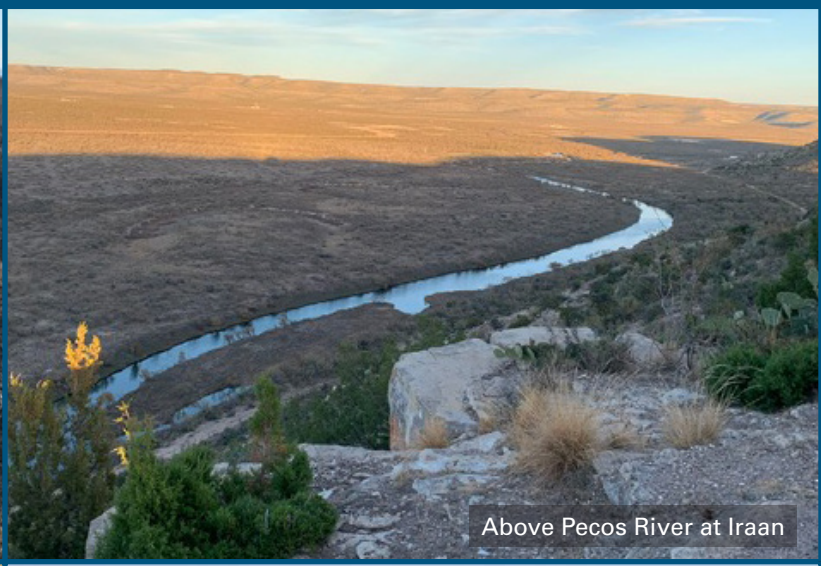
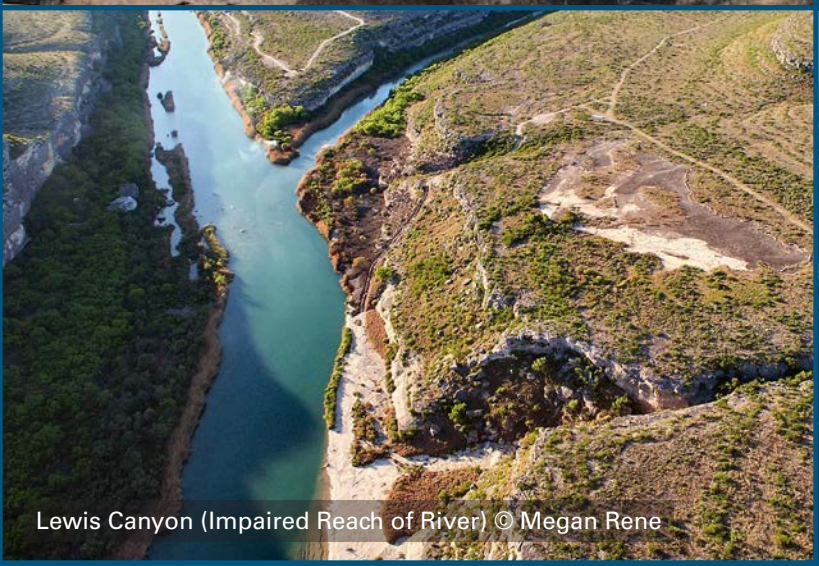
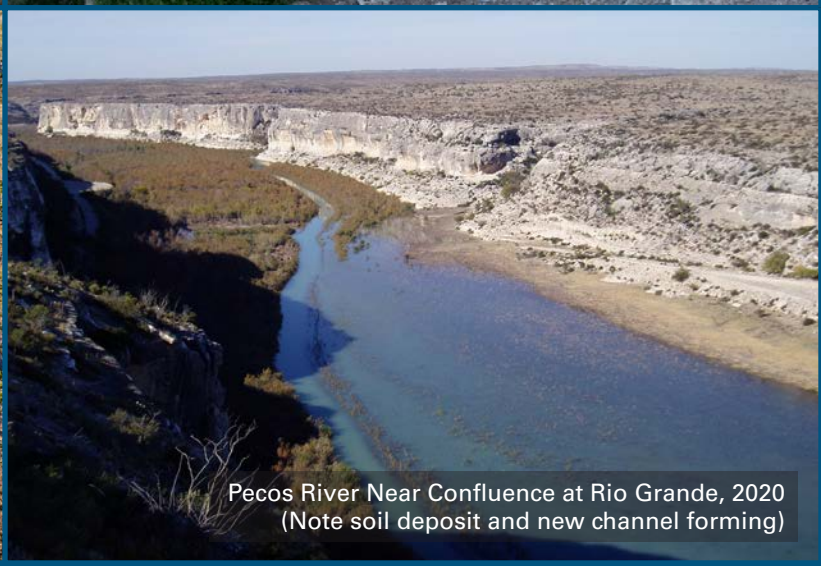
A Path Forward for the Pecos River Watershed Protection Plan

Report: 2021-04
June 2021


Pecos River at Pecos Texas below Red Bluff Dam


Above Pecos River at Iraan


Lewis Canyon (Impaired Reach of River) © Megan Rene


Pecos River Near Confluence at Rio Grande, 2020
(Note soil deposit and new channel forming)

The Meadows Center
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MEMBER **THE TEXAS STATE UNIVERSITY SYSTEM**

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(Lower Pecos Impaired Reach of River)
Wild horses wading in the Pecos River in Val Verde County © Ken Hartlein

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PURPOSE

The purpose of this report is to develop a strategic path forward for the U.S. Environmental Protection Agency (EPA) approval of a revised Pecos River Watershed Protection Plan (WPP) and to consider alternative approaches that would enable effective implementation of management practices for improving water quality in the Pecos River without formal EPA approval of the WPP.

Pecos River at Lake Amistad Pool Level

INTRODUCTION

As declining water quality and suppressed freshwater inflows continue to degrade the Pecos River in Texas, new solutions are sought to address these concerns. In 2004, the Pecos River WPP became one of the first WPPs for the TSSWCB to undertake as an agency. With Clean Water Act Sec. 319(h) funding, the TSSWCB partnered with TWRI to lead a broad scientific research and stakeholder engagement effort culminating with EPA's acceptance of the Pecos River WPP in 2009. Upon characterizing the sources and causes of water quality concerns throughout the watershed, the Pecos River WPP prescribes specific voluntary management measures to address an array of pollutants and indicators of river health. These include: salinity/total dissolved solids (TDS), depressed dissolved oxygen (DO), golden algae and nutrient levels. The WPP also makes two hundred thirty-eight references to invasive saltcedar as a significant concern to riparian ecosystems and major disruptor of natural hydrologic function. With clear direction and measurable goals, the Pecos River WPP remains an important tool for future protection of the Pecos River.

