Pecos River
Watershed Protection Plan Update

October 2013

Funding Provided by the Texas State Soil and Water Conservation Board through a Clean Water Act §319(h) Nonpoint Source Grant from the U.S Environmental Protection Agency

TR-447

Pecos River WPP Update

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Texas Water Resources Institute TR-447

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List of Acronyms

ARS	Agriculture Research Service
BBEST	Basin and Bay Expert Science Team
BMP	best management practice
CEHMM	Center of Excellence for Hazardous Materials Management
CMM	Coordinated Monitoring Meeting
CRP	Texas Clean Rivers Program
CWQMN	continuous water quality monitoring network
CWA	Federal Clean Water Act
DO	dissolved oxygen
EM	electromagnetic
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
IBI	Index of Biotic Integrity
LDC	load duration curve
NPS	nonpoint source
NRCS	USDA Natural Resources Conservation Service
PRCC	Pecos River Compact Commission
RRC	Railroad Commission of Texas
SWCD	Soil and Water Conservation District
SWQM	surface water quality monitoring
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TIAER	Texas Institute for Applied Environmental Research
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USIBWC	International Boundary and Water Commission, United States Section
WPCD	Water Power Control District
WPP	watershed protection plan
WQMP	water quality management plan

Overview

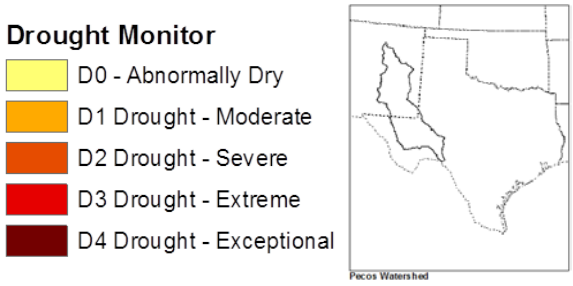
Implementation of the Pecos River Watershed Protection Plan (WPP) began in November 2009. The primary goals of implementing the plan are to improve the health of the Pecos River watershed and instream water quality in the river and its tributaries. Considerable implementation progress has been made across the watershed; however, the need for continued implementation remains.

The Pecos River WPP Update is a document that is developed and approved to be published. This report will contain updates on tracking the progress of implementation, saltcedar eradication efforts, education and outreach activities, and water quality monitoring in the watershed. This report will document and provide updates and any issues or adaptive management decisions on all of the measures within the WPP and any modifications to the goals and strategies identified in the WPP.

Drought

Drought and the Pecos River watershed are practically synonymous terms, which is not surprising since the river flows through the Chihuahuan Desert. Since WPP implementation began, two drought episodes have gripped the watershed. The first episode began in December 2008 when the bulk of the watershed was considered to be under normal moisture conditions. By May 2009, this episode peaked with almost the entire watershed experiencing abnormally dry, moderate or severe drought conditions. Only the lower portion of the watershed downstream from Coyanosa was not in a drought condition. At this point moisture returned to the watershed and in May 2010 the entire watershed was considered to be under normal moisture conditions.

The arrival of fall in 2010 brought with it dry weather conditions and the watershed rapidly dried out. By December 2010, the entire watershed in Texas was abnormally dry or worse. By April 2011, the same area was all under extreme drought conditions and by mid-May this had worsened to exceptional drought; the worst form of drought. Conditions in New Mexico were much the same during these periods thus intensifying the impacts of the drought and further reducing flows to the river. These conditions lasted for an entire year before portions of the watershed in Texas began to receive rains again in September 2012. As of April 2013, Texas is seeing abnormally dry to severe drought conditions across the watershed; however, New Mexico has not fared as well and continues to be gripped by extreme and exceptional drought. Figure 1 on the following pages illustrates the coverage of drought conditions over the watershed since WPP implementation began.



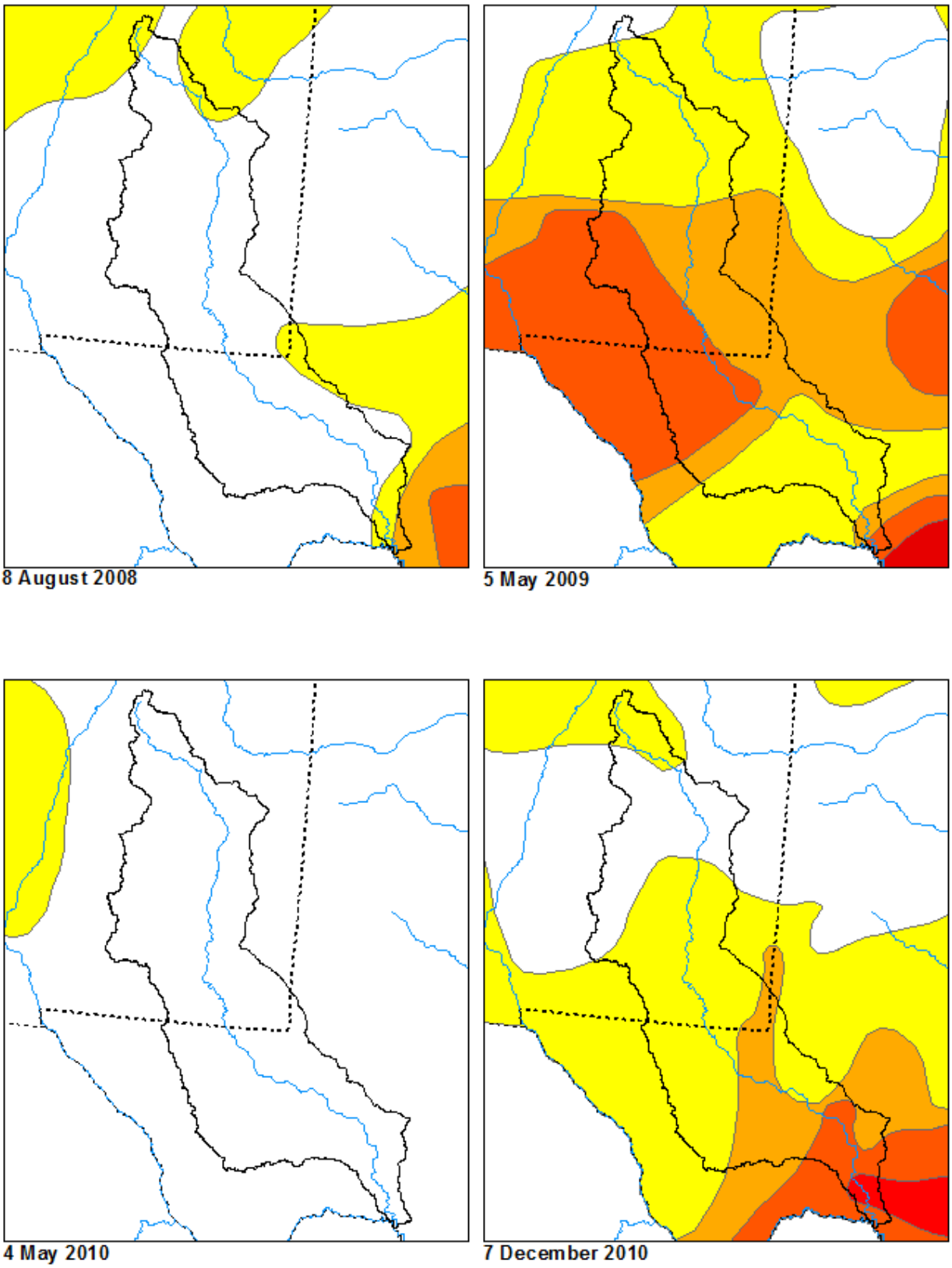
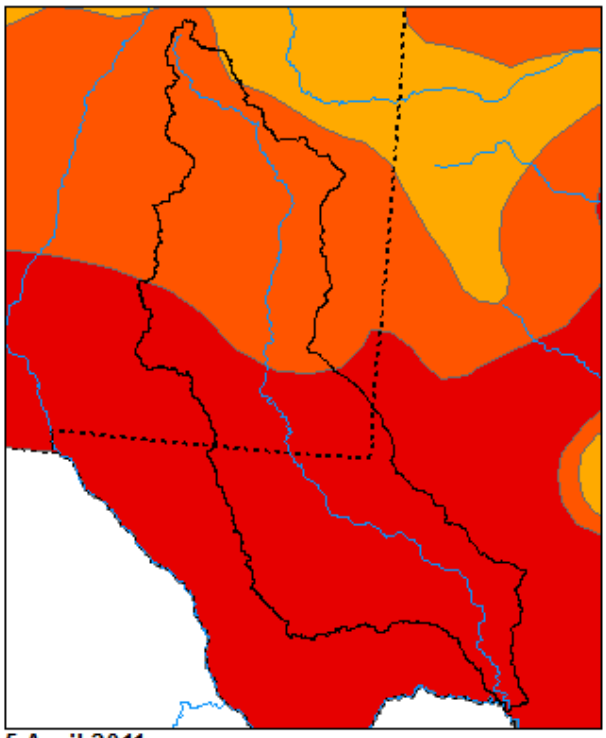


Figure 1. Progression of drought across the Pecos River watershed since WPP implementation began in 2008



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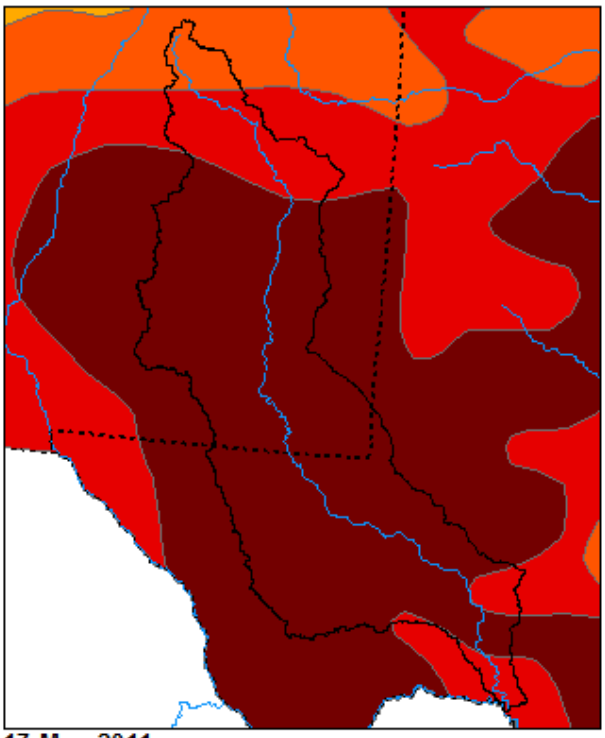

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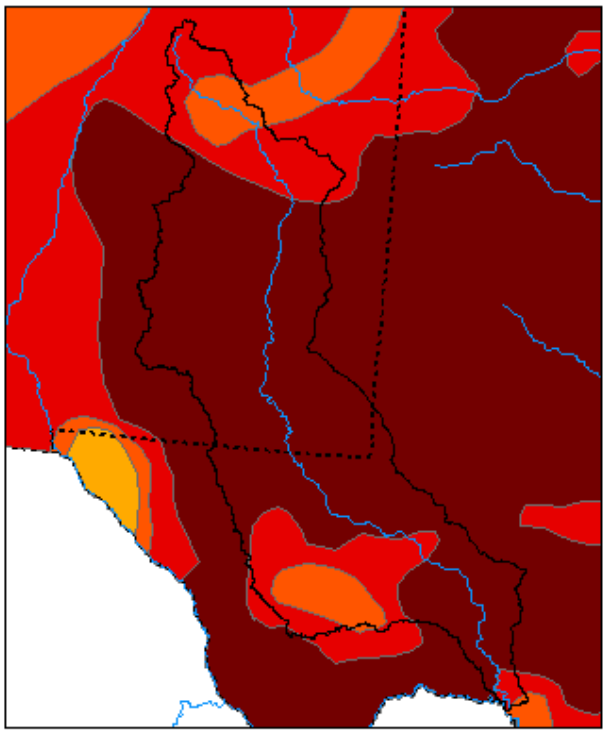

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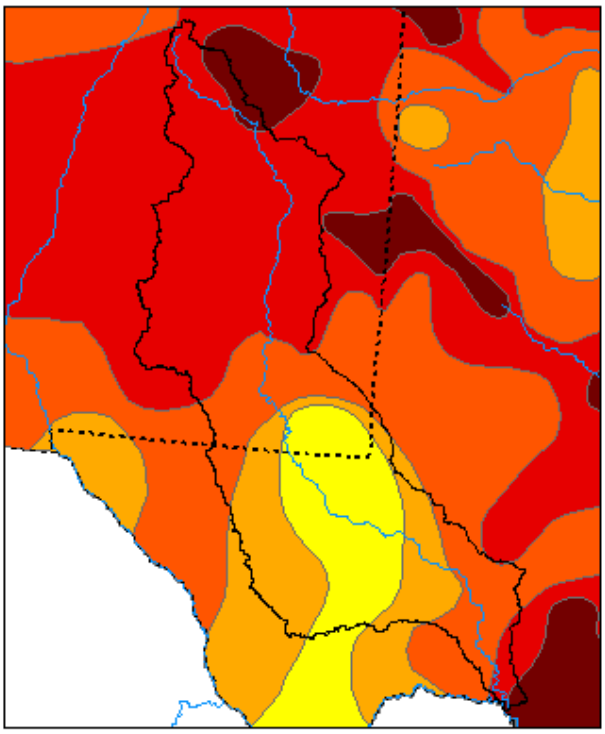

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Reservoir Releases

Under the Pecos River Compact, which was 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 leading up to this most recent drought, the state of New Mexico had built up a credit on water delivered to Texas by delivering more than 43 percent of the river's waters to Texas. As of December 2012, New Mexico's credit stands at 102,000 acre-feet. 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. Despite recent drought conditions, New Mexico has continued to build water delivery credits. Diminished flows into Texas paired with our own sub-par rainfall conditions have caused irrigation water deliveries from Red Bluff Reservoir to downstream irrigators to be suspended for several years.

Salinity Control

Salt levels in the Pecos River and throughout the watershed continue to be a primary concern for landowners across the watershed. Drought conditions experienced since 2008 have not helped salinity conditions in the watershed as much lower than normal levels of fresh rainwater and snowmelt have entered the watershed. Despite adverse conditions, the need to reduce salinity levels in the river persists as the water quality needs of aquatic life, agricultural producers and other users of the river's water are not able to tolerate excessively salty waters.

Salinity Management

With the primary sources of salt influencing water quality in Texas being the upwelling of hyper saline water at Malaga Bend, NM and the intrusion of saline waters between Coyanosa and Girvin, TX, implementation efforts have primarily focused on these two areas; however, other actions have occurred regarding salinity management across the watershed.

Malaga Bend Control Measures

Taking knowledge gained during the Malaga Bend Salinity Alleviation Project which began in 1963 and was a cooperative effort of the U.S. Geological Survey (USGS), the New Mexico Interstate Stream Commission and Red Bluff Water Power Control District (WPCD), a private firm is now conducting a similar operation.

Southwest Salt Company, LLC from Paola, Kansas, a private salt mining company, has acquired the USGS well and land near the well and is in the process of constructing and operating a salt harvesting facility. When completed, the brine evaporation system will consist of four 20-acre holding ponds located 3 miles north of the well, a fiberglass distribution tank and approximately 3 miles of pipeline that connects the pump, distribution tank and holding ponds. As of April 15, 2013, three of the ponds were completed and have been lined with a synthetic liner to prevent seepage and leakage as this was a major problem in early projects.

This facility pumps brine that typically has a chloride concentration of about 330,000 mg/L (sea water is about 35,000 mg/L) from the well and into a distribution tank and thence to the evaporation ponds where the salt is allowed to settle and the water evaporates off leaving the salt to be harvested. Approximately 1 foot of salt will be maintained in the bottom of the ponds to protect the liners from harvesting equipment. Periodically the brine will be drained and the salt will be harvested. It is expected that the process will produce approximately 12 inches of precipitated harvestable salt annually. This has the potential to produce 3,484,800 cubic feet of harvestable salt per year when all four ponds are operational.

Currently, Southwest Salt is authorized to pump up to 400 gallons per minute (576,000 gallons per day or 645 acre-feet of water per year) under their discharge permit from the New Mexico Environment Department. This permit also requires Southwest Salt to inspect the operation daily to ensure that no leaks are occurring and that adequate storage capacity is maintained in the evaporation ponds. Southwest Salt will also be required to monitor groundwater levels down-gradient of the well at two locations quarterly, record the monthly volume of brine pumped and test brine quality on an annual basis and evaluate its pH, temperature, specific conductance, calcium, magnesium, sodium, potassium, sulfate, chloride, and total dissolved solids content annually. Additionally, Southwest Salt has agreed to work with the Center of Excellence for Hazardous Materials Management (CEHMM) to collect instream water quality samples twice per month both upstream and downstream of the brine pumping location.

As of January 8, 2013, Southwest Salt began pumping brine into the first two completed holding tanks and a third pond came online in late March. The last pond should be completed in 2013. Subsequent to the start of pumping, water quality sampling was initiated by CEHMM on January 9, 2013. As of April 1, 2013, 9 sampling events have been completed with no changes in water quality being apparent yet. As pumping continues, it is anticipated that reductions in salt loading will be realized.

Coyanosa to Girvin Salt Source Study

To address the need for additional data collection regarding the sources of salt entering the Pecos River in the Coyanosa to Girvin reach of the river (Figure 2), the Texas Water Resources Institute (TWRI) and Texas A&M AgriLife Research personnel from the El Paso AgriLife Research and Extension Center developed a project proposal and received funding to conduct an assessment of that reach of the river to identify salinity sources and understand the mechanisms of solute transport. Funding for this work was provided by the Texas State Soil and Water Conservation Board (TSSWCB) with Clean Water Act (CWA) Section 319(h) grant funding from the U.S. Environmental Protection Agency (EPA).

A heliborne electromagnetic unit

This project began in November 2012 and will employ a data collection and assessment approach that combines a ground-based hydrogeological data assessment and heliborne

electromagnetic (EM) geophysical survey data. Using this approach, the electrical resistivity of the subsurface soil layers and water they contain along the course of the river between Coyanosa and Girvin will be obtained and interpreted. Data collected will provide a detailed assessment of electrical resistivity, which can be translated into salinity when paired with known lithological data. Previously existing lithology will be used to the extent possible to identify saline hot spots; however, it is likely that new borehole lithology will be needed to verify salinity hotspots. Additional funds will be needed to collect this additional lithological data.

The results of this work will aid in identifying salt sources that influence salt loads and salinity levels in this portion of the Pecos River by providing a high-resolution, 3-D visualization of the electrical resistivity of the soil and water profile from the surface to depths up to 200 m thus providing exceptional detail of the area's hydrogeology. Combining this rapid assessment method with ground based hydrogeological assessments will verify the results and provide a timely and cost effective hydrogeological assessment of the evaluated river reaches. This project will focus on conducting a "desktop" hydrogeological assessment of subsurface flow conditions utilizing only existing data and assessment of collected EM data.

