municipal and industrial uses. All of these solutions have associated environmental consequences as well.

Projects part of plan but not eligible for funding. The Council is involved in watershed-scale environmental restoration projects associated with the NM-TX Sustainable Water Development Project. These activities involve prioritization and recommendations of environmental enhancement and restoration projects that are not part of this program such as the development of biological management plans that will guide the selection and implementation of regional restoration projects.

Implementation of the watershed plan. Implementation of any plan is the responsibility of the individual Council members and their respective organizations (as appropriate). Committees for each project draw upon the expertise/experience required for a particular project. Within our organization we have planners, scientists, engineers, and other experts representing a number of organizations including El Paso Water Utilities, Texas A&M University, University of Texas at El Paso, the New Mexico Water Resources

Research Institute at New Mexico State University, Texas Tech University Health Sciences Center-at El Paso, Southwest Environmental Center, US Bureau of Reclamation (El Paso), International Boundary and Water Commission (IBWC), City of El Paso, City of Las Cruces, and the Fort Bliss Directorate of Environment. This proposal has received the unanimous support of the members of the Paso del Norte Watershed Council and Executive Committee.

DESCRIPTION OF THE PROPOSED PROJECT

A. Relationship of project to watershed plan and goals

Components and goals of project. An EIS was recently conducted by the New Mexico-Texas Water Commission for a regional water supply project (U.S. Section, IBWC and El Paso Water Utilities/Public Service Board, 2000). The EIS reviewed a number of proposed alternatives and found that occasional significant adverse impacts on river water quality would occur under each action alternative. An associated study (Boyle Engineering Corporation and Parsons Engineering Science, Inc., 1997) revealed that significant degradation of water quality occurs between the Mesilla Diversion Dam and the American Diversion Dam (Figure 3). These changes were believed to be the result of several factors including: irrigation drain flows, municipal and industrial wastewater effluents, natural contamination (saline soils /salt deposits/geothermal inflow), groundwater inflow; and contamination due to human activity. The Boyle report identified two drains, the East Drain and the Montoya Drain (Figure 3), in the lower portion of the Mesilla Valley as sources that contribute high TDS water to the river. Suggested alternatives for reducing the inputs from the drains included: segregation of drain flows, impounding and releasing drain flows when river flows are greatest, management of saline lands, and diluting drain flows with groundwater (Boyle Engineering Corporation and Parsons Engineering Science, Inc., 1998).

The management of saline lands appeared to be the most feasible option at that time. The hypothesis was that by taking the saline land out of production, or by reducing or eliminating irrigation of these lands, salt loading into the drain flows and river may be reduced. A number of tools exist to identify and

estimate salt contributions associated with specific land parcels, such as multi-spectral imagery and soil conductivity measurements. This hypothesis, however, was not tested at that time due to limited availability and high cost of multi-spectral imagery for the area and limited salinity monitoring. Identification of saline lands is only the first step. Taking saline land out of agricultural production and fallowing, is necessary to test the hypothesis that particular tracts of land contribute disproportionately to levels of total dissolved solids. This will require measurement of water quality at many sites both before and after land is removed from production to evaluate effectiveness. The fate of fallowed lands is also an important consideration. Uncultivated tracts are susceptible to encroachment by noxious weeds. Of particular concern is salt cedar (Tamarix spp.), an invasive non-native phreatophyte that is capable of consuming significant quantities of shallow groundwater. It does not benefit the watershed to have agricultural lands converted to weed-covered vacant plots or invaded by non-native vegetation.

This project proposes to develop voluntary market mechanisms to provide landowners with options for changing the use of their saline lands, forebearance, leasing of water rights, outright sale of land, economic incentives for irrigation efficiency improvement to reduce return flows (e.g. Colorado River Salinity Control Program), cropping alternatives, delivery system management, conservation easements, habitat restoration, and others. These market-based best management practices will provide mechanisms for improving water quality through willing buyer-willing seller transactions. Research on the value of salinity reduction to producers is currently being conducted by members of the Watershed Council (Michelsen, Ari M. and Frank Ward, 2002) and will provide important information for the development of the proposed market-based water quality improvement program.