While water quality parameters are the primary indicators utilized by the Texas Commission on Environmental Quality (TCEQ) to characterize the health of a waterbody, as with most other western streams, these indicators are intimately tied to the amount of water that flows between its banks. The attainment of water quality goals for the Pecos River will be extremely difficult to achieve under the current flow regime. Drought, impoundments, particularly Red Bluff Reservoir located on the Texas-New Mexico state line, the extraction of alluvial groundwater reversing flow paths, diversions of the river's flow for agricultural irrigation, oil and gas development throughout the Permian Basin, and invasive species including saltcedar and giant cane (Arundo donax) have each combined to result in staggering consequences to the Pecos River's natural hydrology and water quality over the last century. This is particularly noticeable in the segment identified by TCEQ and this report as Segment 2311, Upper Pecos River, from Red Bluff dam to just above the Independence Creek confluence (See Figure 1).

High salinity levels in the Upper Pecos River (TCEQ Segment 2311) are both naturally occurring and exacerbated by manmade changes to the watershed's landscape and its hydrology. As the Pecos River flows across arid rangelands of the Chihuahuan Desert, it is dominated by irrigation water releases from Red Bluff Reservoir and occasional stormwater flows. Immense brackish lakes created by abandoned and improperly plugged oil and gas wells dot this area of the Permian Basin when viewed from above and present serious problems to both surface and groundwater resources. Complicated by high salinity levels, TCEQ Segment 2311 has been identified on the State of Texas 303(d) list since 2006 for depressed dissolved oxygen (DO).

The Pecos, however, undergoes a dramatic change as the river crosses under I-10 and begins to approach its confluence with Independence Creek. With a surge of high quality, spring-fed water from Independence Creek, the Lower Pecos River, defined in this report by TCEQ Segment 2310, takes on new life as its crystal-clear waters course between high canyon walls, past treasure troves of ancient petroglyphs and pictographs, and across challenging rapids on their final decent to Amistad Reservoir and thence the Rio Grande (See Figure 1). That is not to say that the Lower Pecos is immune to upstream impacts. Total Dissolved Solids (TDS) levels have more than doubled in TCEQ Segment 2310 since 2006, increasing from 2,038 parts per million (ppm) to 4,268 ppm according to the 2020 Texas Integrated Report published by TCEQ. This finding led to TCEQ Segment 2310 being named for the first time on the State of Texas 303(d) list as impaired for TDS levels not supporting its designation for high Aquatic Life Use (ALU).

WATERSHED DESCRIPTION

The Pecos River is located within the southwestern United States, crossing state lines between New Mexico and Texas, and is a major tributary of the Rio Grande which makes the international boundary between the United States and Mexico. The Pecos flows generally southeastern for 926 miles from its headwaters in the Sangre de Cristo Mountains, New Mexico, to its confluence with the Rio Grande near Del Rio, Texas, making it the 18th largest river in the United States by length (USGS 1990) (See Figure 1).

From its origins to roughly 20 miles downstream, the Pecos River is a designated Wild and Scenic River managed by the United States Forest Service. Once over the state border into Texas, the river overlies the Pecos Valley Aquifer, an unconfined aquifer mostly made of alluvial deposits. Over 80 percent of groundwater resources of the Pecos Valley Aquifer are pumped for irrigation uses. The Pecos eventually reaches the Edwards-Trinity (Plateau) aquifer, which is largely composed of limestone and dolomite, leading to very hard water with high levels of total dissolved solids (TDS). Like the Pecos Valley, most of the groundwater is pumped for irrigation purposes, with the remainder being drawn for livestock and municipal supplies for the surrounding West Texas communities (Texas Water Development Board). The Pecos acts as the boundary for eight counties in Texas: Loving, Reeves, Pecos, Ward, Crockett, Crane, and Terrell (Texas State Historical Association).

The Pecos River's 44,000 square mile drainage basin is largely encompassed within the Permian Basin, a major oil and natural gas producing area in West Texas, and a small portion of southeastern New Mexico. The climate of the region is generally semiarid or steppe, characterized by hot and dry summers, mild winters, and an annual precipitation average of only 10 inches. Typically, the rate of evaporation outweighs precipitation, leaving surface waters scarce. The watershed is dominated by the shrub/scrub land use classification, covering more than three quarters of the basin, with the second largest land use type classified as grassland/herbaceous. The portion of the watershed in Texas is contained within the larger High Plains physical region of the state, and the Pecos forms the northernmost boundary of the Edwards Plateau subregion within the High Plains (Texas Almanac). The Edwards Plateau can be characterized by rolling topography composed of limestone outcrops, and thin soils supporting shrubs and trees such as cedar, mesquite, and oaks.

The Pecos River Basin in its entirety is largely undeveloped and contains no major U.S. cities within its bounds. Roswell, New Mexico in the upper basin contains the largest population hub with close to 50,000, while the city with the largest population in the Lower Pecos River Basin is Pecos, Texas, which reported a population of just over 10,000 in 2019 (U.S. Census 2019).

Water quality near the headwaters of the Pecos River in New Mexico is of exceptional quality, however the quality downstream decreases as the impacts of historic mining in the area become more evident (Edwards Aquifer Research and Data Center 2009). Red Bluff Reservoir is located on the Texas-New Mexico state line and serves as a defining feature of the Pecos. Under the Pecos River Compact implemented in 1949, the waters of the Pecos River were effectively divided between Texas and New Mexico with Texas being allotted 43 percent and New Mexico receiving 57 percent of the river's average annual flows. The exception to this rule is unappropriated flood waters which are split evenly between the states. Over the years, the state of New Mexico has built up a credit on water delivered to Texas by delivering more than 43 percent of the river's waters to Texas. Per the terms of the agreement, New Mexico can draw against this credit in times of drought effectively eliminating the flow of the Pecos River into Texas.

Figure 1. The Lower Pecos River Basin – New Mexico and Texas.