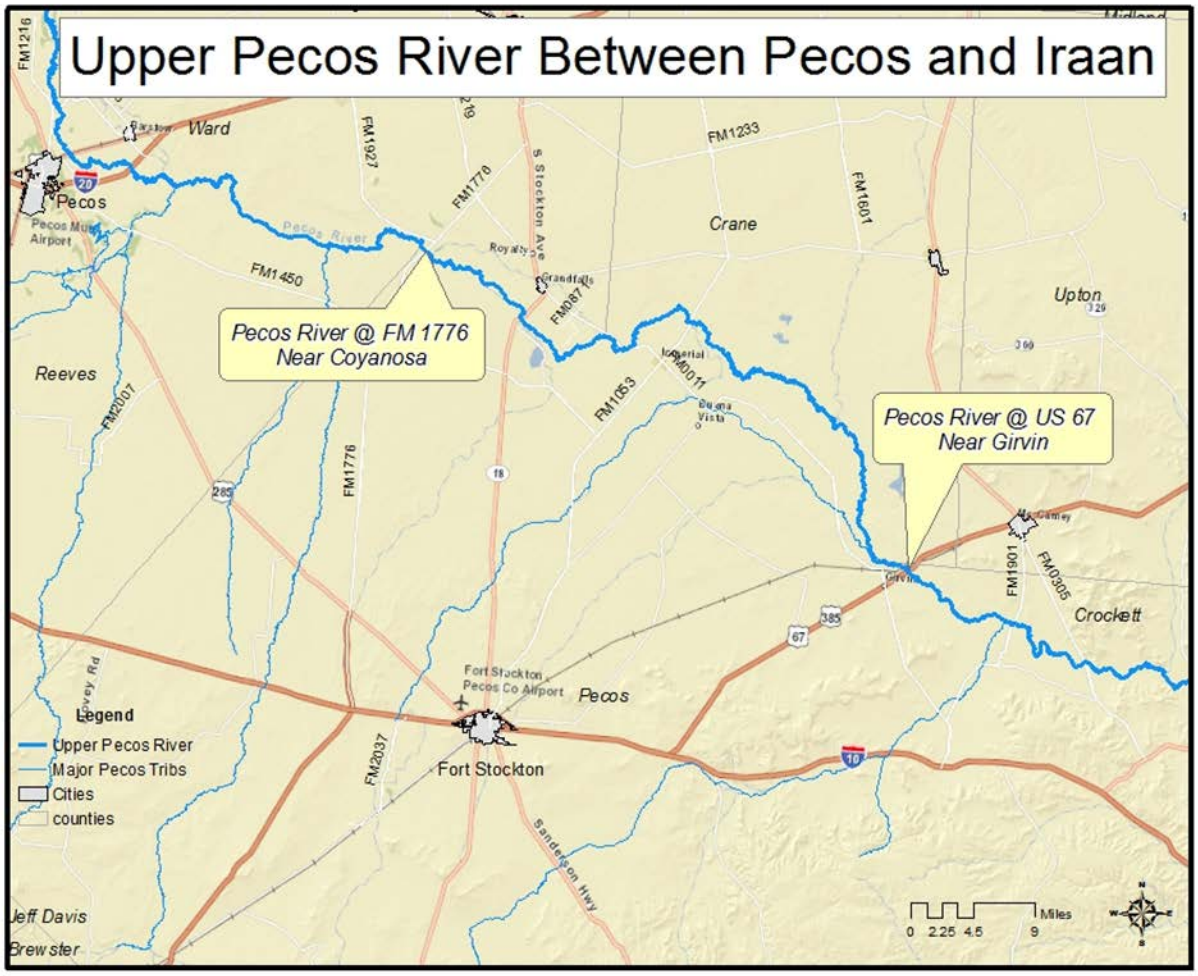


Figure 2. Coyanosa to Girvin stretch of the Pecos River where HEM data will be collected

New Mexico to Texas Water Delivery Scheduling

Any changes to the scheduling of water deliveries to Texas from New Mexico to reduce potential seepage and evaporation losses are unlikely to occur anytime soon. With the drought gripping the area and water resources strained, any water deliveries at any time are appreciated. Additionally, New Mexico must also release at critical periods to support implementation of the Pecos Bluntnose Shiner Recovery Plan.

Salinity Management Feasibility Study

Prior to evaluating the feasibility of salinity management options in the Coyanosa to Girvin area of Texas, more work to evaluate the source and location of salts entering the river in this reach is needed. The Coyanosa to Girvin Salt Source Study discussed in the previous section will fill this need. Upon its completion, an effort to evaluate management feasibility can be initiated.

Pecos River Watershed Assessment

At the request of the Pecos River Compact Commission, the U.S. Army Corps of Engineers (USACE) has initiated an effort to assess the Pecos River and evaluate the feasibility of an integrated management approach to better control salinity sources in the Pecos River watershed. This effort is being carried out under the Water Resources Development Act of 1986 and consists of two parts. The first step was to conduct an "Initial Watershed Assessment" of the river to determine if a Federal interest exists in conducting a more comprehensive "Watershed Assessment." In short, this report concluded that there is a strong Federal interest in conducting a "Watershed Assessment" and that the primary areas of concern across the basin include water quality, water quantity, loss of riparian and aquatic habitat and species, the lack of a comprehensive long-range management plan for the entire river, lack of coordination among federal, state, local and non-governmental agencies as well as the lack of funding to address these concerns. This report was competed in April 2012.

The Watershed Assessment is the second phase in the USACE approach to addressing watershed management concerns. The USACE is currently working with the Texas Water Development Board (TWDB) and Texas Commission on Environmental Quality (TCEQ) to initiate the Watershed Assessment. The goals of this effort are to work collaboratively with watershed stakeholders to help solve water resource problems in an integrated and sustainable manner, use a systems approach to understand the connection between natural and man-made systems, analyze water resource problems at the basin scale, and to strive to achieve multiple goals and functions using water and related resources in a balanced manner. Through this effort, the USACE expects to develop conceptual level recommendations for system wide water resources management.

Additional funding will be required to explore the feasibility of these conceptual project ideas.

Saltcedar and Giant Cane Control

The infestation of invasive species in riparian areas and to a lesser extent upland areas of the watershed continues to be a major watershed health concern throughout the Pecos River watershed. With the harsh environment that is the Pecos River watershed, invasive species such as saltcedar and giant cane often have a competitive advantage over native and other more desirable plant species. As a result, suppression efforts are needed to help minimize the competition gap between invasives and natives. Realistically, management and maintenance of the invasive species issues present in the watershed is the best goal to set as complete eradication is practically impossible. Utilizing an integrated pest management approach that employs multiple management tools provides the highest likelihood for success and is the approach currently being applied across the watershed.

Chemical Saltcedar Control

Saltcedar has been treated in the watershed using aerially applied herbicide periodically since 1999 and has proven to be a highly effective method for treating large areas of saltcedar quickly and with a high success rate. Utilizing CWA §319(h) grant funds, the TSSWCB with assistance from the Crockett and Upper Pecos Soil and Water Conservation Districts (SWCD)s continued the application of aerial herbicide treatments to tackle saltcedar infestations at no cost to the landowner.

The WPP identified 2,158 acres of saltcedar on the main stem of the Pecos River that had not been treated and was accessible by helicopter. Technicians from the Crockett and Upper Pecos SWCDs worked with landowners on the river to acquire permission to treat saltcedar through this program. During the sign up process, it was discovered that the majority of properties that had not been treated on the river were held by property owners that did not wish to treat saltcedar along their portion of the river. Much more interest was found to treat regrowth in areas where saltcedar had been previously treated. As a result, tributaries to the main stem of the river that had not been previously treated were enrolled in the program.

Aerial chemical application conducted in September 2011. A total of 2,642 acres of saltcedar were treated through the WPP Implementation Project.

In September 2011, spraying commenced and within a matter of weeks, a total of 2,642 acres of saltcedar were treated chemically. While this approach did not necessarily achieve the initial goal of treating saltcedar along the main stem of the river, critical upstream seed sources were addressed through this effort. Additionally, significant costs savings were realized through the use of a generic chemical and lower than expected fuel costs. As a result, 867 more acres than were initially planned to be treated were actually covered.

Despite its costs, aerial herbicide treatments remain an extremely valuable tool for treating large amounts of saltcedar quickly and effectively. The continued enrollment of landowners to have their saltcedar

treated signifies the remaining interest in fighting this invasive species and the continued need to support this type of control measure. As of June 1, 2013, approximately 1,600 acres of saltcedar have been signed up to be sprayed should funding become available. Future aerial chemical saltcedar control efforts should focus on any and all areas, riparian and upland, where saltcedar has formed vegetative monocultures.

Biological Saltcedar Control

To control saltcedar in areas that could not be aerially sprayed, areas along tributaries or in pockets not directly adjacent to the water body, biological control measures have been the primary treatment method and have produced excellent results. This approach has used the saltcedar leaf beetle (*Diorhabda* spp.) to repeatedly feed on the plant's leaves and eventually lead to the demise of its host through continued defoliation.

Saltcedar leaf beetles have been utilized extensively across the watershed to manage saltcedar stands and improve the biodiversity of the watershed by diminishing the competitive advantage that saltcedar has over other, more desirable, plant species. Since their initial release in the watershed in 2006, saltcedar leaf beetle populations have expanded widely and defoliated many acres of saltcedar. The use of beetles has not been flawless. Lessons have been learned along the way and now the beetles' potential to mitigate saltcedar on a long-term basis is stronger than ever.

Two species of saltcedar leaf beetles have been released on the Pecos River in Texas. The species of beetle from the island of Crete, *Diorhabda elongata*, was first released on the Pecos River in 2006 at three locations and established at one site in Reeves County. This population quickly increased and by 2010 had defoliated all of the saltcedar along 11 miles of the Pecos River. A second population of Crete beetles was established in 2010; however, following the extreme cold experienced in early February, 2011, the Crete populations could not be detected in 2011 and were presumed extinct.

Defoliated saltcedar in Leon Lake near Ft. Stockton in September 2011

Following this mass die-off, the Tunisian beetle (*Diorhabda sublineata*), which was considered better adapted to the Pecos River watershed than the Crete beetle based on climate models, was released at three locations in the watershed near Leon Springs, Imperial and Iraan by project personnel as well as in Big Bend National Park by the U.S. Department of Agriculture (USDA) – Agricultural Research Service (ARS). The Tunisian beetle was also released by USDA-ARS near Presidio and quickly increased and defoliated large areas of saltcedar along the Rio Grande River. Table 1 illustrates where beetles were released and an estimated number of beetles released in each event.

During 2012, the Tunisian beetles continued to expand their range on the Pecos River as well as at Toyah Creek, Balmorhea Reservoir and Leon Springs. By the end of the 2012 growing season, all visible saltcedar at the release sites was defoliated in addition to saltcedar near Mentone. Adult beetles and larvae were found on all examined saltcedar along the Pecos River near Orla but no defoliation was observed. Adult and larval Tunisian beetles were found at Red Bluff Reservoir and 80 percent of the saltcedar trees were defoliated at this site. In 2012, a total of 116,000 Tunisian beetles were collected at Balmorhea Reservoir and along Toyah creek near Balmorhea and released to establish populations at 2 new sites, and to supplement existing sites on the Pecos River. At the close of 2012, Tunisian leaf beetle populations were well established at ten sites on the Pecos River and had defoliated large expanses of saltcedar at each site. Beetles had dispersed from these original release sites and were present at sites both on and off the river from Iraan to Red River Bluff on the New Mexico border.

Table 1. Saltcedar leaf beetle release locations and numbers released

Location released	Tunisian Beetles Released 2011	Tunisian Beetles Released in 2012
Pecos	29,000	21,000
Imperial: 4 release sites	10,000	60,000
Grandfalls	10,000	11,000
Leon Springs	9,000	
Toyah	10,000	
Pecos North	3,000	5,000
Iraan		
Private Ranch		10,000
Highway 11 Bridge		9,000
Total	71,000	116,000

Reports from watershed landowners, observations made during the September 2011 aerial herbicide treatments, and the fall 2012 survey confirm the rapid and far-reaching expansion of saltcedar leaf beetle populations both on and off the river (Figure 3). Expansion continued in 2013 with beetles widening their range and moving from Texas into New Mexico. AgriLife Extension now considers the saltcedar leaf beetle established on about 88% of the Pecos River. This rapid and expansive trek across the watershed should continue in the future and the beetles are expected to defoliate increasingly greater acreages of saltcedar in the future baring late spring freezes or other weather extremes.

Another positive impact that saltcedar leaf beetles are having across the watershed is on saltcedar regrowth in areas where prescribed burning has top-killed living trees. The amount of time it would take beetles to move back into an area following a prescribed burn was unknown prior to the implementation of prescribed burns. Observations made one to two months post-burn confirmed that beetles had already recolonized these areas and were actively defoliating saltcedar regrowth.

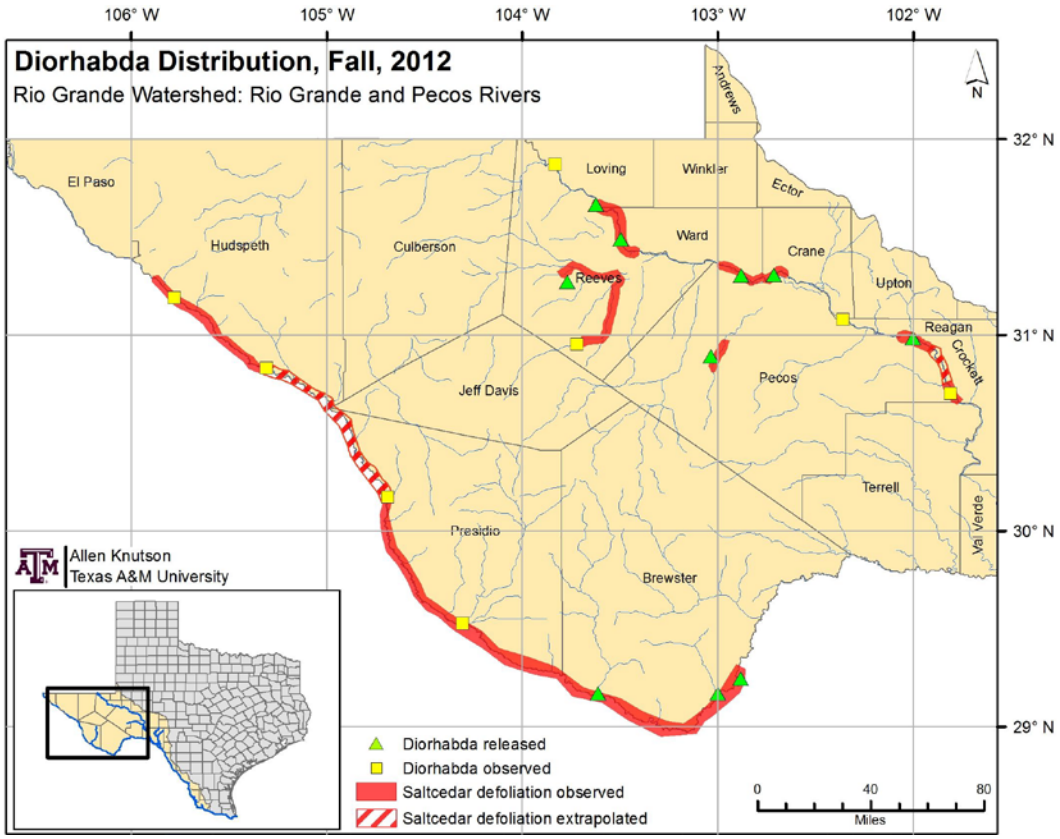


Figure 3. Saltcedar leaf beetle release, observation and distribution locations across the Trans-Pecos region in the fall of 2012

Defoliated regrowth in prescribed burn area and a cluster of adult beetles on regrowth about 2 months post-burn

At this point, the need to establish additional beetle populations in the watershed is considered a low priority since the current population is well established and distributed. Unforeseen beetle population declines could increase the need to establish additional populations in the future. Instead, tracking existing populations and quantifying acres of saltcedar defoliated annually and

inter-annually is the greater need. Given the large expanse of the Pecos River watershed and the fact that saltcedar leaf beetles are highly mobile, remote sensing methods are the only viable method available to track and document saltcedar defoliation. Using aerial imagery, defoliated saltcedar trees can be recognized using well established remote sensing techniques. Imagery taken early in the growing season can be used as a baseline of known saltcedar extent and can be compared to other images taken near the end of the same and subsequent growing seasons to quantify beetle impacts. Eventually, saltcedar mortality will be visible as well in early season imagery. This approach will enable an accurate measurement of the distribution and acreage of defoliated saltcedar on an annual basis and will also aid in determining what areas of saltcedar should be targeted for chemical treatments and which areas should be left to the beetles.

The saltcedar leaf beetle presents a cost effective way to help manage saltcedar populations across the watershed. The beetles not only help control the trees but also help to minimize seed production. By defoliating the saltcedar, the trees are either unable to produce a viable seed crop or produce a greatly reduced crop. Currently the saltcedar leaf beetle has been released at a total of 29 sites along the Pecos River, its tributaries and throughout the Pecos River Watershed. Evidence of the work that the saltcedar leaf beetles are doing can be seen in many locations across the watershed. Since the start of the saltcedar leaf beetle program in the Pecos River Watershed in 2006, more than 30 river miles have been confirmed to be successfully defoliated by the Crete and Tunisian beetles.

The saltcedar leaf beetle is not an option that results in quick control of large stands of saltcedar. This approach takes several years for dispersal of the beetle and repeated defoliation of individual trees to subsequently die and will not result in complete eradication of saltcedar. Therefore, the combination of chemical treatment to get widespread saltcedar infestations under control with biological treatment to ensure long-term control appears to be the best approach for a long-term saltcedar management.

USDA ARS completed work funded with CWA §319(h) NPS grants funds from TSSWCB in which they examined dispersal rates for leaf beetle populations in the Colorado River Basin and attempted to develop a computer model for predicting dispersal of the beetle based on observations made. Conclusions of the project show that environmental factors do not affect the dispersion of the beetles in saltcedar areas during the initial stages of establishment, but dispersal is instead driven mainly by the availability of saltcedar foliage and by the spatial distribution of the saltcedar trees.

Collectively, biological control efforts in the Pecos River watershed to date are considered to be extremely successful. The goal of having 10 established saltcedar leaf beetle sites has been exceeded and the natural dispersal of the beetles has likely exceeded the goal of 20 additional sites established by landowners.