Watershed Improvement Program. The proposed watershed improvement program involves four interlinked tasks that have the ultimate goal of reducing the salinity in irrigation drain flows and the Rio Grande by identifying major sources and by developing market mechanisms for reducing these contributions. **Task 1** is the salinity source assessment and will be made using: 1) spectral analysis, 2) water quality measurements, and 3) soil salinity measurements. Initial assessment will utilize satellite

imagery to identify saline lands followed by field-level soil salinity assessment on core samples (Hendrickx et al., 1999). Drain water salinity will be assessed using real-time conductivity meters and by periodic grab samples. Elephant Butte Irrigation District (EBID) has a number of conductivity monitors in place already. For this project additional sensors will be obtained and EBID will install them and integrate them to their existing network. This task will be coordinated by Texas A&M Agriculture Research Center (TAMU) and NMWRRI. **Task 2** will involve incorporating newly acquired data into the existing coordinated database and using the coordinated database to generate a GIS map linking water and soil data to specific land parcels. This will be a joint task among NMWRRI, TAMU, and NMSU. This data will be available to the NM DEQ, IBWC and TCEQ. **Task 3** will include the development of market incentives for water quality enhancement and will include consideration of forbearance, sale, lease of water rights, conservation easements, economic incentives for irrigation efficiency, cropping alternatives, delivery system management, habitat restoration, etc. Forebearance, the willing lease or donation of water from farmers to other users, as a strategy for improving water quality and enhancing water supply is expected to have utility well beyond this project. TAMU and NMSU will be the leaders for this project. **Task 4** will be a restoration pilot project conducted by the Southwest Environmental Center that will test the feasibility of restoring natural wildlife habitats to saline/vacant lands. There is a need for natural habitats in this watershed and utilizing fallowed farmland to restore natural habitat allows for testing of the hypothesis while addressing another major watershed problem. Examples of desired habitats include cottonwood/willow bosque, tornillo bosque, seasonally flooded wetlands and saltgrass meadows. We will develop market-based incentives for management to improve water quality. Incentives will target various methods for reducing salinity including: improved drain flows, implementing irrigation technology similar to programs in the Colorado Salinity Control Project, changes in crops, delivery system management, as well as incentives for reducing irrigation on saline lands (sale, forbearance, etc). These would be market-based arrangements made with landowners. The El Paso Water Utilities/Public Service Board has offered land as well as other in-kind contributions (mechanical, seed, etc) for the establishment

of a pilot program for natural habitat restoration. Restoration would entail some or all of the following activities: removal of tamarisk and other non-native woody plant species, excavation of wetlands, and planting of native riparian species. Much of this work will be accomplished with volunteers.

Project schedule. **Year 1** Use existing satellite imagery to carryout spectral analysis to identify lands with highest salinity; install additional water quality monitors; collect drain water quality data (real-time conductivity and monthly grab samples for total salinity and component ions); design a soil sampling protocol (conductivity and core samples) and integrate sampling. Examine how, and under what conditions, farmers might be willing to reduce irrigation, either permanently or for an extended period of time. Develop market mechanisms to be used in discussions with farmers whose land may be recommended for fallowing. **Year 2**. Once the water quality monitoring system is in place and the salinity assessment has been initiated, begin assessment on select lands. Continue water quality monitoring with special attention on drain sections where land has may be fallowed. Develop GIS map linking water quality data, soil salinity data, image data, etc. Share data water quality data by internet.

Year 3. Continue water quality monitoring, soil and pilot restoration assessments. Prepare final reports. Begin outreach activities by scheduling presentations of final results.

Estimated budget (See budget table for detailed breakdown) Total cost for four tasks: $1.26 million, grant request of $843,819 from EPA, and matching funds of $417,391; match percentage is 33.1%. This grant will also assist in acquiring other funding for additional matching support and water quality improvement, such as the USDA Wetlands Reserve Program and Wildlife Habitat Incentives Program (WHIP).