(Lower Pecos Impaired Reach of River)
Pecos River at Pandale Crossing, Texas © mlhradio, Flickr

BACKGROUND

Watershed Protection Plan Development - 2008

The Pecos River WPP is the result of a decades-long collaboration between multiple groups and individuals to restore water quality in the iconic Pecos River and improve overall watershed health. The Pecos River WPP was initially developed by the TSSWCB, TWRI and the Texas AgriLife Extension Service in 2008 to address water quality concerns, impairments, and resource management issues associated with high salinity and DO levels, invasive species, and weakened biodiversity. The EPA ultimately accepted the plan after the following recommendations were addressed in April 2009:

1. Provide more clarity on plans to increase collaboration with other state and federal partners, particularly the United States Department of Agriculture Natural Resource Conservation Service (USDA/NRCS), to provide the necessary funding for landowners to implement the best management practices (BMPs) as prescribed in the WPP and increase the chances of program sustainability;
2. Development of a DO model linking the BMPs designed to target salinity reductions where the highest load reductions can be achieved in specific locations with the anticipated increases in DO concentrations and water quality restoration in the Pecos River;
3. Further refine the sources causing DO impairing and estimating the load reduction to target reduce uncertainty;
4. Revise language that suggests uncertainty, a lack of information, and general assumptions.

The WPP was completed and distributed to watershed landowners in December of 2009 and two separate projects were initiated to implement portions of the plan:

1. "Implementing the Pecos River Watershed Protection Plan through Invasive Species Control (Saltcedar) and by Providing Technical and Financial Assistance to Reduce Agricultural Nonpoint Source Pollution"
2. Conducting computer-based DO modeling conducted by Texas Institute of Applied Environmental Research (TIAER) to identify the sources of pollution that influence DO levels in the Pecos River and have led to the DO impairment in its upper reaches.

Modeling Results

"Results of the modeling exercise indicate that a variety of factors influence instream DO levels in the Pecos River. Primarily, low DO levels are caused by hydrological modification of the river that has occurred over the years; however, other conditions resulting from lower water levels and infrequent flushing events leading to excessive aquatic plant life and warmer water temperatures also contribute to the impairment. Through modeling various management options to restore DO in the Upper Pecos River, the findings indicate that it will be extremely difficult, if not impossible, to bring about restoration of the depressed DO levels in the impaired portion of the river without more water." - TWRI March 2014 Pecos River WPP Newsletter

Revised Watershed Protection Plan - 2013

Although considerable progress was made across the watershed, the need for continued implementation remained. TWRI revised the Pecos River WPP in 2013 to highlight implementation progress to date, discuss additional management needs identified by landowners, and report on recent trends in water quality. The revised implementation plan was ultimately not accepted by EPA. TSSWCB described EPA's position with the following general comments:

1. Too large of a watershed to effectively solve a water quality problem in a reasonably short time-frame;
2. Not enough [water quality] data currently available to accurately pinpoint or target an area that would reduce a significant amount of loading to have an effect on water quality;
3. The main source of focus – eradicating salt cedar – to reduce loadings is too broad scoped to reasonably expect to achieve water quality standards in a relatively short time-frame;
4. Expectations to achieve water quality standards in our lifetime seems remote.

EPA suggested reducing the size of focus to work in a significantly large enough area, yet manageable size area to be able to expect to see enough land changes for water quality improvements/achieve standards. EPA would suggest collecting more information linked to water quality data to understand desired outcomes and expectations.

TSSWCB General/Specific Explanations

"In general, this is a good first start with a load of information about the historic past, but much more work needs to be done in terms of water quality impairment quantities and targeting more manageable watershed size areas where locating BMPs and monitoring results of load reductions can more likely occur. Attempting to quantify load reductions in a 418-mile-long waterbody, and several million acres is almost impossible, and likely will not aid in the attempt to restore water quality. Page 3 notes that the 'overall size of the Pecos watershed has limited the assessment group's ability to collect specific non-point source pollutant data for the entire watershed.' Working on a scale of a watershed this size doesn't give this project much chance to succeed."

HINDRANCES

- **EPA Approval**
  - Size and scale
  - Difficult to pinpoint area for targeting effective BMPs to improve water quality (DO modeling requires additional flows to achieve goals)
  - Likelihood of short-term improvements is remote
- **Pecos River Compact (particularly for Upper Pecos)**
  - Reservoir releases quantity and timing
  - Problems exacerbated in drought conditions
- **Agriculture**
  - Irrigation diversions
  - Irrigation methods
  - Groundwater pumping
  - Grazing/brush management
- **Oil and Gas Development**
  - Orphaned, abandoned and improperly plugged wells
  - Unknowns regarding future discharges of fluid oil and gas waste (possible opportunity – Texas Produced Water Consortium legislation)
- **Stakeholders**
  - Lack of trust/private land issues
  - Difficult to engage (huge area, lands owned in trusts with multiple owners)
  - Economics of implementing BMPs
  - Size and scale of necessary BMPs
- **Other Factors**
  - Invasive species, specifically saltcedar
  - Natural salt loading particularly between Coyanosa and Girvin
  - Political changes and unknowns