Giant Cane Acreage Assessment and Control

An initial review of imagery captured prior to development of the WPP revealed that accurately quantifying giant cane acreages with that imagery was not likely to produce realistic results. Additionally, the age of this imagery was also problematic as it was over 5 years old when

initially evaluated and is now approximately 10 years old. As a result, new imagery is needed to verify the extent of giant cane infestations today.

As of June 1, 2013, no progress has been made to control Giant Cane through the Pecos River WPP implementation efforts. Landowners are encouraged to treat Giant Cane stands on their property and incorporate giant cane control into WQMPs; however, this practice does not receive financial assistance and producers are reluctant to incur this cost.

Saltcedar Debris Burning

Debris removal was listed as one of the primary concerns in the watershed in the WPP and continues to maintain this status. Earlier saltcedar control efforts resulted in large quantities of dead trees standing and fallen in the riparian corridor. The mass quantities of this debris that are present in the riparian areas pose numerous problems and limit the ability to implement revegetation efforts in these areas.

Prescribed burning was and still is viewed as the most physically and economically feasible method for removing the saltcedar debris in the Pecos watershed and has been successfully employed by agencies and landowners alike. As of June 1, 2013, approximately 35 miles of river frontage was burned with CWA §319(h) grant monies fully expending the allocated funds for this task. Another 25 miles were burned near Red Bluff Reservoir by Texas A&M Forest Service (TFS) prior to the implementation of the WPP.

Prescribed burning completed through the WPP Implementation project successfully removed the bulk (estimated at >90% in most areas) of saltcedar debris in the areas where fire was applied. The timing of the burns was also very good. Summer monsoons provided timely moisture to promote natural revegetation in the burned areas and did so without causing excessive erosion.

Individual landowners have also burned small areas along the river, but an estimate of mileage is not available. Other landowners have tried other methods for removing this debris with the two most common options being mechanical removal or mulching. Areas receiving these treatments are minimal.

Typical look at dead saltcedar along the Pecos River prior to prescribed burning

Progressive view of saltcedar debris burn areas showing the application of prescribed fire, a burned versus unburned portion of the river bank, post-fire fuel consumption results, observed revegetation approximately 2 months post-burn and saltcedar leaf beetle impact on regrowth of top-killed saltcedar

Upland Brush Control

The need for brush control was identified as the top ranked priority during the development of the WPP. While riparian brush, namely saltcedar, has received considerable attention during WPP implementation thus far, upland brush control has been quite the opposite. The desire for upland brush control continues to be a primary concern for watershed landowners.

NRCS's Environmental Quality Incentive Program (EQIP) program supports upland brush control efforts and has provided the vast majority of funding support for this need since WPP implementation began. In the 15 counties that EQIP stats were aggregated for (Figure 4), brush management has been implemented on 274 properties covering 81,311 acres. Landowners

received a total of $5,083,306 in financial assistance. This is undoubtedly an over-estimation of actual brush control completed in the Pecos River watershed as a sizeable portion of several of these counties is not included within the watershed. Regardless, this illustrates the extensive utilization of the EQIP program by watershed landowners to implement sound resource management practices to improve rangeland health and subsequently the quality of local water resources.

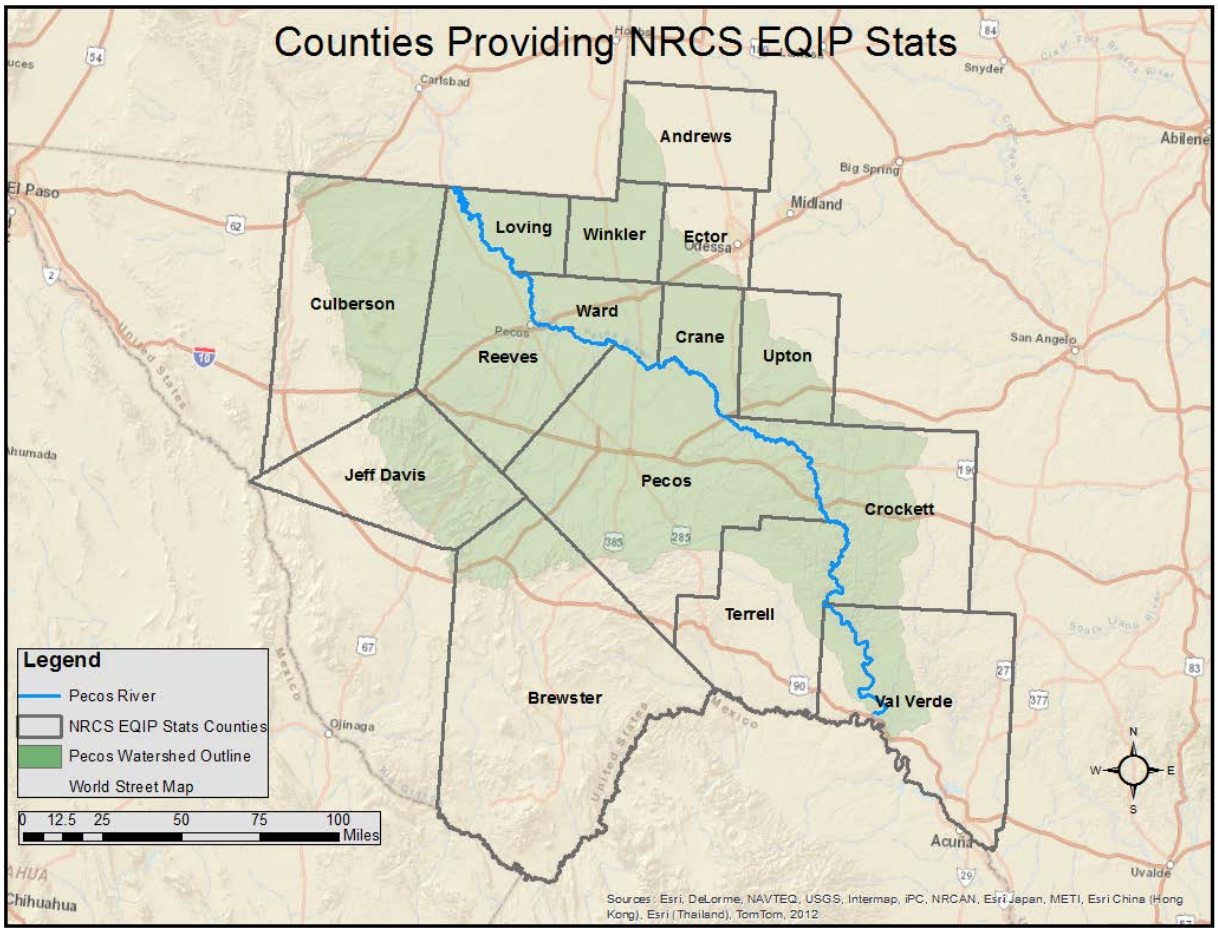


Figure 4. Counties making up the Pecos River watershed that provided NRCS EQIP stats

Biological Diversity

The biological diversity of the Pecos River watershed encompasses many features that are unique to the Trans-Pecos Region of Texas. This includes a wide variety of aquatic, riparian, and upland habitats as well as numerous animals, birds, insects and reptiles that call these places home. Over the years, this biological diversity has decreased as conditions across the watershed have changed and competition for the limited resources available has increased. Within the WPP, several tools were outlined to reduce the continued decline in biological diversity and attempt to

protect and even restore vital habitat across the watershed such that it improves biological diversity and supports healthier water resources.

Water Quality Management Plans

To develop and implement water quality management plans (WQMPs) across the Pecos River watershed, the Crockett and Upper Pecos SWCDs received CWA §319(h) grant monies from TSSWCB in October 2009 to provide technical and financial assistance to landowners throughout the watershed. Through this grant, funding was provided for two SWCD technicians, one in Pecos and another in Ozona, to cover the large watershed area and financial assistance was provided for 20 WQMPs. Other SWCDs covered by this funding and working with Crockett and Upper Pecos SWCDs through cooperative agreements include the Big Bend, Devil's River, High Point, Middle Concho, Rio Grande-Pecos River, Sandhills, Toyah-Limpia and Trans Pecos SWCDs. At the time of this update, the Upper Pecos SWCD technician in Pecos is serving the entire watershed as the Ozona technician position was vacated and not refilled due to current funding limitations.

WQMPs are site-specific plans whose development is initiated at the request of the landowner operating a property for agricultural or silvicultural purposes. These plans include appropriate land treatment practices, production practices, management measures, technologies, or combinations thereof that achieve a level of pollution prevention or abatement that is consistent with state water quality standards, while meeting the landowner's management goals.

Practices available for implementation through this program include:

- Cross Fencing (382): facilitates the implementation of a rotational grazing system by creating multiple fields for forage utilization by livestock while improving forage and stream health by excluding livestock from areas for a given period of time
- Watering Facilities (614) (for livestock only): places a device for providing animal access to water and protects streams, ponds, and water supplies from contamination by providing alternative access to water
- Pumping Plants (533) (associated with 614 only): pumps groundwater for livestock uses
- Pipelines (516): facilitates the transportation of water to a watering facility for livestock
- Wells (642): provides groundwater for use by livestock
- Rangeland Planting (550): establishes a permanent vegetative cover of native grasses to be utilized by livestock for forage
- Riparian Herbaceous Buffer (390) (for practice establishment only): establishes an area of grasses, grass-like plants and forbs along water courses to improve and protect water quality by reducing the amount of sediment and other pollutants in runoff as well as nutrients and chemicals in shallow groundwater
- Riparian Forest Buffer (391) (for practice establishment only): establishes an area predominated by trees and shrubs located adjacent to and up-gradient from watercourses to reduce excess amounts of sediment, organic material, nutrients, and pesticides in surface runoff and excess nutrients and other chemicals in shallow groundwater
- Nutrient Management (590) (for establishment of 550, 390 or 391 only): manages the amount, sources, placement, form and timing of the application of plant nutrients and soil

amendments to minimize agricultural nonpoint source pollution of surface and groundwater resources

The SWCD technician(s) and watershed coordinator have promoted the adoption of WQMPs since WPP implementation began by developing and distributing an informational brochure on the WQMP program and available assistance through the WPP, by speaking at various events and meetings on the WQMP program and by developing popular press articles that generally describe the purpose and benefit of the program. Despite these efforts by the project team to garner interest in the program, landowner interest has been lower than expected.

Initial landowner interest in the WQMP program was also low as qualifying properties were restricted to those areas adjacent to the main stem of the Pecos River. Additionally, priority was given to those properties where chemical saltcedar control had been completed and debris burning had taken place. This focus severely limited the potential pool of applicants resulting in program interest from only several landowners. While these priorities were in place, only seven WQMPs were developed and implemented. As a result of this low participation rate and at the suggestion of numerous SWCD board members, discussions on amending the focus area of the WQMP program supported through WPP implementation began in 2011. Using the input and guidance received from the SWCDs in the watershed the focus area was extended in the spring of 2012 to encompass upland areas of the watershed as well.

Following these amendments, interest in the WQMP program has increased. As of April 2013, 13 WQMPs have been certified and 4 more are in development.

In addition to promoting and developing WQMPs, the SWCD technician also works closely with local NRCS personnel to maximize implementation opportunities by pairing WQMP development with EQIP project planning. By coordinating planning, often sufficient financial assistance can be secured to encourage the landowner to implement practices when they otherwise may not have participated in either program. This tact has been especially useful in the difficult economic times experienced since the Pecos River WPP was developed and implementation began.

Riparian Revegetation

With the reduction of riparian saltcedar infestations and debris burning being primary objectives of WPP implementation thus far, revegetation efforts are extremely important to ensure that healthy, water quality protecting habitat be quickly reestablished. Time has proven that natural revegetation does typically occur quickly following saltcedar treatment and debris burning; however, low quality species are often the plants that dominate this revegetation.

Saltcedar is the plant species that commonly dominates naturally revegetated areas after several years of regrowth. Treatment and burning are effective tools for decimating “old-growth” saltcedar, but plants remaining upstream or upwind of these areas prolifically deliver new seeds to the area and saltcedar once again utilizes its competitive advantage to outcompete other more desirable plants.

Two factors are working against saltcedar that will improve the likelihood of successful riparian and upland revegetation in the future. First is the saltcedar leaf beetle. The recent expansion of saltcedar leaf beetle populations across the watershed in recent years is reducing the competitive advantage that saltcedar has held for so long. The leaf beetle accomplishes two critical missions in its repeated defoliation of saltcedar trees. Young saltcedar trees are primarily focused on growth and are rapidly increasing their leaf surface area rather than building their carbohydrate reserves. As a result, repeated defoliation by the leaf beetle is more devastating to younger trees resulting in quicker mortality. Older trees are also adversely impacted by repeated defoliation, but may take longer to succumb to repeated defoliation. Additionally, seed production is suppressed or eliminated when trees are defoliated further reducing saltcedar's grip on the area.

During this repeated defoliation, other plant species have a better chance to colonize these areas; this leads to the second factor: native plants. These plants are naturally adapted to the harsh climate and conditions of the Pecos River watershed. Additionally, native species typically provide higher quality habitat that promotes improved riparian area functioning and subsequently improved water quality than a riparian area dominated by non-native species would. The only problem with using native plants is that the current supply of seed stock for plants native to the Trans-Pecos region is severely limited.

Texas Native Seeds and Trans Pecos Native Plant Materials Initiative

Texas Native Seeds, a project of the Caesar Kleberg Wildlife Research Institute at Texas A&M Kingsville, and the Trans Pecos Native Plant Material Initiative, a project of the Borderlands Research Institute at Sul Ross State University, is working to expand the availability of local native seed stock by collecting, evaluating, planting and producing native seeds for use in rangeland restoration, oil and gas production site restoration, pipeline easement restoration, highway right-of-way planting, riparian area restorations, and watershed protection. The goal of this effort is to provide economically viable sources of *locally adapted* native plants and seeds that can be used for the restoration of the native plant communities across west Texas, including the Pecos River watershed.

Restoration of native plant communities is a growing need in west Texas. Commercial sources of locally adapted native seeds are critical for successful restoration. Currently, with the exception of one or two grass species, there are no commercial sources of native seeds available that originated from the Trans Pecos region of Texas. As a result of the lack of native seeds, exotic grasses are often planted to prevent soil erosion in reclamation projects or following habitat improvement efforts. However, research continues to show that exotic grasses have many negative impacts to wildlife and the ecosystems they are introduced into. As disturbance and fragmentation increase in West Texas, commercial sources of native seeds for restoration will be critical for conservation of the region's unique biodiversity.

The development of native plant materials from these projects includes the collection of native plant seeds from species of interest as determined by Texas Native Seeds and The Trans Pecos Native Plant Materials Initiative technical committees, SWCD District Technicians, NRCS staff, and the Texas Department of Transportation. Following collection of adequate plant material from multiple populations, evaluation plantings are established from greenhouse grown

transplants at multiple field evaluation sites representative of growing conditions across west Texas, including areas with similar land use histories of the Pecos River Watershed, to compare plant performance between populations. Data on plant population performance, including ability to establish in adverse conditions, ability to compete with common weeds and exotic species, and ability to be grown in large-scale agronomic production settings and yield quantities of seed that will result in economical seed sources for use are collected. Once adequately performing native populations are identified, these populations are increased at local sites (if irrigation water is available), or in adjacent regions using transplanted seed increase fields. The fields are mechanically harvested, the seed cleaned and tested, and resulting seed distributed to qualified commercial seed growers or local producers for large scale production. Formal releases of select native germplasm are made to insure high-quality, weed free seed is available for restoration and revegetation plantings in the area, and to insure resulting seed sources will meet specification standards of state and federal agencies.

Over the next decade, Texas Native Seeds and the Trans Pecos Native Plant Materials Initiative hope to release, and ensure the commercial availability of, seed sources of 15+ native species, eventually resulting in diverse native seed mixes that will successfully meet restoration needs across West Texas. To accomplish this goal, additional resources are needed to collect, evaluate, demonstrate and produce viable seed crops for use in future revegetation efforts. Additionally, revegetation method evaluations and demonstrations are needed to determine applicable approaches for revegetating riparian areas that have saltcedar in various stages of growth, death or decay.

Dissolved Oxygen

Low dissolved oxygen (DO) levels remain as a problem in the Pecos River. Recent water quality data utilized in the 2012 Texas Water Quality Inventory and 303(d) List indicate that the stretch of the river between US 67 and the Ward Two Irrigation Turnout upstream of FM 1776 remain impaired because half of the 24 hour minimum DO readings are below the state's water quality standard.

Following the release of amended surface water quality monitoring guidance by TCEQ in 2003, 24 hour DO monitoring became a standard tool used to assess a waterbody's ability to support its designated aquatic life uses. At the time that the 2006 Texas Water Quality Inventory was conducted, four of these 24 hour DO monitoring events had been conducted in each of the portions of the river between US 67 and FM 1776 and Business 20 and FM 1776 (now AUs 2311_03 and 04 respectively). As a result of this monitoring, the river was listed as impaired for low DO levels in the 2006 Texas Water Quality Inventory and 303(d) List which was published in 2007 and approved in 2008. At that point, the WPP was already being developed and investigative work conducted to support the development of the WPP by evaluating water quality concerns had been completed. This left little time and no resources available to evaluate the cause of the impairment or evaluate potential solutions to the problem.

Evaluating the DO Impairment

Following development of the WPP, TWRI worked to secure CWA §319(h) grant monies from TSSWCB to conduct a DO impairment source assessment and evaluate a variety of management options for the upper Pecos River. To accomplish this, TWRI contracted with the Texas Institute for Applied Environmental Research (TIAER) to conduct a computer-based evaluation of the problem using the QUAL2K model.

Prior to developing and running the model, load duration curves (LDCs) were developed using existing water quality data to establish the current DO loading as compared to the water quality standards. In this assessment, the problematic area of the river (from the Ward II Irrigation turnout to US 67) was included in a slightly larger assessment area termed Section C and is described as:

> From SH 349 to Ward Two Irrigation Turnout near the junction of Reeves and Pecos counties. This middle portion of the Upper Pecos is a transitional section wherein the relative balance of influences on hydrology shifts from regulated to natural, i.e., factors such as precipitation and the water demands of vegetation have an increasingly dominant role in the quantity and quality of water in the stream channel.

LDCs were developed in each river section using available water quality and stream flow data. In Section C, a consistent flow record was available at USGS Gage 08446500 located near the US 67 road crossing and water quality data from SWQM Stations 13257 and 13260 as well as CWQN Station 709 were available and used to develop LDCs. Once developed, the LDCs clearly indicate that minimum DO loadings do exceed allowable levels while average DO levels are not problematic. The LDCs also illustrate that the bulk of minimum DO exceedances occur during low and mid-range flow conditions (Figure 5).