Environmental criteria for determining if goals being met. Improvement in TDS and/or sulfate water quality levels in the drain flows and Rio Grande. Also, successful restoration/establishment of native vegetation on fallowed lands.

B. Monitoring and evaluation

Real time conductivity monitoring (correlated with monthly laboratory water and soil measurements) in agricultural drains and the river will be used to identify salinity sources, and monitor and evaluate the

difference in water quality before and after saline land has been taken out of production. New monitoring stations will be installed on the East and Montoya Drains to monitor water quality and will compliment stations already in use by Elephant Butte Irrigation District. These measurements will provide valuable water quality tracking information. We will track the amount of acreage actually fallowed, how many landowners are interested in retiring their land and/or water rights, and the total acreage converted to natural habitat.

C. How projects complement other local, state, federal projects

Identification of sources of water salinity will help river managers, including the Bureau of Reclamation, International Boundary and Water Commission, and irrigation districts, meet the their goals of improving water quality. The improved water quality will also help reduce treatment costs for municipal use which will benefit citizens in the US and Mexico. Reduced salinity will also benefit downstream agriculture producers and the Rio Grande ecosystem.

Demonstrating the viability of using market incentive programs as a vehicle which simultaneously addresses water quality and habitat needs will be of great value elsewhere in the watershed. Data from this project will provide valuable information about options that could be implemented on a region-wide scale.

D. Entity responsible for coordinating projects

Project coordination will be undertaken by Watershed Council coordinator and principal investigators assigned for each task.

PROJECT MANAGEMENT AND STAKEHOLDER INVOLVEMENT

A. Management, staff, supporters, and stakeholders for the watershed plan and subsequent projects see preceding discussion

B. <u>Plan's</u> leader, staff, and partners. Implementation of the watershed plan is the responsibility of the Watershed Council Officers (see attached) who have led and conducted numerous state and federal projects/studies and/or have direct responsibility for water resource management in this region. Chair: C. Keyes, ScD, PE (water resources consultant); Vice Chair: S. Watts, PhD, Texas Tech University Health

Sciences Center (ecologist); Treasurer: A. Michelsen, PhD, Director Texas A&M University Agricultural Research and Extension Center (environmental economist); Secretary: E. Fierro, El Paso Water Utilities (Water rights engineer).

C. Project's leader, staff, and partners. Co-leader-A. Michelsen-Director Texas A&M University Agricultural Research and Extension Center; (environmental economist); past president UCOWR. Co-leader-Bobby Creel, PhD-Assoc director NM Water Resources Research Institute. Partner-Kevin Bixby-Executive Director, Southwest Environmental Center. Partner-Gary Esslinger-Manager/Treasurer, Elephant Butte Irrigation District.

D. Source and nature of technical expertise required. Economics-Ari Michelsen, PhD, Brian Hurd, PhD, Bobby Creel, PhD; water quality monitoring-Ed Fierro, Phil King, PhD; soil salinity-S. Miyamoto, PhD; GIS mapping-Christopher Brown, PhD, Bobby Creel, PhD, John Kennedy, PhD, Zhuping Sheng, PhD.

E. Description/list of stakeholders who may play an indirect role in projects or watershed plan. Citizens of El Paso and Juarez; irrigators in Texas, New Mexico, and Chihuahua; Tri-regional planning group (developing water supply strategies for Southern New Mexico, West Texas, and Ciudad Juarez).

OUTREACH ACTIVITIES

A. Knowledge transfer. Copies of the final report will be provided to El Paso Water Utilities, all regional irrigation districts, City of El Paso, City of Las Cruces, and others requesting copies.

B. Enhancing public understanding. An electronic copy of the final report will be made available on the Council's website where it will be available to all interested stakeholders. Additional information about the market incentives will be presented separately because of their potential to be used beyond the scope of this project. Presentations will be made to public and professional groups and others by request.