FEASIBILITY

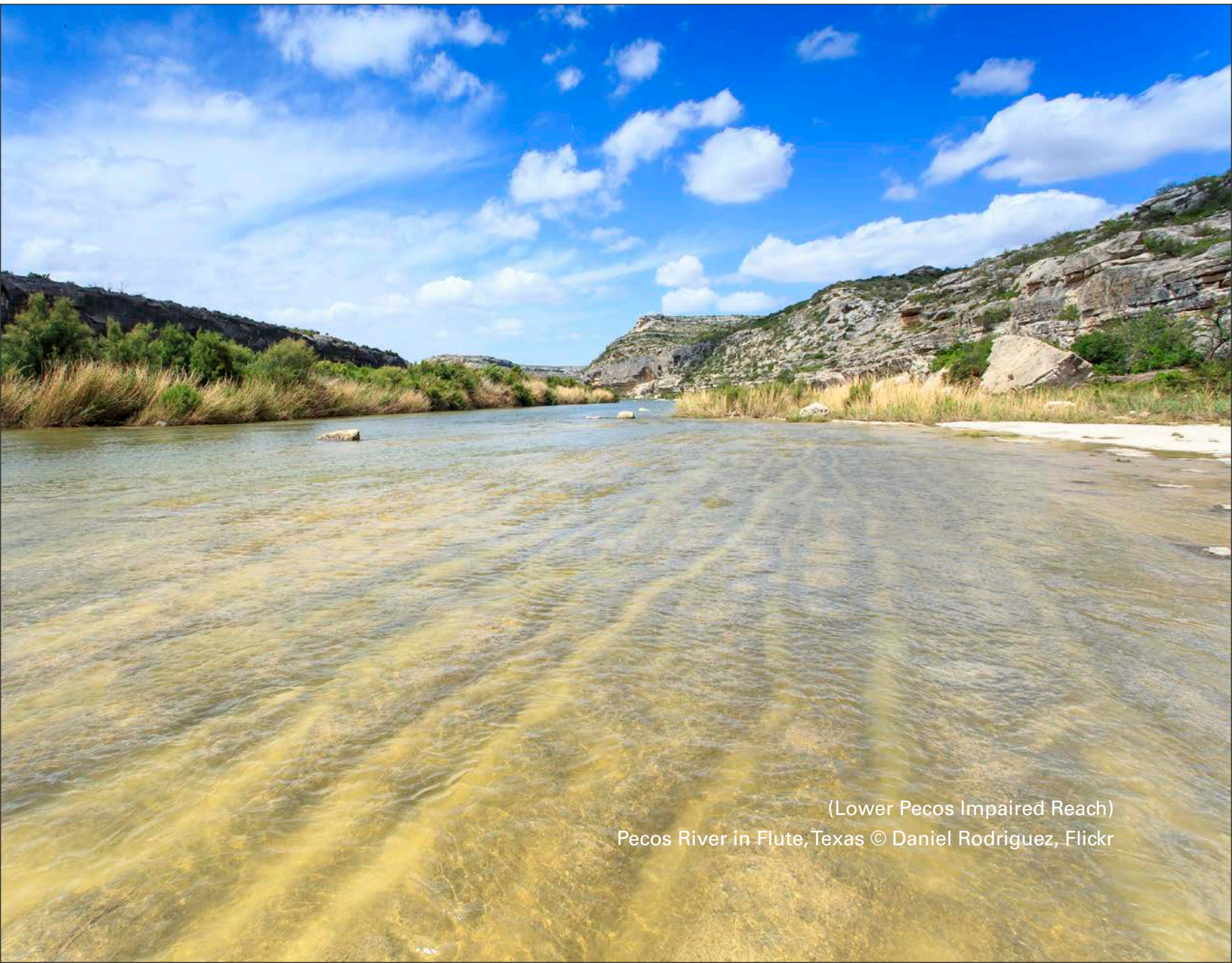
- *Revision of current, full-scale Pecos River WPP* – ***Very Low***
- *Revision of current Pecos River WPP to split between Upper Pecos Segment 2311 and Lower Pecos Segment 2310* – ***Low***

  Focus remains too broad at this scale and limits opportunity for specific management measures in critical subwatersheds.

- *Rangeland management as potential for increasing long range but perhaps measurable water quantity* – ***Low***

  EPA has expressed interest in shorter term projects with more immediate results. Support and funding from USDA, however, is possible.

- *Revision of Pecos River WPP to combine two subwatersheds, the Lower Pecos and Independence Creek subwatershed* – ***Medium to High (see Figure 2)***



(Lower Pecos Impaired Reach)
Pecos River in Flute, Texas © Daniel Rodriguez, Flickr

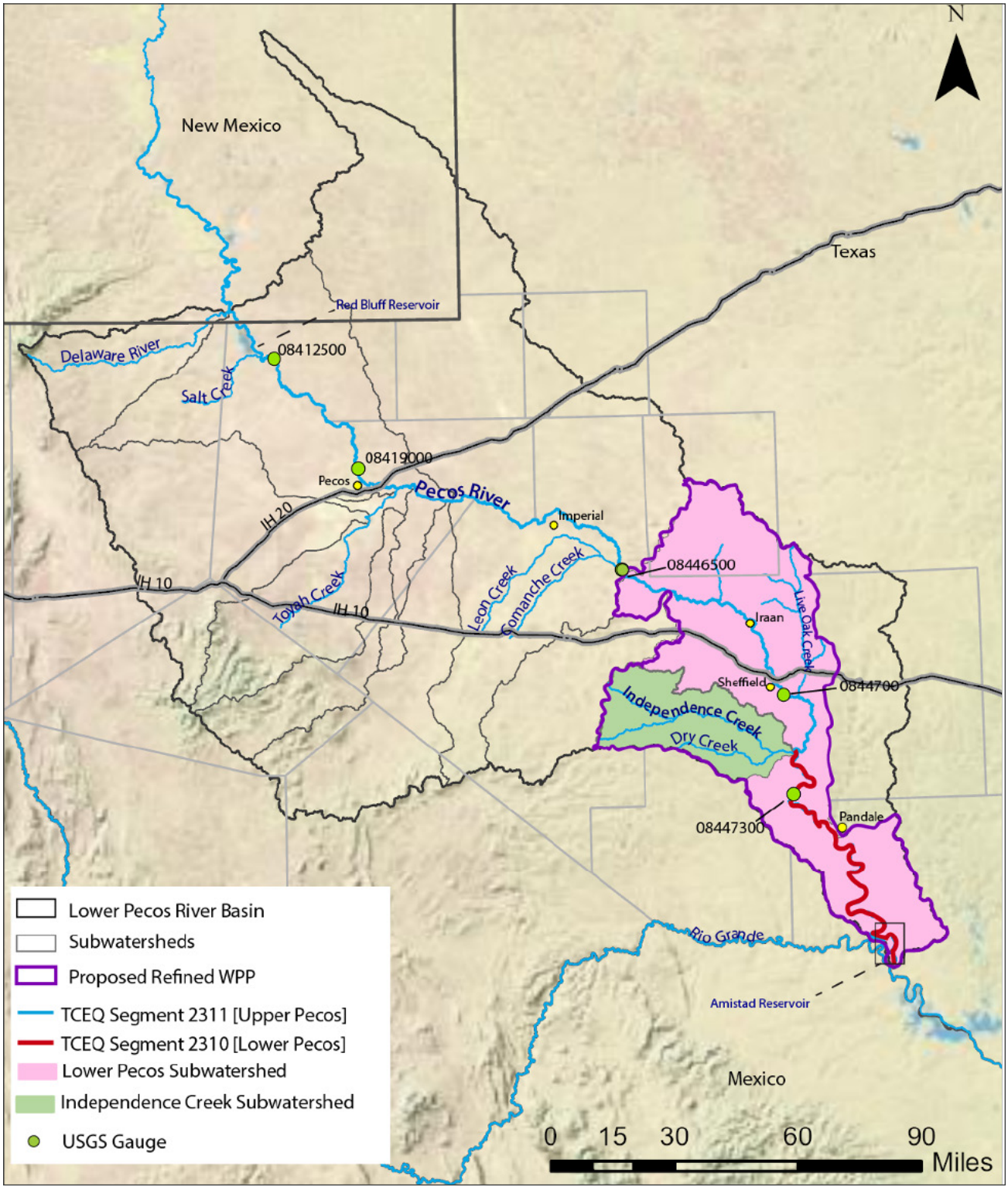


Figure 2. Lower Pecos Subwatershed and Independence Creek Subwatershed recommended for focus of refined Pecos River WPP.