Ward II Irrigation Turn Out just upstream of the FM 1776 road crossing

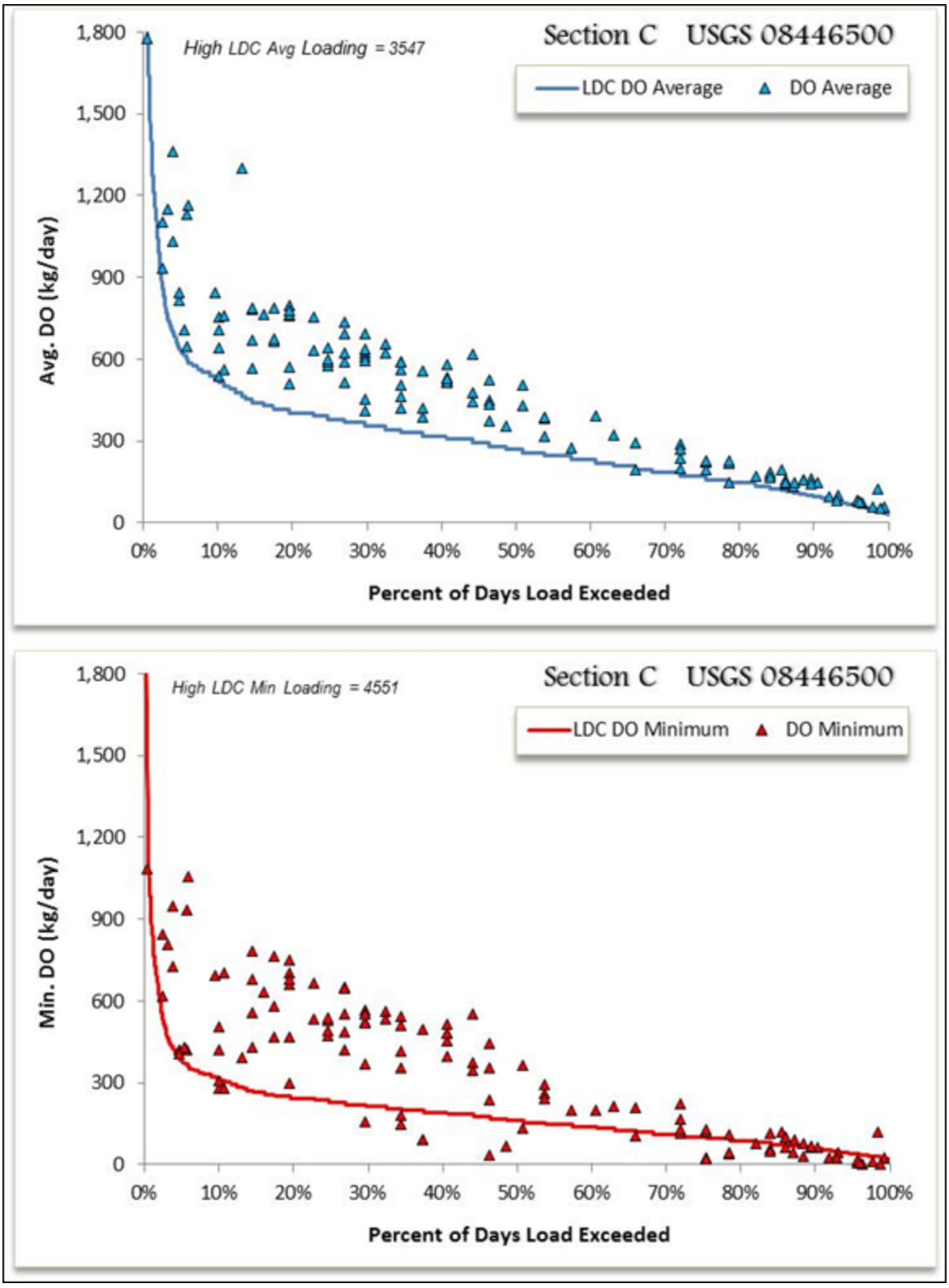


Figure 5. LDCs of daily average DO and 24 hour minimum DO in the impaired portion of the Pecos River

Following development of LDCs for the entire river, the model was built, calibrated, validated and then run to evaluate the existing (base) conditions and management option conditions under a range of environmental factors (e.g., releases from Red Bluff, withdrawals of stream flow for irrigation, seasonal weather variation in sunlight and air temperature) performed through separate runs of QUAL2K. Evaluations of model output were then conducted to determine the change in DO resulting from the management option as compared to the base condition at the Pecos River at FM 1776 – locations of both CAMS Station 709 and TCEQ Station 13260. The predicted changes in DO were then applied systematically to the observed DO data and those data analyzed to evaluate the improvement in DO resulting from a management option.

Results of this 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 such as excessive aquatic plant life and warm water temperatures also contribute to the impairment. The hydrologic modifications that have occurred include human actions such as the construction of reservoirs, irrigation diversions and groundwater pumping which has reduced groundwater inflows to the river. Natural conditions such as the routine drought conditions experienced across the watershed are also part of the problem.

In response to the variety of factors adversely influencing DO levels, a variety of management options were considered and evaluated to determine their potential impacts on DO. Several hypothetical management scenarios modeled came from recent work by the Rio Grande Basin and Bay Expert Science Team (BBEST) which suggested minimum flow thresholds to support aquatic life in the Pecos River. **These along with some of the other management measures evaluated are not likely to be realistically feasible; however, one goal of the modeling effort was to determine what type of intervention it would take to restore DO levels to within the state's standard.** Options 8 and 9 are combinations of measures 3 through 6 and were selected by picking individual practices showing the most potential to improve instream DO conditions.

Evaluated management options include:

1. The Malaga Bend Project
   The Malaga Bend project involves the control of brine intrusion in the Pecos River above Red Bluff Reservoir in New Mexico. Lower salinities slightly increase the saturation level of DO in water resulting in potential benefits to DO in the river.

2. Increased stream flow in the impaired AU (BBEST 50^{th} percentile flows)
   Prescribe 50^{th} percentile flow minimums in the impaired AU as recommended by the local basin and bay expert science team (BBEST) during the period of lowest DOs. These flows were implemented by increasing the flow in each QUAL2K scenario to 50th percentile recommendation levels at Grandfalls and Girvin for the months of April – October. Notably the initial flow recommendations made by the BBEST are made without regard to the need for the water for other uses. Likewise, the use of the BBEST flows in this analysis does not take into account other uses for the water or even availability of the water. Rather, this management option, as well as Option 3, was included because it is generally recognized that the Upper Pecos River has a

highly modified hydrologic regime and as such the benefits of increased flow in the zone of impairment were addressed through this study.

3. Increased stream flow in the zone of impairment (BBEST 50^{th} & 75^{th} percentile flows)
   Same as Management Option 2 above, but used 75th percentile flow recommendations from BBEST for the period June – August keeping the 50th percentile flow recommendations for April, May, September and October. These flows were implemented by increasing the flow in each QUAL2K scenario to the recommendation levels at Grandfalls and Girvin for the months of April – October.

4. Decreased periphyton biomass by 25 percent.
   This option of decreasing periphyton (or bottom algae as represented in QUAL2K) biomass was implemented in the model by increasing the input parameter controlling bottom algae die-off by 55 percent. Biological or chemical means could be used to accomplish the 25 percent reduction though both means could be associated with unintentional environmental concerns and consequences.

5. Decreased sediment-water fluxes by 25 percent.
   This management option considered in the model prescribed a flux of nutrients released from bottom sediments into the water column and sediment oxygen demand (SOD) to both be reduced by 25 percent by unspecified means. Land management practices and increased pulses of elevated flows could collectively or individually contribute to reducing sediment-water column exchanges. Periodic elevated flows would serve to reduce sediment build-up in the bottom of the riverbed, which anecdotally has been indicated to be abundant by TCEQ staff familiar with the river and to others. Also, various farm and range management measures have a potential to reduce sediment losses from the landscape into the Pecos River, though the arid conditions of the region make such measures of unknown efficacy.

6. Decreased headwater nutrients from Red Bluff Reservoir by 50 percent.
   Under this management option the nutrient concentrations specified at the headwater in QUAL2K were reduced by 50 percent.

7. Added riffle area above FM 1776 crossing of Pecos River.
   This management option was implemented in QUAL2K by changing input to the model to include a 1-meter high broad-crested weir 1.5 km upstream of FM 1776 crossing the Pecos River. A series of riffles spaced every few kilometers would be required to bring improvement to the entire impaired stretch of the Pecos which may persist for about 150 km (almost 100 miles). Because implementing riffles through QUAL2K is manually very time consuming and requires reworking the segmentation of the Pecos River, a single riffle was evaluated located upstream of the point of evaluation for management options.

8. Combination of management Options 3, 4 and 6.

9. Combination of management Options 2, 4 and 5.

10. Combination of management Options 3, 4, 5 and 6.

The model and LDC results indicated that the 24 hour minimum DO standard of 3.0 mg/L was only achieved 79 percent of time under baseline conditions. To meet the state's water quality requirements, this minimum standard must be maintained at least 90 percent of the time. As such, the 90 percent attainment of the 24 hour minimum DO loading was set as the goal for modeled management options to attain.

Results of QUAL2K simulations show that only Option 9 results in the goal of minimum DO being raised above 3mg/L for 90 percent of the measurements (Table 2; Figure 6). This evaluation of various management options to restore DO in the Upper Pecos River indicates that it will be extremely difficult, if not impossible, to bring about restoration of the depressed levels in the impaired portion of the river. Impacts from decades of hydrologic modification (change in the natural flow regime) in the Upper Pecos River have resulted in portions of the river experiencing abundant sedimentation as well as prolific periphyton beds. The combined QUAL2K predictions and modification of observational DO measurements used to evaluate these management options indicated that no single measure will result in restored water quality.

Table 2. Summary of CWQMN Station 24-hour minimum DO exceedance data graphs for baseline and management option conditions considering the percent time the absolute minimum DO criterion is obtained at FM 1776.

Management Option	Brief Description	Percent time 24-hr minimum DO ≥ 3.0 mg/L on Pecos at FM 1776
None	Existing baseline conditions	79.0
1	Malaga Bend Project (decreased salinity in Red Bluff Reservoir releases)	79.0
2	BBEST 50th percentile environmental flows applied April – October	83.6
3	BBEST 50th & 75th percentile flow selectively applied April – October	84.4
4	Decrease algal biomass 25% in summer in zone of impairment	85.2
5	Decreased sediment-water fluxes by 25%	85.0
6	Decreased Red Bluff Reservoir nutrients 50%	79.0
7	Added riffle 1.5 km (1 mile) above FM 1776 crossing of Pecos River	87.7
8	Combination of Management Options 3, 4 & 6	87.2
9	Combination of Management Options 2, 4 & 5	93.0
10	Combination of Management Options 3, 4, 5 & 6	96.0

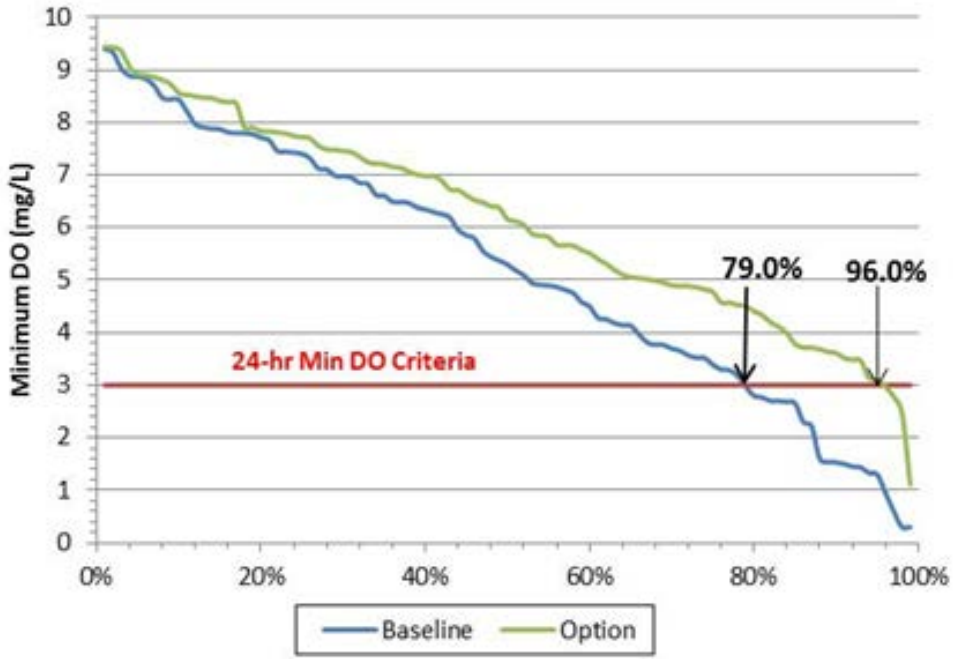


Figure 6. Modeled DO load under application of Management Option 9

A complete review of the DO modeling effort and the results are presented in the project's final report which is in the final stages of completion and will be available online at http://pecosbasin.tamu.edu/reports.

Artificial Riffles

Artificial riffles were included in the Pecos River WPP as a potential management strategy to improve instream DO levels. This strategy was evaluated using the QUAL2K model discussed above and illustrated that artificial riffles can be quite effective in raising the minimum DO levels; however, the water quality effect of the riffle is only realized for a short distance downstream of the structure.

As a result this management strategy is not viewed favorably as a solution to the DO impairment as numerous riffles would be needed to increase minimum DO levels throughout the zone of impairment. This measure also further increases hydrologic modification of the channel and would result in lengthy areas of ponded water held behind each dam.

Well Plugging

As of April 2013, the Railroad Commission of Texas (RRC) reports that there are a total of 14,928 known inactive oil and gas wells in the counties that comprise the Pecos River watershed and an additional 315 known orphan wells. This is a reduction of 22 orphan wells since the WPP was developed indicating that some progress is being made on addressing these potentially problematic wells. Additionally, the RRC is planning on plugging an additional 21 wells in these

counties; however, none are known leaking wells. Using the "Well Plugging Priority Determination System" (Appendix E in the WPP), these wells rank as Priority 2s and 3s. A well that is leaking on the surface or subsurface is automatically ranked as a Priority 1.

Anecdotal evidence from landowners continues to document the presence of flowing wells in the watershed that need to be addressed. Some of these wells are flowing good quality water while others are flowing poor quality water. Little has been done to address these wells since WPP implementation began as these wells are located on private property and go unaddressed unless the landowner wants to do something about the well. As a result, the locations of these wells across the watershed are largely unknown.

The biggest need in well plugging is identifying where these wells are and evaluating their potential to directly impact the Pecos River. Given the expanse of the watershed and the fact that it is almost exclusively owned by private landowners, an indirect method for finding flowing well locations is most appropriate.

Once potential flowing well locations are identified, efforts can be taken to come up with management strategies that address those wells most likely to influence instream water quality data first. For those wells that yield water that is of good quality, putting the water to a beneficial use may be the most appropriate action. This water could support much needed livestock or wildlife habitat or could provide a very useful alternative source of water for livestock or wildlife that call the Trans-Pecos region home.

Nutrient Concerns

Concerns for elevated nutrients continue to exist in portions of the watershed and should be addressed when feasible. Recent water quality data indicate improving trends in monitored nutrient levels for ammonia, nitrate and orthophosphorus levels monitored in Red Bluff Reservoir. As a result, it is no longer listed in the 303(d) List as having a concern for elevated nitrate levels. That said, chlorophyll-a levels continue to persist at levels above the established screening levels resulting in concerns for Red Bluff Reservoir and various parts of the Upper Pecos River.

Drought conditions have undoubtedly influenced the delivery of nutrients to Texas from New Mexico. The 3 years of continuous drought that New Mexico is currently experiencing has led to an unprecedented restriction on water deliveries to downstream irrigators and as a result has essentially led to the cessation of irrigation return flows to the river. Subsequently, any nutrient loading from this irrigation tail water has also ceased.

Regardless of these conditions, development of nutrient management plans in both Texas and New Mexico was listed as a goal in the WPP. To date, only two nutrient management plans have been developed by NRCS through their EQIP program and cover 397 acres. Thus far, we have been unable to obtain any data from New Mexico on nutrient management plans developed north of the border.

Water Quantity

Water quantity is and most likely always will be the biggest concern for the Pecos River watershed. The prolonged drought in the basin discussed earlier has drastically reduced the flows of the river and is of course compounded by the ever increasing demands on its water resources. As a result, no progress has been made on the goals listed to improve water quantity management in the WPP.

Reservoir Release Scheduling

Water release schedules and irrigation delivery timing from reservoirs in New Mexico and from Red Bluff Reservoir have been drastically altered by drought. New Mexico has not made reservoir releases specifically to deliver water to Texas since 2008 and is not likely to do so until the drought subsides. Releases for irrigation from Red Bluff Reservoir have been curtailed since irrigation releases ceased in September 2011 and beginning in early 2012, all flow from Red Bluff was suspended. Prior to that, leaky gates at Red Bluff yielded a continuous release of 12 cubic feet of stream flow per second. This continuous release was suggested in the WPP to maintain bank moisture conditions between irrigation water releases and minimize percolation losses when irrigation waters are sent downstream. Until the drought eliminated this release, this was considered successful implementation of a modified release schedule for Red Bluff.

Irrigation System Improvements

The WPP called for several management measures to improve irrigation systems throughout the watershed. These included irrigation canal water audits and the implementation of efficient irrigation systems. Drought is of course the biggest factor preventing progress from being made in any of these efforts; however, other factors such as water quality and the economy have also influenced this lack of action.

Irrigation canal water audits have been discussed with several of the irrigation districts served by the Red Bluff WPCD; however, the costs to an audit are prohibitive at this time as is the lack of irrigation water. With irrigation deliveries being curtailed for more than 2 years, irrigation canal audits have been impossible. Economics is also a factor limiting interest in conducting an irrigation audit. The profitability of irrigation districts and producers has been greatly reduced by the lack of water and has perhaps diminished the desire for an irrigation canal audit. Despite these factors, several irrigation districts have expressed a slight interest in conducting an audit though and discussion will be continued when appropriate.

Drought conditions have seemingly had an inverse impact on implementing efficient irrigation systems throughout the watershed. High efficiency irrigation systems can improve irrigation efficiency when implemented thus allowing producers to irrigate the same acreages that they always have with less water. However, these upgrades often come at a significant cost; especially for the higher efficiency systems such as subsurface drip. With the depressed economic conditions of recent years paired with higher production costs for fuel and the volume of energy required to pump deeper and deeper groundwater; producers are apprehensive to incur these added costs. Additionally, the Pecos River watershed is notorious for sodic and hyper saline soils

that require irrigated fields to be periodically leached. This requires large amounts of water to be applied to the soil that high efficiency systems may not be able to provide.

According to NRCS, 22 producers in the 15 county area have participated in EQIP and received technical and financial assistance to implement drip irrigation systems on 1,090 acres. Sprinkler irrigation system upgrades or installations have been made on an additional 15 producer's lands totaling 2,097 feet of new coverage. Land leveling and irrigation pipeline are two other irrigation related conservation practices that NRCS' EQIP has provided assistance to producers to implement in the watershed. Land leveling was applied on 8 producer's properties totaling 495 acres while 21 producers implemented 56,049 feet of new irrigation pipeline.

Monitoring Program

Water quality monitoring is a critical component to determining the long term impacts of a WPP. The Pecos WPP outlined the need for several types of monitoring that includes aquatic life, continuous water quality and clean rivers program monitoring.

Aquatic Life Monitoring

In 2011, TCEQ, with assistance from the U.S. International Boundary Water Commission (USIBWC), performed two aquatic life monitoring sampling events at four continuous water quality monitoring network (CWQMN) stations designed to collect information on aquatic habitat as well as the benthic macroinvertebrate and fish community richness. This assessment is analogous to the assessment conducted in 2006 by TCEQ and USGS; however, slightly different metrics were used to in this most recent assessment. Instead of using a singular index of biotic integrity (IBI) score like the 2006 survey did, a dual IBI score was utilized and included a Regional IBI and a Southern Desert IBI. The Regional IBI utilizes fish and benthic macroinvertebrate data collected statewide and as a result may not appropriately represent the conditions in the Pecos River. The Southern Desert IBI index is a new evaluation criterion that is under development by TCEQ and only utilizes habitat and assemblage data collected from the Chihuahuan Desert's Ecoregion of the state thus making it more appropriate for evaluating aquatic community resources. It should be noted that this Southern Desert IBI has not been adopted by TCEQ or Texas Parks and Wildlife Department for assessing the aquatic community. In addition to habitat and species monitoring, 24-hr DO, conventional water analysis, field measurements, and instantaneous flow rates are also recorded. These measurements produce the additional data needed to assess the impairment of aquatic life due to depressed oxygen (DO) for the Upper Pecos River (Segment 2311). Combined, these water quality data results, the regional IBI and benthic macroinvertebrate scores are used to determine a water body's ability to support its designated aquatic life use.

Results from this evaluation are shown in Table 3 and indicate that the health of the aquatic community has remained largely unchanged since the WPP was completed. With the exception of the Orla station, the number of fish species collected declined at each site. Comparing the Southern Desert IBI score to the IBI score reported in the WPP, the Orla site showed some improvements, the Sheffield site stayed approximately static while slight declines were noted at the Coyanosa and Girvin sites. Habitat scores exhibited a similar trend with Orla and Sheffield

staying the same while Coyanosa and Girvin declined slightly. Benthic macroinvertebrate scores for monitored sites also showed a similar trend with Orla showing a fair improvement and Girvin slightly declining.

While these slight shifts in aquatic community scores illustrate improvements and declines in aquatic community health, the changes are subtle. In light of the extended drought conditions experienced across the watershed and lack of flow in the upper part of the river, only slight declines in some of these scores should be viewed as an outcome that is as good as it can be given the adverse weather conditions.

Table 3. Aquatic life survey results from December 2010 – January 2011 sampling

Pecos River Sampling Locations	TCEQ Station ID	# of Fish Species Collected		Regional IBI Score†		Southern Desert IBI Score‡		Habitat Score*		Macro-invertebrate Score
		Dec. 2010	Jan. 2011	Dec. 2010	Jan. 2011	Dec. 2010	Jan. 2011	Dec. 2010	Jan. 2011	
Orla	13265	5	3	31	29	24	19	15	15	14 - Limited
Coyanosa	13260	3	3	21	27	17	18	N/A	16	N/A
Girvin	13257	4	4	23	27	18	17	N/A	15	18 - Limited
Sheffield	15114	6	6	22	23	17	18	21	25	N/A

†Regional IBI Scores: <35 Limited; 35-36 Intermediate; 37-42 High; >43 Exceptional
‡Southern Desert IBI: <18 Limited; 18-20 Intermediate; 21-26 High; ≥27 Exceptional
*Habitat Quality Index Scores: ≤13 Limited; 14-19 Intermediate; 20-25 High; 26-31 Exceptional
N/A = not assessed

TCEQ is also in the process of conducting another aquatic life monitoring effort in the Pecos. Geographically, this work will focus primarily in the transitional area around Sheffield where water quality begins to improve as a result of fresh groundwater inflows. The purpose of this monitoring is to provide TCEQ with both aquatic community and water quality data thus enabling them to determine if the designated aquatic life use for the Pecos River is appropriate. A report summarizing the findings of this assessment is expected to be published in 2014.

Clean Rivers Program Monitoring

USIBWC has continued in their capacity as a partner in TCEQ's Clean Rivers Program (CRP) monitoring program and is conducting surface water quality monitoring (SWQM) on the Pecos and Rio Grande rivers. The WPP indicated that 10 sites were being actively monitored at the time of its development and established a minimum goal of maintaining this level of SWQM. According to the coordinated monitoring schedule (http://cms.lcra.org), monitoring is planned for 9 sites in the watershed during state fiscal year 2014. Table 4 describes these stations as well as the monitoring regime and parameters evaluated. Of these 9 sites, 8 sites were being monitored when the WPP was developed and are still being monitored. Stations no longer being monitored through the CRP program are the Pecos River near Pecos, TX (Station 13261) and the Pecos River 0.7 miles downstream of US 90 (Station 16379). The station near Pecos, TX

continues to be monitored with a continuous water quality monitoring station while the station downstream of US 90 has been dropped as it is more representative of a lake environment than a river.

Funding limitations within the CRP program have limited the ability to expand CRP monitoring to other stations across the watershed.

Table 4. CRP stations where monitoring is planned in state fiscal year 2014

River Segment	Staion ID	Station Description	Sampling Frequency	Parameters Monitored
2310	18801	Lower Pecos River Upstream of Terrell/Val Verde/Crockett County Line on Brotherton Ranch	quarterly	pH, DO, temp, conductivity, nutrients, metals, bacteria, flow
2310A	13109	Independence Creek 0.5 mi downstream from John Chandler Ranch Headquarters	quarterly	pH, DO, temp, conductivity, nutrients, bacteria, flow
2311	13249	Upper Pecos River at US 290 Bridge near Sheffield	quarterly	pH, DO, temp, conductivity, nutrients, metals, flow
2311	13257	Pecos River at US 67 near Girvin	quarterly	pH, DO, temp, conductivity, nutrients, flow; semiannual 24 hr DO
2311	13260	Pecos River at FM 1776 SW of Monahans	quarterly	pH, DO, temp, conductivity, nutrients, flow, benthics
2311	13265	Pecos River at FM 652 near Orla	quarterly	pH, DO, temp, conductivity, nutrients, flow; semiannual 24 hr DO
2311	20558	Kokernot Springs on Sul Ross State University Campus in Alpine	quarterly	pH, DO, temp, conductivity, nutrients, semiannual organics in water and sediment, bacteria
2312	13267	Red Bluff Reservoir Upstream of the Dam North of Orla	semiannual	metals, pH, DO, temp, conductivity, nutrients
2312	13269	Red Bluff Reservoir 0.5 mi South of Texas-New Mexico Border	semiannual	metals, pH, DO, temp, conductivity, nutrients

Continuous Water Quality Monitoring Stations

When the Pecos River WPP was developed in 2008, there were 5 CWQMN deployed across the watershed that record data at hourly intervals on water temperature, pH, DO and specific conductance. Additional parameters such as gage height and stream flow are recorded at some locations. Since that time, 4 additional stations have been added. Table 5 provides information on these stations and Figure 7 illustrates the distribution of these stations throughout the watershed.

CAMS 785 near Girvin

Table 5. CWQMN stations in the Pecos River watershed

River Segment	Station ID	Station Description	Date Data Collection Began
N/A	CAMS 788	Pecos River near Red Bluff, NM	6/23/2011
2311	CAMS 798	Pecos River near Orla, TX	4/4/2012
2311	CAMS 710	Pecos River near Pecos, TX	9/24/2004
2311	CAMS 709	Pecos River near Coyanosa, TX	9/22/2004
2311	CAMS 785	Pecos River near Girvin, TX	8/18/2011
2311	CAMS 735	Pecos River near Sheffield, TX	7/19/2006
2310A	CAMS 764	Independence Creek at Caroline T-5 Spring, TX	7/17/2008
2310	CAMS 729	Pecos River at Brotherton Ranch, TX	2/23/2006
2310	CAMS 799	Pecos River near Langtry, TX	4/4/2012

One goal of the Pecos River WPP was to secure funding for the installation, operation and maintenance of one new CWQMN station. With the help of the Pecos River Compact Commission and the TSSWCB, sufficient funding to install and operate four new CWQMN stations on the Pecos River was secured. One of these four new CWQMN stations was installed in New Mexico just upstream of Red Bluff Reservoir. Considerable discussion and cooperation between the states went into the establishment of this station on New Mexico soil and greatly benefits both states by illustrating water quality near the state line. With the addition of these stations, the Pecos River now has one of the largest networks of continuous water quality monitoring stations in Texas (only the Rio Grande has more stations).

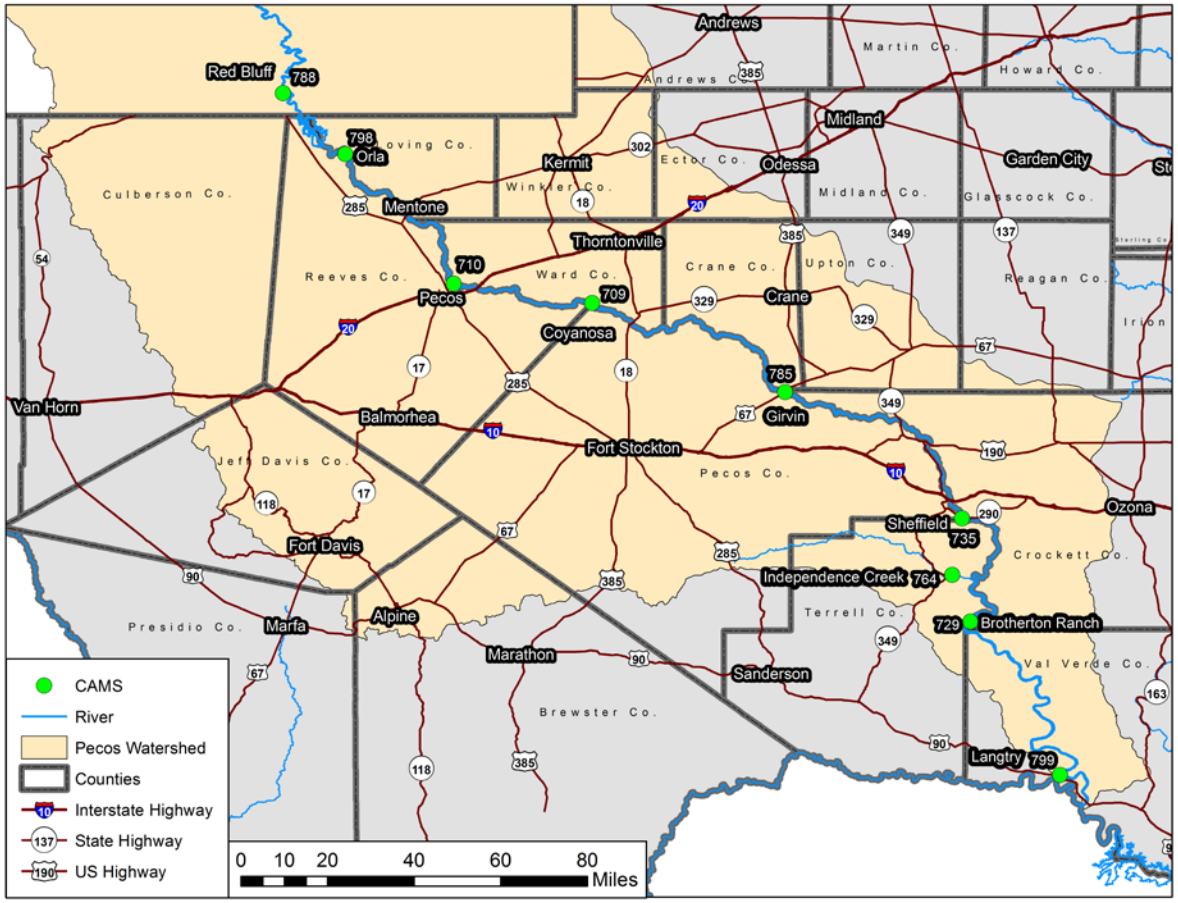
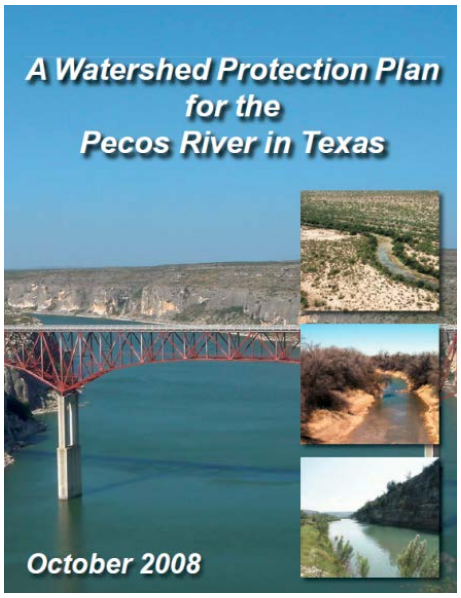


Figure 7. TCEQ CWQMN station distribution in the Pecos River watershed

A significant change to the operation and maintenance of all the stations in the CWQMN was the transition of operational duties from TCEQ to USGS. This change was effective on September 1, 2011 and was facilitated as a result of reduced staff capacity at TCEQ to continue this task. Utilizing funds provided by TCEQ, TSSWCB and the Pecos River Compact Commission, USGS began operating these sites and ensures that instrumentation is functioning properly, data are transmitted correctly and that validation of these data is completed in a timely fashion.

Education and Outreach

Maintaining contact with watershed landowners and providing needed information remains a critical component of implementation efforts. A diverse suite of education and outreach efforts have been utilized and have been quite effective in maintaining a good level of local engagement in implementation activities. Utilizing funding from TSSWCB and EPA through their CWA §319(h) program, the *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* has provided much of the needed resources to facilitate education and outreach efforts across the watershed.



Cover of the Pecos River WPP

Pecos River Watershed Protection Plan

The Pecos River WPP is a 161 page color document that can be found electronically at the Pecos River website below. Over 500 copies have been printed and distributed throughout the watershed at public meetings, SWCD meetings and offices, irrigation district meetings, thru AgriLife Extension and NRCS offices, field days, workshops and other events.

Pecos River WPP Executive Summary

As a concise complement to the WPP, *A Watershed Protection Plan for the Pecos River in Texas: An Overview* was developed to provide a brief look at the WPP and its contents. This overview describes the watershed and discusses the WPP in general, the role of the watershed coordinator, and landowner concerns regarding resource management in the watershed. Additionally, this overview highlights each area of concern and briefly discusses management recommendations made in the plan as well as implementation schedules and future monitoring needs to track implementation success.

This document is always available at the project website, is distributed at meetings across the watershed and is available to be picked up at AgriLife Extension, NRCS, and SWCD offices. Approximately 4,600 copies of this summary have been distributed.

Pecos River WPP Implementation Program Website

The Pecos River WPP Implementation Program website was developed prior to completion of the WPP by TWRI who continues to maintain the site. The website has undergone several changes as the program has evolved, but continues to serve as a repository of all things Pecos. The website includes general information on the watershed, past meetings are listed, future events are advertised, pertinent news releases are reposted, links to surface water quality data are provided, best management practice information is provided, and project reports are posted along

with newsletters and contact information for program personnel. Other potentially useful links are also provided as well as an online interactive map dubbed the Pecos River Information Management System which illustrates WPP implementation progress.

http://pecosbasin.tamu.edu

Pecos River Information Management System

The Pecos River Information Management System, available through the program website, was develop as a means to illustrate useful information about the watershed, its features and its uses while simultaneously providing a platform to display WPP implementation progress. Using a base map similar to those found on widely used online map tools, information is displayed in its general geographic location for informational purposes only. Much of the information displayed in this mapping application is publicly available while some is not. As a result, this system was built to ensure that the privacy of this non-public information is maintained at all times.

This tool, shown in Figure 8, provides a readily accessible way to visualize completed implementation measures and where they are generally located within the watershed. Information is continually added to the viewer as it becomes available; currently included items are:

Water
- irrigation turnouts
- water quality monitoring stations
- water rights diversions
- wastewater outfalls
- stream gauges
- surface well locations
- stream network
- watershed boundary
- subbasin boundaries
- major aquifers
- minor aquifers
- water district boundaries
- dissolved oxygen impairment area

Management
- Electromagnetic survey area
- Malaga Bend salt harvesting operation
- prescribed burn areas
- saltcedar leaf beetle release locations
- saltcedar leaf beetle distribution estimate areas by year
- saltcedar spray areas
- general WQMP locations

General
- soils
- SWCD boundaries
- county boundaries
- world street map

Figure 8. Screen shot of the Pecos River Information Management System

Communication and Education

Disseminating information to landowners has been and will continue to be a vital element of fostering project support and involvement. A number of information distribution techniques have been used in the WPP and will continue to be used.

Newsletters

Beginning in June 2011, a series of semi-annual newsletters began being developed and has since served as an outlet to keep landowners across the watershed informed about WPP implementation progress, educational events planned in the watershed, financial and technical assistance opportunities available to landowners, program meeting summaries and announcements as well as other pertinent information related to the watershed.

Copies of each newsletter are sent in paper format and electronically to approximately 1,200 landowners and agency personnel interested in the Pecos River watershed. The newsletters are also available on the program website.

News Releases and Popular Press

News releases have been and will continue to be an integral method of disseminating information to the general public regarding WPP implementation. TWRI works with local contacts as well as TSSWCB to develop effective news releases that describe progress made and work to promote the adoption of effective resource management practices proven to have positive impacts on watershed health and water quality.

AgriLife Today, the news agency of Texas A&M AgriLife, also develops numerous news releases that focus on topics relevant to landowners in the Pecos River watershed. Many of these announce meetings, field days and workshops hosted by AgriLife Extension on topics such as rangeland management, predator control, nutrient management, water conservation and other relevant topics. When these articles are released, they are reposted on the program website to further disseminate the useful information they contain.

To date, 41 articles relevant to managing the resource of the Pecos River watershed have been posted to the program website since WPP implementation began.

Direct Mailings and Emails

In some cases, direct mailings and emails are utilized to inform landowners and others interested in the Pecos River. Direct contacts are used primarily for meeting announcements and newsletters. Occasionally, direct mailings will be used to notify landowners of management activities that are occurring in the general vicinity of their property.