The EPA should see a renewed interest in Pecos River WPP implementation with the Lower Pecos River, TCEQ Segment 2310, once considered a section of the river to be almost pristine, now being listed as impaired for TDS on the 2020 State of Texas 303(d) list of impaired waters. Upstream impacts are clearly influencing this section of the river. With salinity more than doubling in this reach from 2006, it should raise concerns for future salinity levels in Amistad Reservoir, a primary public drinking water source for the region. Texas Parks and Wildlife, other outdoor groups including anglers, wildlife conservationist and paddlers alike should be engaged regarding the new 303(d) listing for TCEQ Segment 2310. Further, with the potential for fluid oil and gas waste to be treated and discharged to the river, downstream impacts will come under increased scrutiny. SB601 to create a Texas Produced Water Consortium was passed by both chambers of the Texas Legislature in the 2021 session and awaits Governor Abbott's signature. The work and findings of this Consortium could have a significant impact on future water management and the long-term health of the Pecos River.

Based on interviews and meetings with Friends of the Pecos, TSSWCB, TWRI and others, the greatest likelihood for effective stakeholder engagement and public support would come from the area spanning from Imperial to Sheffield and in the Independence Creek subwatershed where The Nature Conservancy's work has been well received by local stakeholders. These areas have clear hydrologic connections to the impaired reach and should be engaged. Intensive water quality monitoring activities in this area should be included in the revised scope.

Special Study Area: While the proposed boundary of the revised Pecos River WPP does not extend all the way northwest to Imperial, continued water quality monitoring and stakeholder engagement in the Imperial area to implement best management practices should be captured as a study area of high interest in the scope of any revised WPP. In particular, stream channel and riparian area restoration along the mainstem of the river in the Imperial area to USGS Gauge 08446500 should be given high priority for both baseline water quality investigations and potential for water quality improvements in the most downstream portions of TCEQ Segment 2311 and all of TCEQ Segment 2310 (**See Figure 2**).

Note: While outside of the target area described, research being conducted by The Meadows Center and Texas Water Trade to restore Comanche Springs in Fort Stockton could result in long-term improvements to the overall health of the Pecos River and set a precedent for future restoration efforts. Other work prescribed in the Pecos River WPP for stream segments and uplands outside of the refined WPP focus area should continue to be supported, however, it is not likely that a revised Pecos River WPP would be approved for this area or that it would meet with much success from the standpoint of removing a water quality impairment. Hydrologic restoration in the Upper Pecos from Red Bluff Reservoir to Imperial should be the focus of these efforts.

The following factors should be considered as a rationale for a renewed effort to engage in a revised Pecos River WPP approval for two subwatersheds:

- Narrowed geographic scope – focused on Lower Pecos subwatershed (TDS impairment) and Independence Creek subwatershed (preventative WPP efforts). **See Figure 2.**
    - Note that the "Lower Pecos subwatershed" refers to the 8-digit HUC delineation, which does not correspond entirely with the TCEQ segment 2310.
    - The Lower Pecos subwatershed includes the downstream portion of TCEQ Segment 2311 from just below the Pecos River confluence with Comanche Creek to the Pecos River confluence with Independence Creek and all of TCEQ Segment 2310, Independence Creek to Amistad Reservoir.
- Extensive historic data collected providing clear trends
    - Particularly the new listing for TCEQ Segment 2310 for high levels of TDS – doubling since 2006
- Historic characterization of the Pecos River watershed and approval of original Pecos River WPP eliminates need to start from scratch
    - Characterization completed

- Modeling completed
- BMPs already implemented
- Areas and practices of concern identified
- Stakeholder contacts established
- Education programs implemented

- Potential for renewed interest in research and development of treatment technologies for produced water by the oil and gas industry
  - Research interest by government entities and NGOs
  - Potential funding for research and development (R&D) and other supporting efforts to improve Pecos River WQ in impacted area
  - SB601 – Texas Produced Water Consortium
    - Texas Tech University (Host University)
    - Railroad Commission of Texas
    - State Energy Conservation Office
    - Texas Commission on Environmental Quality
    - Texas Economic Development and Tourism Office
    - Texas Water Development Board
    - Participation from oil and gas industry; water transport/storage companies; agriculture, municipal and other water users
    - Funding for Consortium would come from "sponsorships and funding in exchange for the Consortium's research and development data"
    - Combine state and private resources to "study the economics and technology of the water that is produced and emerges from the ground during oil and gas production" [1]
- Potential partnerships
  - Friends of the Pecos – Potential Watershed Coordinator Entity

1 From https://arctx.org/2021/03/texas-produced-water-consortium-proposed-in-sb601/

Pecos River High Bridge
© Marcus Calderon, Flickr

- Groundwater Conservation District – Particularly Middle Pecos GCD
- Irrigation Districts
- Municipalities along the river
- International Boundary and Water Commission (IBWC) – Interim Commissioner Daniel Avila was recently appointed by President Biden to replace Jayne Hawkins. The U.S. IBWC might play a role in commenting on any proposed water disposal into the Pecos and might be a source for funds to mitigate the salinity in Lake Amistad.
- Riparian landowners
  - Land value
  - Recreation value
  - Habitat restoration
- Agriculture Producers and Industry Representatives as funding partners
  - R&D
  - Public Relations
  - Conservation
- Amistad Groups
- Many NGOs including Audobon Texas (El Paso Trans Pecos Chapter)
- Key to engage oil and gas industry as funding partners
  - R&D
  - Public Relations
  - Preemptive approach to avoid future regulations
  - Plugging wells
- State Agencies and Research Institutions