Field Days, Meetings, Seminars and Workshops

Field days, meetings, seminars and workshops held across and near the watershed have also played an important role in promoting WPP implementation and general resource management. While some of these events are developed and delivered as a part of the WPP implementation program, many of these programs are conducted by AgriLife Extension, NRCS, SWCDs or other organizations. Regardless of which entity conducts these events, program personnel are in attendance at these events and often provide an update on WPP implementation as well as opportunities for landowners to receive technical or financial assistance. Table 6 below illustrates the date, location, topic and attendance of each of these events hosted in or near the watershed since completion of the WPP.

Table 6. Informational meetings conducted in and near the Pecos River watershed since WPP implementation began (events in bold were delivered as a direct part of WPP implementation efforts)

Date	Location	Event Topic	Attendance
10/1/2008	Midland/Odessa	Water Conservation/Rainwater Harvesting	125
10/15/2008	Coyonosa	Ag Water Conservation, Nutrient Management and Pesticide Control	55
11/13/2008	Fort Stockton	Pesticide Management	113
11/25/2008	McCamey	Water Conservation/Rainwater Harvesting	8
12/9/2008	Fort Stockton	Water Conservation (Judges and Commissioners)	38
1/20/2009	Stanton	Pesticide Management	147
2/20/2009	Sanderson	Effective Water Management	18
4/28/2009	Alpine	Water Well Screening	188
4/29/2009	Sanderson	Lawn & Garden Water Conservation	12
6/25/2009	Kermit	Rainfall Erosion	6
7/12-16/2009	Monahans	State Youth Water Camp	12
7/29/2009	St. Lawrence	Pesticide Management	93

9/1/2009	Andrews	Water Conservation/Rainwater Harvesting	33
9/15/2009	St. Lawrence	Water Efficiency and Pesticide Management	112
10/14/2009	Marfa	Water Conservation/Rainwater Harvesting	16
11/9/2009	Midland	Water Efficiency	8
11/18/2009	Alpine	Water Conservation/Rainwater Harvesting	12
11/19/2009	Fort Stockton	Pesticide Management	87
12/8/2009	**Pecos**	**WPP Implementation Overview**	**17**
12/8/2009	**Imperial**	**WPP Implementation Overview**	**21**
12/8/2009	**Iraan**	**WPP Implementation Overview**	**19**
12/8/2009	**Ozona**	**WPP Implementation Overview**	**15**
1/7/2010	**Pecos**	**Watershed Protection Plan**	**22**
1/19/2010	Stanton	Water Efficiency and Pesticide Management	122
04/8-9/2012	Alpine	Trans-Pecos Prescribed Fire Symposium	150
5/26/2010	Del Rio	Wildlife Water Management	10
7/13/2010	Monahans	Pecos Valley RC&D Council, Inc.	10
7/15/2010	Monahans	State Youth Water Camp	35
7/15/2010	Pecos	Alfalfa Water Management	33
7/22/2010	Sanderson	Landscape Irrigation Efficiency	12
7/22/2010	Van Horn	Water Quality and Efficiency	37
8/16/2010	Alpine	Well Screening	148
9/1/2010	Marfa	Wildlife Water Management	6
9/9/2010	Pecos	Pecos Rotary Club	35
9/13/2010	Ozona	Water Conservation/Rainwater Harvesting	13
9/14/2010	Midkiff	Irrigation Efficiency	139
9/14-16/2010	Alpine	Saltcedar Biological Control Consortium	50
10/13-15/2010	Odessa	Texas Section Society for Range Management Annual Meeting	150
10/26/2010	Ozona	Predator Workshop	22
11/10/2010	Fort Stockton	Pesticide Management	115
11/17/2010	Marfa	Water Management	31
12/9/2010	Midland	Pesticide Management	78
3/15/2011	**Pecos**	**WPP Implementation Update**	**15**
3/15/2011	**Imperial**	**WPP Implementation Update**	**13**
3/16/2011	**Iraan**	**WPP Implementation Update**	**20**
3/16/2011	**Ozona**	**WPP Implementation Update**	**22**
3/24/2011	Alpine	Groundwater Rights	13
3/25/2011	Big Lake	Rancher's Workshop	14
4/5/2011	Fort Stockton	Well Contamination by Energy	6
4/7/2011	Ozona	Well Contamination by Energy	10
4/18/2011	McCamey	Irrigation Efficiency	8
6/7/2011	Fort Stockton	Pecos-Reeves County Texas Farm Bureau Board Meeting	8
6/28/2011	**Pecos**	**Texas Watershed Stewards**	**20**
6/29/2011	**Iraan**	**Texas Watershed Stewards**	**23**
7/22/2011	Pecos	Salt Accumulations during Drought	24
8/2/2011	**Pecos**	**WPP Implementation Update**	**13**
8/2/2011	**Imperial**	**WPP Implementation Update**	**13**
8/3/2011	**Iraan**	**WPP Implementation Update**	**5**
8/3/2011	**Ozona**	**WPP Implementation Update**	**8**
10/12-13/2010	San Angelo	Texas Section Society for Range Management Annual Meeting	150

10/13/2011	Monahans	Groundwater Conservation Districts	41
10/27/2011	Van Horn	Water Conservation/Rainwater Harvesting	6
11/2/2011	Alpine	Water Well Screening	101
11/10/2011	Fort Stockton	Pesticide Management	66
11/29/2012	El Dorado	Range and Pasture Management	23
11/30/2011	Marfa	Water Quality and Use	12
12/13/2011	Midland	Pesticide Management	95
1/24/2012	Stanton	Groundwater Contamination via Oil and Pesticides	94
3/1/2012	Crane	Permian Basin Range Recovery Conference	19
3/1/2012	Monahans	Groundwater Conservation Districts	44
3/13/12	Fort Stockton	Pecos-Reeves County Farm Bureau board meeting	8
3/21/2012	Pecos	Pecos Downtown Lion's Club	20
4/5/12	Pecos	Pecos Rotary Club	20
4/10/2012	Pecos	Pecos River Compact Commission	60
4/23/2012	**Live Oak Ranch**	**WPP Implementation Field Day**	**31**
4/24/2012	**Santa Rosa Springs**	**WPP Implementation Field Day**	**39**
7/16/2012	Del Rio	Wildlife and Range Workshop	17
7/17/2012	Garden City	West Texas Livestock and Range Conference	21
7/31/2012	Ozona	Range, Livestock and Wildlife Management	29
8/2-3/2012	Alpine	Trans-Pecos Wildlife Conference	165
10/12/2012	Sonora/Rock Springs	Predator Management	13
10/12/2012	Fort Stockton	Pesticide Management	
10/16/2012	Rankin	Livestock and Range Update	8
4/10/2013	Ruidoso, NM	Pecos River Compact Commission	45
4/18/2013	Sonora	Water is Life Conference	8

Events listed in bold text are WPP Implementation specific meetings

Texas Watershed Steward Workshops

The Texas Watershed Stewards Program administered two workshops in the Pecos River Watershed on June 28-29, 2011. Texas Watershed Steward is a science-based watershed training program that helps citizens identify and take action to address local water quality impairments. The Texas Watershed Stewards Program is funded through Clean Water Act §319(h) nonpoint source grants from the Texas State Soil and Water Conservation Board and the U.S. Environmental Protection Agency. A total of 20 participants attended the workshop in Pecos and 23 attended the workshop in Iraan. Post workshop evaluations indicated that as a result of the event:

Pecos

- 88% of participants were better equipped to be stewards of their watershed.
- 81% indicated an intention to participate in community cleanup activities.
- 56% indicated an intention to get involved in local planning/zoning decisions.
- 50% indicated an intention to communicate water issues to elected officials.
- 69% indicated an intention to help develop a plan for their watershed (WPP).

- 63% indicated an intention to help form or become a member of a local watershed group.
- 60% indicated an intention to adopt new BMPs to help protect their watershed.

Iraan

- 100% of participants were better equipped to be stewards of their watershed.
- 65% indicated an intention to participate in community cleanup activities.
- 53% indicated an intention to get involved in local planning/zoning decisions.
- 53% indicated an intention to communicate water issues to elected officials.
- 59% indicated an intention to help develop a plan for their watershed (WPP).
- 53% indicated an intention to help form or become a member of a local watershed group.
- 63% indicated an intention to adopt new BMPs to help protect their watershed.

More information about this program is available on the WPP website or at the Texas Watershed Steward Program Website listed below:

Texas Watershed Steward Program: http://tws.tamu.edu/

Water Quality Update

Water quality and the factors that influence the quality and quantity of water in the river have and continue to be the primary concerns driving the development and implementation of the WPP. When the WPP was being developed, the state was working on completing the *2006 Texas Water Quality Inventory and 303(d) List* which was finally published in July 2008. With this lists' publication, the Pecos River between US 80 (Business 20) and US 67 was officially considered impaired for dissolved oxygen levels lower than the state's designated water quality standard. Additionally, golden algae was considered to be a concern throughout the entire waterbody; nitrates, ammonia, and orthophosphorus were listed as concerns in Red Bluff Reservoir and chlorophyll-a was at problematic levels between US 67 and US 290.

Since the WPP's completion, the *2008 Texas Water Quality Inventory* and *2010 and 2012 Texas Integrated Report* (the name of the report changed) have been developed and published by TCEQ. In each of these reports, water quality concerns remain; however, some changes have occurred. Some of these changes could be caused by changing conditions in the watershed or simply a result of improved monitoring techniques while others are a result of changes at TCEQ that impact the way waterbodies are assessed.

As discussed earlier, drought has gripped the watershed for much of the time since the WPP was developed. These conditions paired with the ever increasing demand for water across the basin have undoubtedly impacted instream water quality and quantity as well.

Assessment Units

Waterbodies in Texas are categorized based on their size and volume flow. Two main categories, classified and unclassified, are used to designate a stream. Classified waterbodies are typically larger streams while unclassified streams are smaller and often tributaries of the classified

segments. Classified and unclassified segments are subdivided into sections called assessment units (AU). TCEQ defines an AU as "the smallest geographic area of use support reported in the water body assessment."

During the time between the publication of the *2008 Texas Water Quality Inventory* and the *2010 Texas Integrated Report*, TCEQ reorganized AU boundaries statewide. Prior to this change, AU numbers were generally allocated in ascending order from the upper part of a waterbody to the lower. Now AU numbers (Figure 9) have been essentially reversed so that numbers are allocated in ascending order starting with the lower extent of the waterbody and working upstream.

In 2011, the Pecos River watershed coordinator proposed to TCEQ during the annual Coordinated Monitoring Meeting held in Midland that the boundary between AU units 2311_03 and 04 be moved. FM 1776 had previously served as the AU boundary prior to this; however, the Ward Two Irrigation Turnout upstream of FM 1776 drastically alters the hydrology of the river upstream and downstream of its location. Water in the river above this irrigation diversion often never passes the diversion point due to the minimal flow of the river in this area. Below the diversion point, the amount of water in the river is solely dependent upon groundwater inflows to the river in the immediate area often resulting in little or no flow in the river. Subsequently, water quality parameters such as DO and water temperature measured at FM 1776 are not representative of this segment of the river. Moving the AU boundary to the diversion point provides a more reasonable split between the portion of the river above the diversion and that below. Table 7 below illustrates the changes made to the AU by TCEQ. This shift in AU boundaries resulted in the removal of AU 2311_04 (Business 20 to Ward Two Irrigation Turnout) from the *2012 Texas Integrated Report* as an impaired water body.

Ward Two Irrigation Diversion Dam completely stops the flow of the river under most conditions

Table 7. Descriptions of Pecos River segments and assessment units as defined by TCEQ

Segment No.	Segment Name	Segment Description
2310	*Lower Pecos River*	From a point 0.7 km downstream of the confluence of Painted Canyon in Val Verde Co. to a point immediately upstream of the confluence of Independence Creek in
2310A	*Independence Creek*	From the confluence of the Pecos River NE of Sanderson in Terrell Co. to a point approximately 4.1 km east of US Hwy 285 in Pecos County
2311	*Upper Pecos River*	From a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell Co. to Red Bluff Dam in Loving/Reeves Co.
2312	*Red Bluff Reservoir*	From Red Bluff Dam in Loving/Reeves Co. to New Mexico state line in Loving/Reeves Co., up to normal pool elevation 2842 feet (impounds Pecos River)

Assessment Units (Sub-Segments of the above reaches)	Assessment Unit Description: Prior to 2010	Assessment Unit Description: 2010 and Beyond
2310_01	Upper segment boundary to Big Hackberry Canyon	From the Devils River Arm of Amistad Reservoir confluence upstream to FM 2083 near Pan Dale
2310_02	From FM 2083 near Pan Dale Rd to the lower segment boundary	From FM 2083 near Pan Dale upstream to just upstream of the Independence Creek Confluence
2310A_01	Upper end of creek to Surveyor Canyon	From the Pecos River confluence to the unnamed tributary 0.37 km upstream of State Hwy 349
2310A_02	From Surveyor Canyon to the confluence with the Pecos River	
2311_01	Red Bluff Dam to FM 652	From just upstream of the Independence Creek confluence to US Hwy 290
2311_02	FM 652 to SH 302	From US Hwy 290 upstream to US Hwy 67
2311_03	SH302 to Barstow Dam	From US Hwy 67 upstream the Ward Two Irrigation Turnout
2311_04	Barstow Dam to US 80 (Bus 20)	From the Ward Two Irrigation Turnout upstream to US Hwy 80 (Business 20)
2311_05	US 80 (Bus 20) to FM 1776	From US Hwy 80 upstream to the Barstow Dam
2311_06	FM 1776 to US 67	From the Barstow Dam upstream to State Hwy 302
2311_07	US 67 to US 290	From State Hwy 302 upstream to FM 652
2311_08	US 290 to lower segment boundary	From FM 652 upstream to Red Bluff Dam
2312_01	Texas/New Mexico state line to Mid-lake	From the Red Bluff Dam to mid-lake
2312_02	Mid-lake to Red Bluff Dam	From mid-lake to the Texas/New Mexico state line

2012 Texas Integrated Report

The *2012 Texas Integrated Report* was accepted by U.S. EPA on May 9, 2013 and is the most recent, state-approved assessment of Pecos River water quality. Data in this report was used to gauge changes in water quality since the WPP's development. In a several cases, water quality data were not available during the 2006 assessment and thus a direct comparison cannot be made. Table 8 illustrates water quality parameters identified in the WPP 'criteria for assessing success' in WPP implementation. This table compares water quality as reported in the *2006 Texas Water Quality Inventory and 303(d) List* and *2012 Texas Integrated Report.*

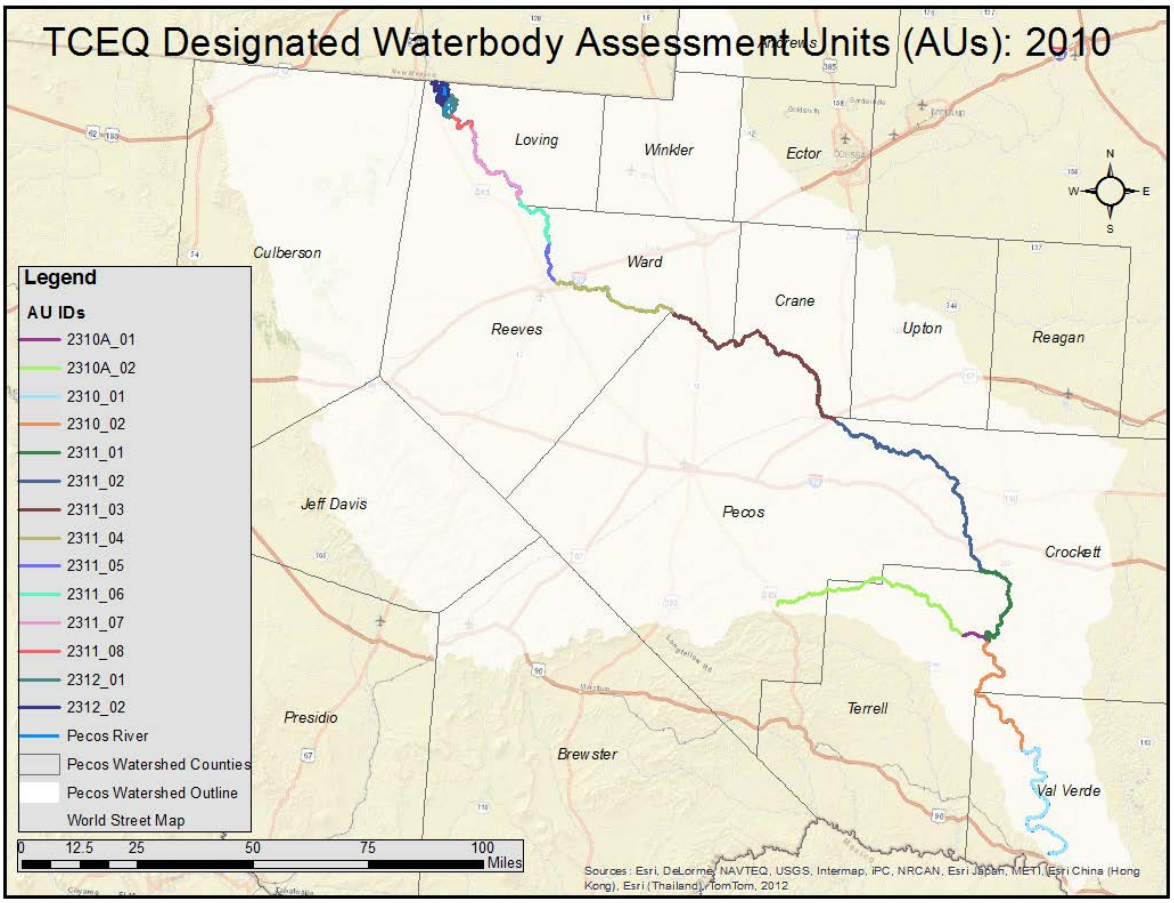


Figure 9. Waterbody assessment units in the Pecos River watershed

In general, the quality of water in the river as reported in the 2006 and 2012 303(d) Lists can be described as static. Notable improvements observed include DO grab sample levels in the portion of the Pecos River between US 80 and US 290. Additional samples collected in AUs 2311_02, 03 and 04 did not record any DO levels below the designated water quality standard. Nutrient parameters collected in Red Bluff Reservoir also illustrated an improving trend with additional samples collected resulting in no screening level exceedances. Chlorophyll-a did not resemble this same trend though and continued its decline with many additional samples collected being above the screening level designated for the lake and river. Total dissolved solids (TDS) behaved much the same way with average levels recorded in Red Bluff Reservoir and the Upper Pecos showing improvements while the Lower Pecos and the Lake Amistad (Rio Grande arm) showed slightly higher TDS levels than before.

While comparing the results of the *2006 Texas Water Quality Inventory and 303(d) List* and *2012 Texas Integrated Report* is useful, this approach doesn't clearly illustrate how water quality changes over time. Many spatial and temporal changes are masked in these reports and the daily, weekly, monthly and annual variations in water quality seen in the Pecos River are hidden.

Table 8. Water quality findings as reported in the 2006 and 2012 303(d) Lists

		2006 303(d) List				2012 303(d) List			
			# of Samples				# of Samples		
Water Quality Parameter	Water Quality Standard	Assessment Unit	Assessed	Exceeding	Mean of Samples	Assessment Unit	Assessed	Exceeding	Mean of Samples Exceeding
Dissolved Oxygen Grab (screening)	5.0 mg/L	2310_02	43	0		2310_01	41	1	4.6
		2310_01	21	0		2310_02	28	0	
	6.0 mg/L	2310A_02	20	0		2310A_01	27	0	
	5.0 mg/L	2311_07	20	1		2311_02	28	0	
		2311_06	19	4		2311_03	55	7	3.89
		2311_05	19	1		2311_04			
		2311_04				2311_05	3	0	
		2311_02	12	0		2311_07	4	0	
		2311_01	20	1		2311_08	27	4	4.13
		2312_02	11	0		2312_01	16	2	4.57
		2312_01	11	2		2312_02	14	2	3.58
24 hr Dissolved Oxygen Average	6.0 mg/L					2310A_01	57	0	
	5.0 mg/L	2311_06	4	0		2311_03	24	1	4.9
		2311_05	4	0		2311_04	0	0	
24 hr Dissolved Oxygen Minimum	4.0 mg/L					2310A_01	57	0	
	3.0 mg/L	2311_06	4	4		2311_03	24	12	1.75
		2311_05	4	3		2311_04	0	0	
						2311_08	5	1	2.4
					Mean of Samples				Mean of Samples
Total Dissolved Solids	4,000 mg/L	2310	70		2038.00	2310	71	0	2538.08
	15,000 mg/L	2311	115		11139.00	2311	258		10351.45
	9400 mg/L	2312	22		6433.00	2312	30		6104.73
	800 mg/L	2305_01	59		522.00	2305_01	85		561.19
Ammonia	0.11 mg/L	2312_02	11	5		2312_01	15	4	0.17
Chlorophyll-a	14.10 µg/L	2310_02	10	0		2310_01	16	2	18.90
		2310_01	20	0		2310_02	25	1	19.80
						2310A_01	26	0	
		2311_07	22	8		2311_02	26	10	27.62
		2311_06	20	3		2311_03	52	12	28.43
		2311_05	21	4		2311_04	0	0	
		2311_04	11	2		2311_05	3	0	
		2311_02	11	2		2311_07	2	0	
		2311_01	21	4		2311_08	24	15	31.49
	26.7 µg/L	2312_02	11	3		2312_01	12	6	48.07
		2312_01	11	3		2312_02	10	7	51.59
Nitrate	0.37 mg/L	2312_02	11	4		2312_01	14	0	
		2312_01	11	6		2312_02	11	2	0.55
Orthophosphorus	0.15 mg/L	2312_02	11	6		2312_01	15	0	
									Mean of Samples
Bacteria									
Enterococcus	33 cfu/100 mL	N/A				2311_02	4	1	45.56
						2311_03	4	1	47.71

Cells colored green indicate improving trends in water quality between the 2006 to 2012 assessments
Cells colored yellow indicate a relatively static status in water quality between the 2006 to 2012 assessments
Cells colored orange indicate deteriorating trends in water quality between the 2006 and 2012 assessments
Red cells indicate the water quality impairment for low dissolved oxygen on the Pecos

Clean Rivers Program Monitoring

Quarterly monitoring conducted through CRP is the basis for water body assessments conducted in Texas. CRP monitoring is conducted on a quarterly basis at designated locations in the watershed as illustrated in Figure 10. Data collected at these stations is integrated into TCEQ's SWQM database and are available online. For the purposes of this WPP update, data at each of these sites are presented to illustrate changing water quality over time. The period of record of data available at each site varies with some data available back to the early 1970s. Showing the complete data record provides a long-term look at water quality trends at each site.

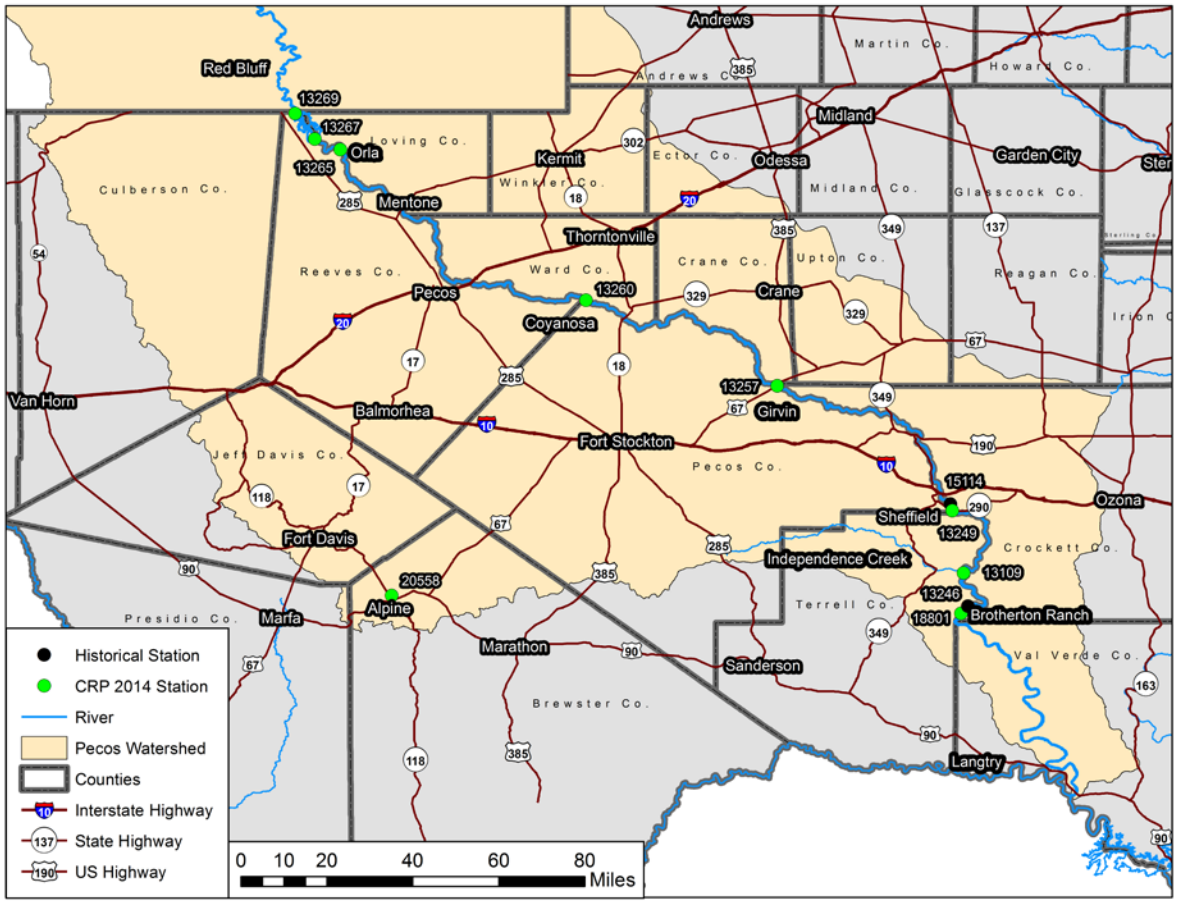


Figure 10. CRP stations monitored in fiscal year 2014 and other stations where available 'historical' water quality data was graphed to illustrate water quality over time

Dissolved Oxygen

Observed levels of DO vary considerably along the length of the river and over time. Generally speaking though, the range of variation in observed DO concentrations is increasing over time. This suggests that the photosynthesis-respiration cycle of instream aquatic vegetation is stronger (produces more oxygen during the day and consumes more oxygen at night) and may be fueled by nutrients buried in the stream's sediment. The dwindling flows of the river further support this assessment as scouring flows to remove deposited sediments downstream rarely occur and when they do, are commonly caught by irrigation diversion dams. Figure 11 illustrates changes in DO over time from upstream to downstream.

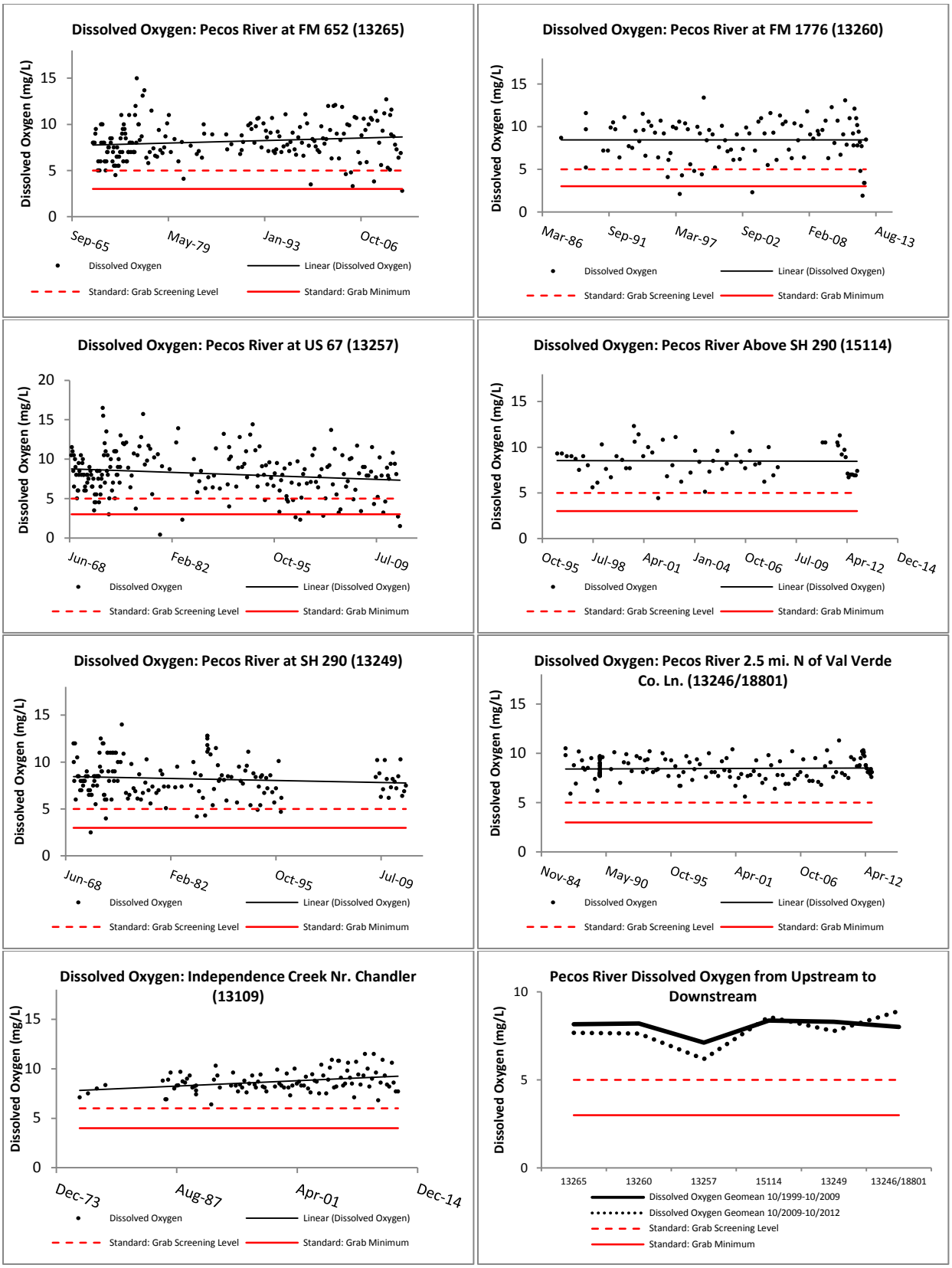


Figure 11. DO data collected at each CRP monitoring site over time and the long-term average of the DO at each site pre and post-WPP implementation

In addition to data being presented by site, the last graphic in Figure 11 compares long-term average DO levels between stations. Pre and post-WPP implementation averages are presented and illustrate general trends in DO over time at each site. With the exception of the US 290 and Val Verde County line sites, DO levels have been lower following the implementation of the WPP. Logic suggests that drought conditions experienced since WPP implementation began are the primary influence of instream DO levels. The CWQMN data on DO presented following this section suggests otherwise.

Specific Conductance

Observed specific conductance levels in the river are quite variable and do not exhibit any obvious responses over time. In some cases, trends over time at a given site are decreasing while others are increasing. The range of specific conductance levels recorded within each site also varies considerably illustrating the dynamic nature of salt levels in the river.

Despite its variability and changing trends along the length of the river, the specific conductance data are more telling of ambient water quality. For example, elevations in monitored specific conductance levels coincide with drought conditions or times of limited reservoir releases from Red Bluff. Late 2001 and 2002 provide an example of this. During this time, moderate to severe drought conditions were experienced in the basin and water deliveries from New Mexico fell to deficit levels. As a result, no water was released from Red Bluff reservoir other than what seeped through the gates. Rises in specific conductance can be seen at the Orla and Coyanosa sites illustrated in Figure 12 (13265 and 13260 respectively) during this same time period. This suggests that as less water is present in the river, salts become concentrated. Alternatively, in wetter years such as 2005 and into 2006, specific conductance levels decrease as a result of increased rainfall and inflows from New Mexico.

With the exception of the monitoring site at US 67 near Girvin, observed trends in specific conductance levels are generally improving. The site at Girvin is the obvious deviant from this tendency. Data collected at this site continues to yield increasing specific conductance levels. One factor potentially driving this increase is the influence of saline groundwater. Below Coyanosa, the river becomes groundwater dominated as any waters released from Red Bluff for irrigation purposes have been diverted by this point. The exact locations where saline groundwater enters the river upstream of Girvin are not known; however, the salinity source assessment that will be conducted between Coyanosa and Girvin should provide the needed information to find these intrusion points.

The last portion of Figure 12 compares average specific conductance levels from upstream to downstream both pre and post WPP implementation. Average stream flow levels are also provided to illustrate how specific conductance levels respond to changes in stream flow levels. Upstream of US 290, specific conductance levels were found to be higher since WPP implementation began than before while downstream of US 290, the opposite is observed. Stream flow levels are also lower at all sites since WPP was completed and implementation began.

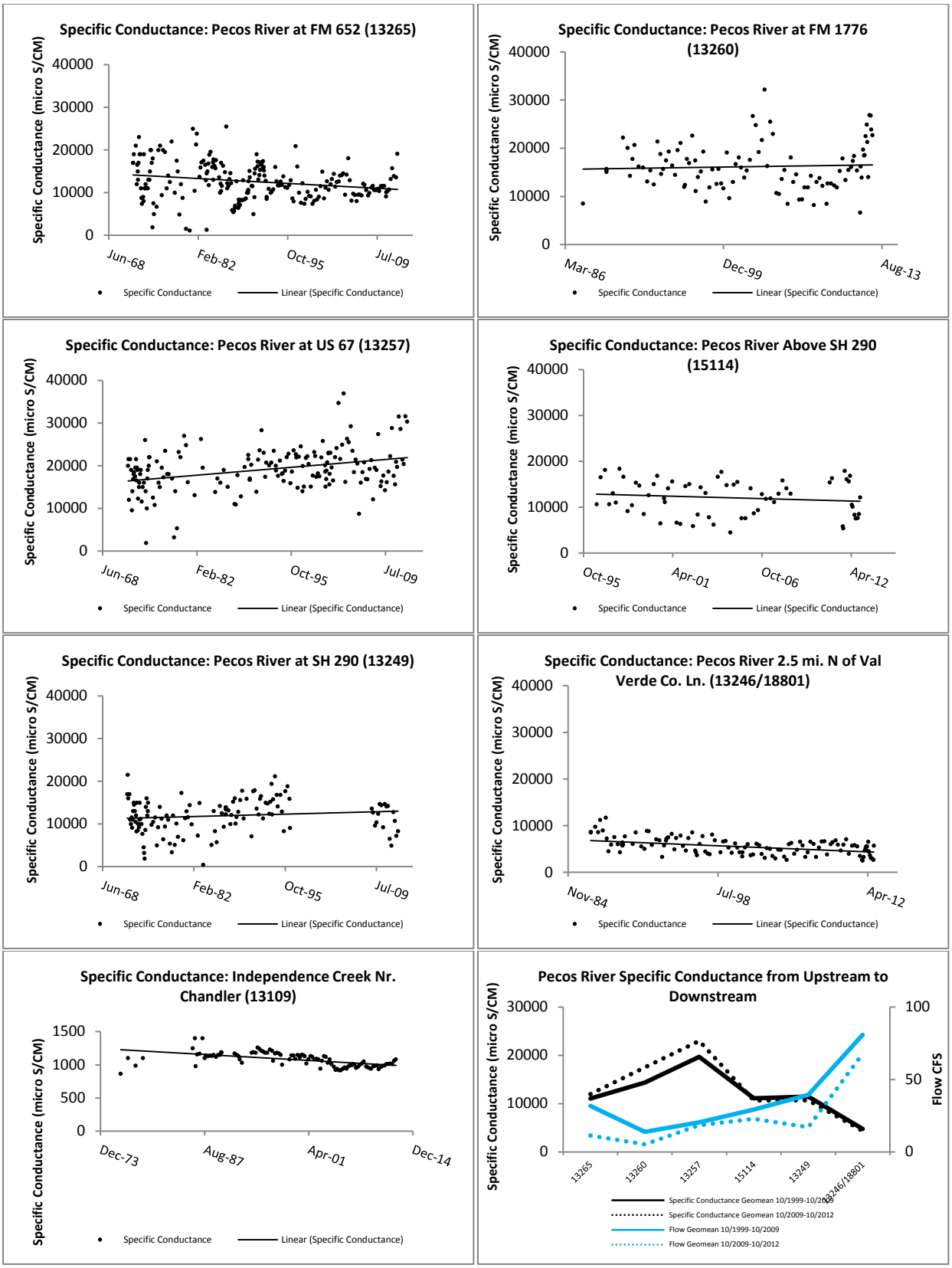


Figure 12. Specific conductance data collected at each CRP monitoring site over time and the long-term average of the specific conductance at each site pre and post-WPP implementation

Continuous Water Quality Monitoring Network Data

To better illustrate the daily, weekly, monthly and annual trends in water quality across the Pecos River not obvious in the 303(d) Lists, data from the CWQMN stations can be utilized. Of the 9 CWQMN stations in the Pecos River watershed, only 4 of these stations (see Table 4 on Page 25) have a data record that predates or coincides with the development of the WPP. As a result, these 4 stations have been selected to illustrate water quality variations since WPP implementation began.