RECOMMENDATIONS, TIMELINE AND BUDGET

1. Carve out the Lower Pecos subwatershed and Independence Creek subwatershed for a revised WPP approach that also includes a "special study area" along the main channel from Imperial to USGS gauge 08446500
2. Robust grassroots and targeted outreach, education and branding campaigns
3. Focus on activities addressing the TDS impairment in TCEQ Segment 2310
    a. Management measures in lower portion of TCEQ Segment 2311 from Comanche Creek to Independence Creek – should include upland and riparian efforts
    b. Management measures in Independence Creek subwatershed to maintain high quality inflows into the Pecos River and protective of Exceptional ALU designation for Independence Creek
    c. Water quality monitoring efforts in Segment 2310 including biological monitoring
    d. Hydrologic monitoring of river and springs influencing Lower Pecos subwatershed and Independence Creek subwatershed
    e. Invasive species control efforts
4. Special Study Area – Imperial to USGS gauge 08446500
    a. Kickstart potential research project studying alluvial transmission of polluted orphan artesian well water; harness related momentum from local activists, such as Commission Shift, and spotlight in federal infrastructure plan
    b. Strategically placed check dams could be a component (based on findings from Pecos River Water Quality Data Analysis and Dissolved Oxygen Modeling study, TIAER, 2013), however, this approach was not viewed as a feasible or strategic approach for improving water quality in interviews with TSSWCB and TWRI personnel
    c. R&D efforts and impacts of produced water from Oil and Gas – Participation in Texas Produced Water Consortium
5. Identify outside funding sources to leverage federal Clean Water Act Funds
    a. Outside funding less restrictive and requires less administration
    b. Obtaining non-federal matching funds and support is critical to WPP funding and success
    c. Public-private partnerships
    d. Economic drivers for communities and landowners
    e. Raise the public profile of the Lower Pecos and the importance of its restoration and protection from archaeological to environmental; define the Pecos River as the "thread that ties" the work and mystique of West Texas to the story of Texas for ALL TEXANS
    f. Potential funding partners: Dixon Water Foundation, Cynthia and George Mitchell Foundation, Texas Water Trade, Pecos County GCD, Audubon Texas, The Nature Conservancy, National Wildlife Federation, Other recreation-centered businesses like REI, etc.
6. Dedicate a full-time employee of the Meadows Center or another research entity or NGO to lead the effort described below, provide a primary point of contact for partners and ensure continuity for the effort.

Table 1. Implementation Table and Budget

Time Period	Activity	Responsible Party	Estimated Cost
Year 1	Partner Building – Develop relationships with partners and funders including the development of a strategic plan with EPA and TSSWCB. Heavy outreach and education efforts. Public relations blitz. Develop online presence.	The Meadows Center for Water and the Environment full time employee (FTE) in coordination with Friends of the Pecos (joint effort)	$50,000
6 months to Year 2	Submit funding applications and proposals to TSSWCB, private industry, philanthropic groups, individuals for formal WPP revision and implementation funding	The Meadows Center for Water and the Environment FTE (lead) in coordination with Friends of the Pecos	$50,000
Year 2	Develop revised Pecos River WPP – Revised analysis and modeling, stakeholder engagement, coordination with TSSWCB and EPA	The Meadows Center for Water and the Environment FTE & Support Staff (lead) in coordination with Friends of the Pecos	$150,000 (grants and gifts)
Year 3 - 5	Revised Pecos River WPP Implementation and Coordination – BMP construction/implementation, water quality monitoring and analysis,	Friends of the Pecos River (lead) with support from The Meadows Center for Water and the Environment FTE & Consultants	$300,000 to $1,000,000 (grants and gifts)
Years 1-5	Support non-WPP efforts throughout Pecos River watershed – Comanche Springs, Environmental Flows, Oil and Gas BMPs, NRCS Programs, Engage Irrigation Districts, GCDs, State/Fed Agencies, NGOs	The Meadows Center for Water and the Environment FTE	$125,000

CONCLUSION

Timing and funding are the most critical components of an effective and successful WPP. With the additional impairment added to the Lower Pecos, TCEQ Segment 2310, for elevated TDS levels combined with potential challenges and opportunities associated with fluid oil and gas waste in the watershed, it is the determination of this analysis that a revised Pecos River WPP with a narrowed geographic focus to the Lower Pecos and Independence Creek subwatersheds with a special study area from Imperial to USGS gauge 08446500 is feasible with a moderate to high likelihood of approval at the proposed funding levels. Successful EPA approval of a revised WPP will require a strategic and meticulous grassroots effort to engage key stakeholder groups in the first year and to secure funding and implementation commitments. The stakeholder engagement effort must be paired with a high level of communication to key staff at both the TSSWCB and EPA. An approved WPP is required to seek implementation support through CWA Sec. 319(h) funding. This form of federal funding, in turn, requires that 40 percent of the effort be covered by "local match" which may be a combination of cash and in-kind services.

CWA Sec. 319(h) funds could be sought to revise the Pecos River WPP once sufficient groundwork has been completed, likely during the 2022 request for proposals; however, early work would require other funding sources. Implementation funds would likely be requested through this program the following year.

It should be noted that CWA Sec. 319(h) program funds require a high level of administration, oversight and technical capabilities. This can be overwhelming for some NGOs and municipalities. That said, smaller entities have done it before and been successful. The Meadows Center for Water and the Environment is experienced in CWA Sec. 319(h) partnerships, WPP development and WPP implementation and can provide guidance, assistance or lead agency capabilities throughout the process.

An alternative to the revised WPP approach would be to develop a supplement to the Pecos River WPP with specific recommendations based on the existing science and conditions on the ground to achieve the goals of Friends of the Pecos that may not align directly with CWA Sec. 319(h) goals. There are many other government funding programs and philanthropic avenues through which successful restoration and protection activities for the Pecos River could be achieved. While a specific funding approach outside of CWA Sec. 319(h) for Friends of the Pecos cannot be provided without further consultation, other programs and funding mechanisms often provide more freedom to the recipient to conduct activities outside of rigorous deliverable schedules and quality assurance requirements.

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APPENDIX I: EXCERPT FROM PECOS RIVER WPP – IMPLEMENTATION MILESTONES

Implementation Milestones

Adaptive management is a process in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices (USGS, 2000).