Each of the CWQMN stations is equipped with an automated water instrument that allows the station to collect data on specific conductance (a proxy for TDS), DO, pH and temperature and records data on an hourly interval. These data are automatically transmitted to TCEQ and posted to the internet where the complete data record can be accessed.

Dissolved Oxygen

The availability of the DO data through the CWQMN greatly enhances the ability to evaluate DO trends over time and at various locations across the watershed. DO data from these sites was also utilized in the effort to evaluate DO levels in the river; however, it was discovered that fouling of the instruments installed at these sites is quite common in the Pecos River. The term fouling refers to the buildup of algae, biofilm (bacteria) or even sediment on and around the instrument. This can cause the accuracy of the instrument to decline thus causing the data to drift. The level of drift experienced at each site is not consistent; therefore, the use of these data for modeling purposes was not advised. To account for this data drift, only data collected within 2 days of instrument calibration and maintenance was used in the computer model to evaluate DO loads and potential impacts of management implementation.

Despite the drift in data from the CWQMN sites, they are still quite useful in illustrating seasonal changes in water quality. Figure 13 utilizes the complete data set available at the CWQMN stations and illustrates DO levels observed on the Pecos River moving downstream in order from Pecos (710) to Coyanosa (709), to Sheffield (735) and to the Val Verde County line (729). Hourly data were screened to identify the daily minimum value recorded for DO. Since this is the measure of concern, only the daily minimum DO value was plotted thus making the dataset more manageable and plots easier to interpret.

The CWQMN data illustrate that DO along the river exhibits sizable changes daily, seasonally and spatially. With the exception of early 2005 at Station 710, DO levels generally exhibit the same trends on an inter-annual basis. As expected, DO levels peak during the winter months when the photosynthesis-respiration cycle is depressed and cooler water temperatures allow for increased oxygen dissolution into the water column. Alternatively, DO levels are at their lowest in the summer months when water temperatures are warmer and the photosynthesis-respiration cycle is operating at its highest. Somewhat surprisingly, DO levels observed in the summer of 2011 were higher than in previous summers. With this time being the hottest and driest period on record, it was expected that DO levels would be adversely impacted.

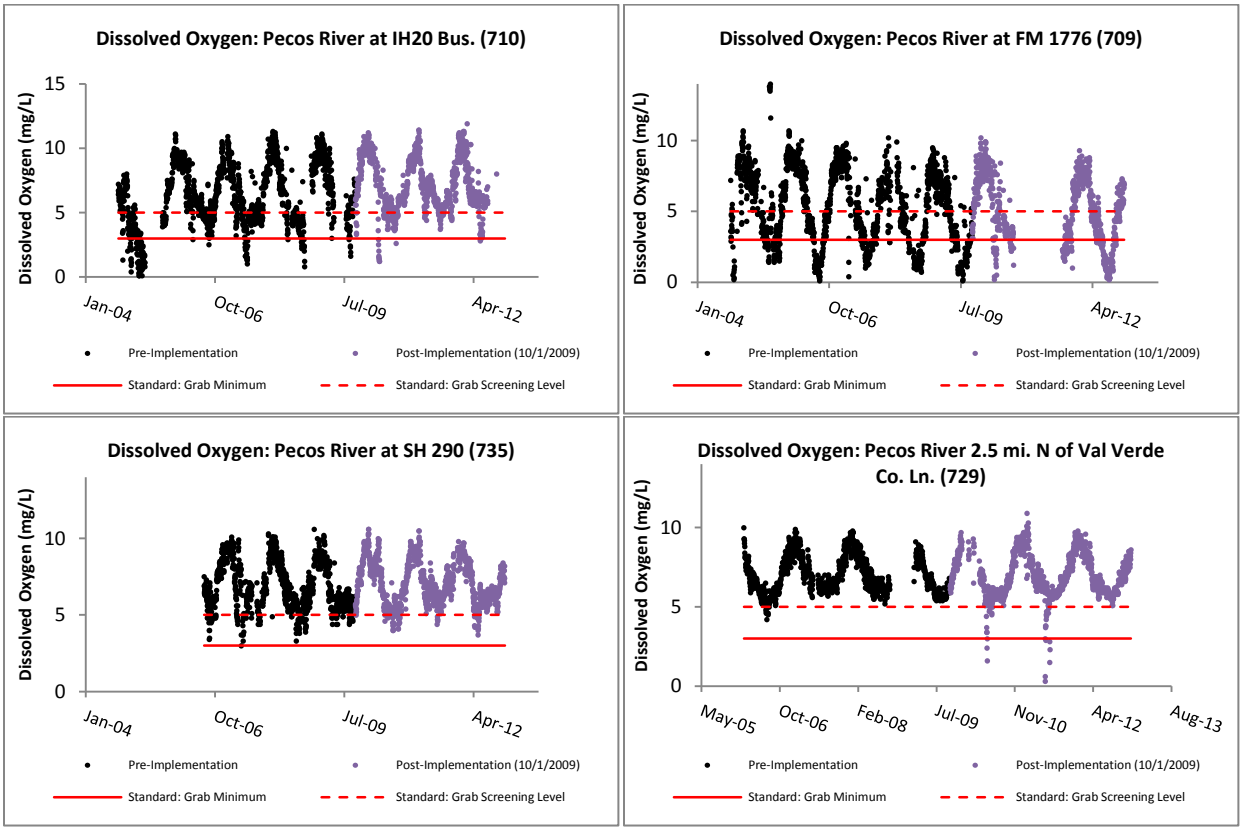


Figure 13. Continuous dissolved oxygen daily minimum data on the Pecos River (purple points denote those recorded following the initiation of WPP implementation)

Specific Conductance

Specific conductance is a measure of the conductivity of dissolved ions in the water column and is directly related to conductivity and TDS. Specific conductance is much easier to measure in the field as an automated instrument can quickly and accurately collect the reading. Inversely, measuring TDS is usually conducted in a laboratory and involves evaporating water off of the sample and weighing the remaining solids. As a result of the ease of measurement, specific conductance is more commonly utilized than TDS. To convert from specific conductance readings to conductivity, the measurement simply needs to be adjusted for temperature. A conversion factor must be applied to convert specific conductance to TDS; for the Pecos River, the appropriate conversion has been found to range between 0.63 for the Lower Pecos to 0.73 for the Upper Pecos (Hoff 2012).

As with the DO data, the continuous data for specific conductance improve insight into the daily, seasonal, inter-annual and spatial variation in specific conductance measurements on the river. Figure 14 illustrates specific conductance levels observed on the Pecos River moving downstream in order from Pecos (710) to Coyanosa (709), to Sheffield (735) and to the Val Verde County line (729). Hourly data were aggregated using a daily average.

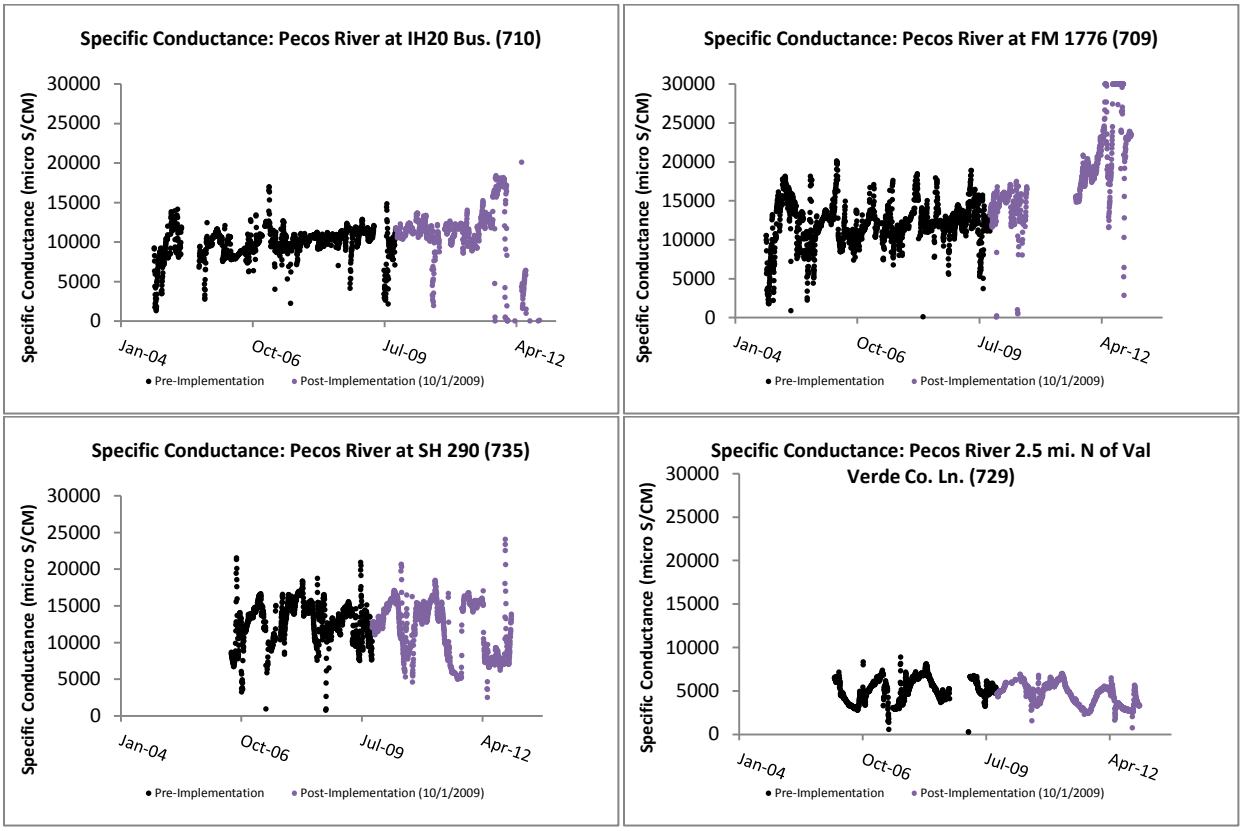


Figure 14. Specific conductance data collected from Pecos River CWQMN stations (purple points denote those recorded following the initiation of the first WPP implementation project)

Trends observed in specific conductance data from the CWQMN stations are more definitive than those in the DO data. These trends are not unexpected as the presence of drought in the watershed during the years following development of the WPP has had adverse impacts on in stream water quality and quantity. This lack of rainfall highlights the influence of groundwater on the river and supports the long held understanding that saline groundwater in the upper portion of the river causes instream specific conductance levels to increase downstream to the area around Girvin near US 67. Below this point, groundwater inflow that is of better quality begins to enter the river and measured specific conductance levels begin to decrease.

Implementation Schedule and Progress

In this section of the WPP update, the original schedule for implementing management measures and activities described in the WPP is presented along with implementation accomplishments made to date. This table (Table 9) also shows the number of practices planned as well as those completed to date. The implementation timeline is an estimate that is subject to change because a multitude of factors dictate when a project or task will be carried out. Delays in project development, securing funding, acquiring adequate support for the management measure or practice, weather and permitting or legal constraints are just a few hurdles that can prevent implementation from being conducted on schedule. Ultimately, implementation of voluntary BMPs on private property will be solely at the discretion of the landowner.

The implementation schedule was designed with a 10-year implementation period set to start in 2009. Table 9 illustrates targeted implementation timelines for specific management measures and includes the anticipated number of practices planned for implementation as well as the implementation status as of June 1, 2013.

Implementation carried out through the WPP Implementation Project: WQMPs, Saltcedar Leaf Beetles, Saltcedar Spraying, Saltcedar Debris Burning

Table 9. Management practice implementation goals and accomplishments

Management Measure	Responsible Party	Estimated Units to be Implemented	Estimated Number of Practices Implemented			Total Number of Practices Completed as of June 1, 2013	Comments
			Year				
			1-3	4-6	7-10		
Salinity Control							
Malaga Bend control measures	State of New Mexico/ Private Sector	1	1	---	---	1	Operational and expansions planned
Coyanosa to Girvin salt source study	TCEQ/ AgriLife Research	1	1	---	---	0	Initiated November 2012; projected completion date of October 2014
New Mexico to Texas delivery schedule revision	PRCC/ Red Bluff WPCD/ New Mexico	TBD	TBD				No water deliveries to Texas due to drought
Salinity management feasibility study (Coyanosa to Girvin)	TWDB/ USACE/ AgriLife Research	1	---	1	---	0	USACE in process of initiating watershed assessment to evaluate salinity mgmt. options
Saltcedar and Giant Cane Control							
Saltcedar (chemical)	TSSWCB/ Upper Pecos SWCD/ Crockett SWCD	2,158 acres	1,775 †	383	---	2,642 acres	As much virgin saltcedar as possible was treated where landowner permission granted
Saltcedar (biological w/ dispersion eval.)	Extension	20 sites	10 †	10	---	29	Need for future dispersal is minimal barring extreme climatic conditions
Saltcedar (biological)	Landowner	50 sites	20	30	---	unknown	Natural beetle dispersal achieved this goal; however, without sufficient tracking quantification is impossible
Giant cane (chemical)	TSSWCB/ Crockett SWCD	TBD	TBD	TBD	---	0 acres	
Debris burning /regrowth suppression	Texas A&M Forest Service / Private Co.	350 miles	225 † miles	125 miles	---	35 miles	Private Co. began burning in April 2013 and ended in June 2013
Giant cane acreage assessment	TBD	1	1	---	---	0	

Management Measure	Responsible Party	Estimated Units to be Implemented	Estimated Number of Practices Implemented			Total Number of Practices Completed as of June 1, 2013	Comments
			Year				
			1-3	4-6	7-10		
Upland Brush Control							
Chemical	Extension/ NRCS/ SWCD	TBD	TBD	TBD	TBD	< 81,311 acres	EQIP funding enabled this level of brush control in counties identified in Figure 4.
Mechanical	Extension/ NRCS/ SWCD	TBD	TBD	TBD	TBD		
Biological Diversity/Land Management in Riparian Zone							
WQMPs	Upper Pecos and Crockett SWCDs	120 plans	20 †	40	60	16	Landowner interest has been much less than expected
WQMP technician	Upper Pecos and Crockett SWCDs	2 technicians for 10 yrs.	2 †	2	2	1	1 technician left the program after year 2 and the position was not refilled
Riparian revegetation (planted)	Extension/ Landowner/ NRCS/ SWCD	~3,750 ac	25%	25%	50%	0	NRCS nor SWCDs have provided technical or financial assistance for riparian planting
Riparian revegetation (natural)	Landowner	~11,250 ac	All areas will be naturally revegetated				
Dissolved Oxygen							
River assessment to ID suitable locations for artificial riffles	TCEQ/ TPWD/ University	1	1	---	---	1	DO Modeling Project completed by TIAER
Artificial riffles	Extension/ TCEQ/ TPWD/ USACE	as many as feasible	---	TBD	TBD	0	Practice no longer considered feasible
Sediment Control							
Riparian revegetation (planted)	Extension/ Landowner/ NRCS/ SWCD	~3,750 ac	25%	25%	50%	0	NRCS nor SWCDs have provided technical or financial assistance for riparian planting
Riparian revegetation (natural)	Landowner	~11,250 ac	All areas will be naturally revegetated				

Management Measure	Responsible Party	Estimated Units to be Implemented	Estimated Number of Practices Implemented			Total Number of Practices Completed as of June 1, 2013	Comments
			Year				
			1-3	4-6	7-10		
Oil and Gas Production							
Well plugging	RRC/ Landowners	As many as needed	TBD	TBD	TBD	22	The Texas Railroad Commission indicated that 22 orphan wells were plugged since WPP implementation began
Nutrient Concerns							
Nutrient management plans in NM	NM Extension/ NRCS	N/A	---	---	---	N/A	
Nutrient management plans in TX (WQMPs) on land away from river	SWCD	50	20	40	60	2	EQIP provided technical and financial assistance for 2 NMPs on 397 acres. Declining crop production has decreased landowner interest in these plans
Water Quantity							
Irrigation canal water audits	Extension/ Irrigation Districts	TBD	TBD	TBD	TBD	0	Exceptional drought has halted irrigation deliveries preventing an audit
New Mexico to Texas delivery schedule revision	PRCC/ Red Bluff WPCD/ New Mexico	TBD	Begin Immediately				No water deliveries to Texas due to drought
Red Bluff release schedule	Red Bluff WPCD/ Irrigation Districts	TBD	Begin Immediately			12 cfs continuous release implemented in 2004	Exceptional drought halted the continuous releases on September 26, 2011 to retain water in the lake to maintain dam integrity
Irrigation delivery timing	PRCC/ Red Bluff WPCD/ New Mexico	TBD	TBD				Exceptional drought has halted water deliveries from NM preventing a change
Efficient irrigation systems	Irrigation Districts/ Landowners	TBD	TBD			66	EQIP has provided assistance for land leveling, drip irrigation, sprinkler irrigation and irrigation pipeline installation

Management Measure	Responsible Party	Estimated Units to be Implemented	Estimated Number of Practices Implemented			Total Number of Practices Completed as of June 1, 2013	Comments
			Year				
			1-3	4-6	7-10		
Monitoring Program							
CWQM new stations (installation)	TCEQ/ USGS	1	---	1	---	4	Strong local desire to monitor waterbody led to secured funding
CWQM new stations (maintenance)	TCEQ/ USGS	annually	---	1		1	Funds currently identified for all stations
Aquatic life and habitat survey	USGS/ TCEQ/ TPWD	1 survey in yr. 7	---	---	1	1	Additional survey by TCEQ underway
Continued level of CRP SWQM	TCEQ/ TNC/ USGS	5	15 ††	15 ††	20 ††	25	CRP has been maintained at 10 sites
Education and Outreach							
Correspondence	Extension/ TWRI	4 mailings/ yr.; emails as needed	12 †	12	16	22	Mailings limited to an as needed basis (~2/yr.)
Texas Watershed Steward Program	Extension	2	2 ††	---	---	2	Delivered in June 2011
Lone Star Healthy Streams Program (Livestock Grazing Mgmt.)	Extension	1	2	2	2	0	Delivery of the LSHS program is in progress
Nutrient Management Workshop	Extension	3	1	1	1	1	Supported through Extension programming near watershed; need has diminished
Biannual meetings	TWRI	20	6 †	6	8	8	Meetings held as needed per local feedback
Watershed Coordinator	TWRI	10	3 †	3	4	5	Watershed Coordinator in place
Web site maintenance	Extension/ TWRI	10	3 †	3	4	5	Website continually updated

† Funds currently being sought through a CWA §319 Grant from TSSWCB

†† Funding currently in place, no additional funds needed at this time

* Two WQMP technicians were hired; Crockett SWCD technician resigned, Upper Pecos SWCD technician covers duties in both districts