The WPP has set interim goals as a means to track progress and ensure that the plan is being implemented in a timely fashion. These goals are divided into short-term, mid-term and long-term goals that will build upon each other to eventually accomplish the overall goals of the WPP. These milestones are set forth as a target to reach during a certain period. If these targets are not reached, the reasoning behind not reaching these targets should be determined. If it is merely delayed implementation, no action is needed; however, if the implemented management measures are not having the anticipated impact then adaptations to the management scheme must be undertaken. It is assumed that year one translates into the 2010 calendar year, 2011 will be year two and so on. Some flexibility will be required in meeting these milestones due to differences in calendar years, fiscal years, funding cycles, and other unforeseen delays such as weather conditions. Nonetheless, efforts will be made to implement these milestones on schedule if possible.

Short-term Milestones (1 to 3 years)

Salinity Control

- Begin additional studies between Coyanosa and Girvin to identify specific salinity sources in this reach of the river
- Begin implementing salinity management measures at Malaga Bend
- Begin work with the PRCC, Red Bluff PWCD, and New Mexico to modify the water delivery schedule between states so that water is stored longer in deeper upstream reservoirs

Saltcedar and Giant Cane Control

- Begin spraying the remaining treatable acres (2,158) of previously untreated saltcedar and giant cane infestations along the main channel and tributaries of the river with landowner permission. A target of 1,775 acres has been set for the first 3 years
- Establish and release saltcedar leaf beetles at 10 initial sites across the watershed where landowner permission has been granted
- Work with area landowners to establish additional saltcedar leaf beetle colonies
- Begin burning standing dead saltcedar with landowner permission. Approximately 225 river miles are expected to be burned in the first 3 years of implementation

Biological Diversity / Livestock Management in Riparian Zone

- Work with landowners to further educate them about the benefits of establishing grazing management plans and/or WQMPs on their land

- Work with landowners along riparian areas to implement management practices that reduce the amount of time livestock and wildlife spend in or near waterways; many of these measures will be included in a WQMP
- Begin burning dead saltcedar (See Saltcedar and Giant Cane Control)
- Establish a voluntary riparian revegetation program that focuses on areas where debris from spraying efforts was burned

Dissolved Oxygen Management

- Work with area universities to conduct river assessment to determine feasible locations for constructing artificial riffles

Sediment Control

- Establish a voluntary riparian revegetation program that focuses on areas where debris from spraying efforts was burned
- Begin burning dead saltcedar (See Saltcedar and Giant Cane Control)

Oil and Gas Production

- Work with RRC and area landowners to identify and plug leaking or abandoned wells

Nutrient Management

- Work with landowners to develop cropland WQMPs specific to their property
- Conduct nutrient management workshops (See *Education and Outreach*)

Water Quantity Management

- Work with Red Bluff WPCD management to attempt to create a reservoir release schedule that maintains a constant flow regime
- Work with Red Bluff WPCD, PRCC, and New Mexico to store water delivered to Texas in upstream reservoirs longer to reduce evaporation losses
- Work with local irrigation districts to conduct water audits on their canal systems

Monitoring Program

- Work to set up partnerships and secure funding sources for the implementation of new continuous water quality monitoring (CWQM) stations along the river, and establish the first site at Girvin
- Maintain at least the current level of surface water quality monitoring being conducted through CRP

Education and Outreach

- Establish steering committees and/or watershed councils for the upper and lower Pecos River watershed to guide the implementation process
- Conduct workshops or field days to educate landowners and managers, watershed citizens, government officials, and others about management techniques that will improve watershed health and water quality (Texas Watershed Stewards, Lone Star Healthy Streams, Nutrient Management, etc.)

- Continually update the project Web site to include meeting/event notices and the most recent materials project materials
- Include project updates in various newsletters across the watershed
- Conduct semiannual educational meetings to inform participants about implementation activities, goals achieved, upcoming milestones, and improvements made in watershed quality and to receive feedback from attendees
- Train local government personnel, landowners, and land managers on the proper methods and timing of spot spraying saltcedar and/or giant cane regrowth

Mid-term Milestones (4 to 6 years)

Salinity Control

- Continue implementing salinity management measures at Malaga Bend
- Continue to work with the PRCC, Red Bluff PWCD, and New Mexico to modify the water delivery schedule between states so that water is stored longer in deeper upstream reservoirs
- Begin salinity management feasibility studies between Coyanosa and Girvin based on completed salinity source assessment conducted in the same area
- Evaluate defoliation progress at and around saltcedar leaf beetle release sites and release beetles at new sites as needed

Saltcedar and Giant Cane Control

- Complete spraying of all remaining targeted areas (about 383 acres) of saltcedar infestation where landowners have given permission to do so
- Complete burning of standing dead saltcedar to remove debris and suppress regrowth where permitted by landowners
- Implement 10 additional saltcedar leaf beetle sites along the river and track their dispersion
- Continue to work with area landowners to establish additional saltcedar leaf beetle colonies
- Establish and implement a saltcedar, giant cane and restored vegetation monitoring and treatment program
- Work with area landowners to conduct localized treatment of saltcedar and giant cane regrowth when discovered

Biological Diversity / Livestock Management in Riparian Zone / Upland Brush Control

- Continue voluntary riparian revegetation efforts
- Continue to work with landowners to further educate them about the benefits of establishing grazing management plans and/or WQMPs on their land
- Continue to work with landowners along riparian areas to implement WQMP
- Continue burning standing dead saltcedar (See *Saltcedar and Giant Cane Control*)
- Implement a riparian revegetation monitoring program (See *Saltcedar and Giant Cane Control*)

Dissolved Oxygen Management

- Install two artificial riffles per year until feasible sites all have artificial riffles in place, after completing the river assessment

Sediment Control

- Continue voluntary riparian revegetation efforts

Oil and Gas Production

- Continue to work with RRC and area landowners to identify and plug leaking or abandoned wells

Nutrient Management

- Continue to work with landowners to develop cropland WQMPs specific to their property
- Conduct nutrient management workshops (See *Education and Outreach*)

Water Quantity Management

- Continue working with Red Bluff WPCD management to attempt to create a reservoir release schedule that maintains a constant flow regime
- Continue working with Red Bluff WPCD, PRCC, and New Mexico to store water delivered to Texas in upstream reservoirs longer to reduce evaporation losses
- Continue to work with local irrigation districts to conduct water audits on their canal systems
- Work with irrigation districts and landowners to implement more efficient irrigation systems

Monitoring Program

- Implement a real-time water quality monitoring station above Red Bluff Reservoir
- Establish and implement a saltcedar, giant cane, and restored vegetation monitoring and treatment program

Education and Outreach

- Continue to educate landowners about the benefits of establishing and implementing grazing management and/or WQMPs.
- Conduct several field tours on properties that have implemented practices recommended by these plans so producers can see their benefits first hand
- Establish a monitoring network of technical professionals and landowners to assess the effectiveness and integrity of artificial riffles after high flow events
- Conduct semiannual educational meetings to inform participants about implementation activities, goals achieved, upcoming milestones, and improvements made in watershed quality and to receive feedback from attendees
- Include project updates in various newsletters across the watershed
- Conduct workshops or field days to educate landowners and managers, watershed citizens, government officials, and others about new management techniques that will improve watershed health and water quality

- Continually update the project Web site to include meeting/event notices and the most recent project materials

Long-term Milestones (7 to 10+ years)

Salinity Control

- Begin implementing salinity management practices in the Coyanosa to Girvin reach of the river based on the findings of the salinity management feasibility study conducted in that area
- Continue implementing salinity management measures at Malaga Bend

Saltcedar and Giant Cane Control

- Continue to evaluate the progress of saltcedar leaf beetle dispersed from initial release sites and redistribute beetles to new sites in the watershed
- Continue to educate persons interested in learning how to treat localized areas of saltcedar regrowth and promote the utility of this practice
- Continue to work with area landowners to establish additional saltcedar leaf beetle colonies

Biological Diversity / Livestock Management in Riparian Zone / Upland Brush Control

- Begin work to develop a fish repopulation program
- Continue to develop and implement the fish repopulation program after aquatic and riparian habitat have been re-established, water quality improvement measures have been put in place, and sufficient water quality improvement have been realized

Dissolved Oxygen Management

- Continue to install artificial riffles if needed and continue the riffle monitoring program

Sediment Control

- Continue voluntary riparian revegetation efforts

Oil and Gas Production

- Continue to work with RRC and area landowners to identify and plug leaking or abandoned wells

Nutrient Management

- Continue to work with landowners to develop cropland WQMPs specific to their property
- Conduct nutrient management workshops (See *Education and Outreach*)

Water Quantity Management

- Continue to work with local irrigation districts to conduct water audits on their canal systems
- Continue to work with irrigation districts and landowners to implement more efficient irrigation systems

Monitoring Program

- Continue the saltcedar, giant cane, and restored vegetation monitoring and treatment program
- Implement two real-time water quality monitoring stations, one at Orla and one upstream of the US 90 bridge
- Conduct an aquatic life and habitat survey to document the changes, if any, since the WPP implementation began

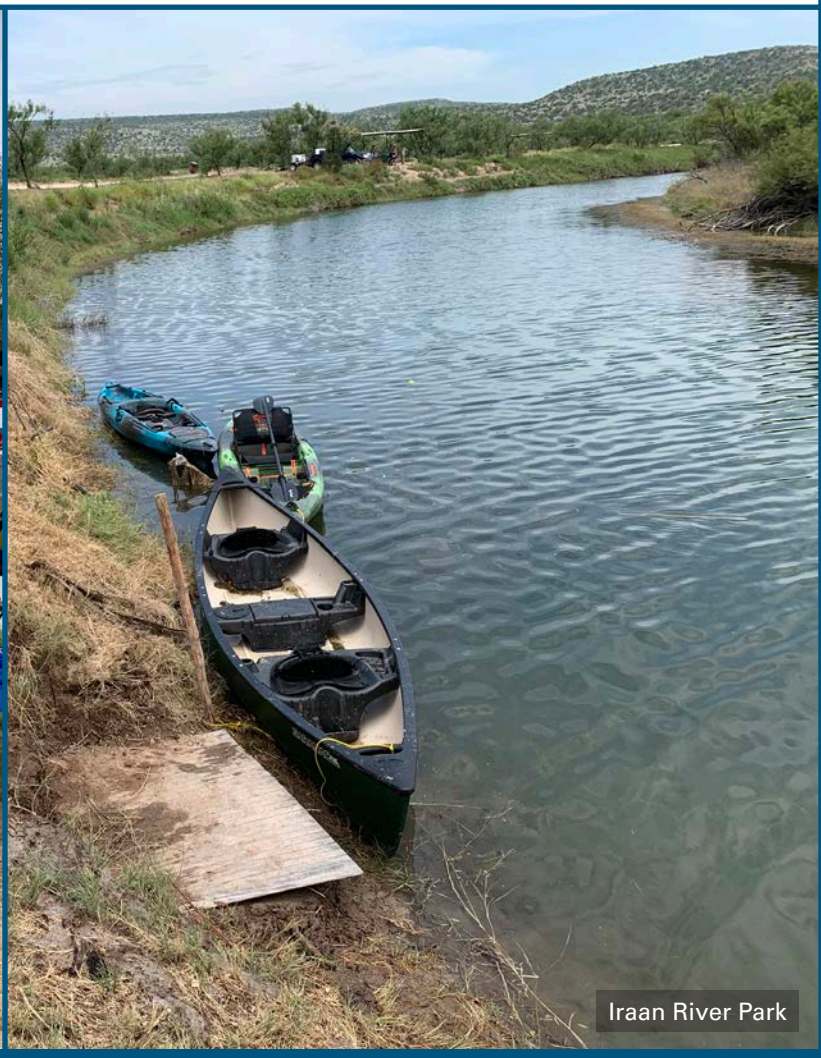
Education and Outreach

- Continue to educate landowners about grazing management and WQMPs. Host more field tours of properties that have implemented these plans
- Conduct semiannual educational meetings to inform participants about implementation activities, goals achieved, upcoming milestones, and improvements made in watershed quality and to receive feedback from attendees
- Include project updates in various newsletters across the watershed
- Conduct workshops or field days to educate landowners and managers, watershed citizens, government officials, and others about new management techniques that will improve watershed health and water quality
- Continually update the project Web site to include meeting/event notices and the most recent materials project materials

The Meadows Center
for Water and the Environment

TEXAS STATE UNIVERSITY

Iraan River Park (Friends of the Pecos River)


Iraan River Park

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