

QUAL2K Dissolved Oxygen Modeling Upper Pecos River (Segment 2311) Evaluation of Best Management Practices



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Presentation Topics

- Pecos River Dissolved Oxygen Issue
- Model Verification (Calibration & Validation)
- Model Application to Evaluate BMPs

Pecos River Dissolved Oxygen Issue



Photo: May 4, 2010, US Hwy 67 Bridge, Abundant Attached Algae (Periphyton)

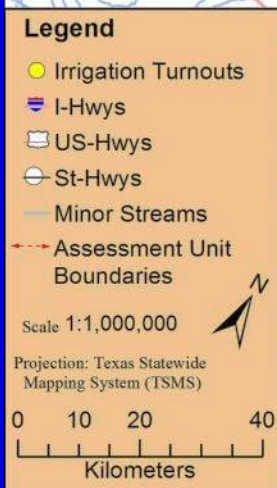
Legend

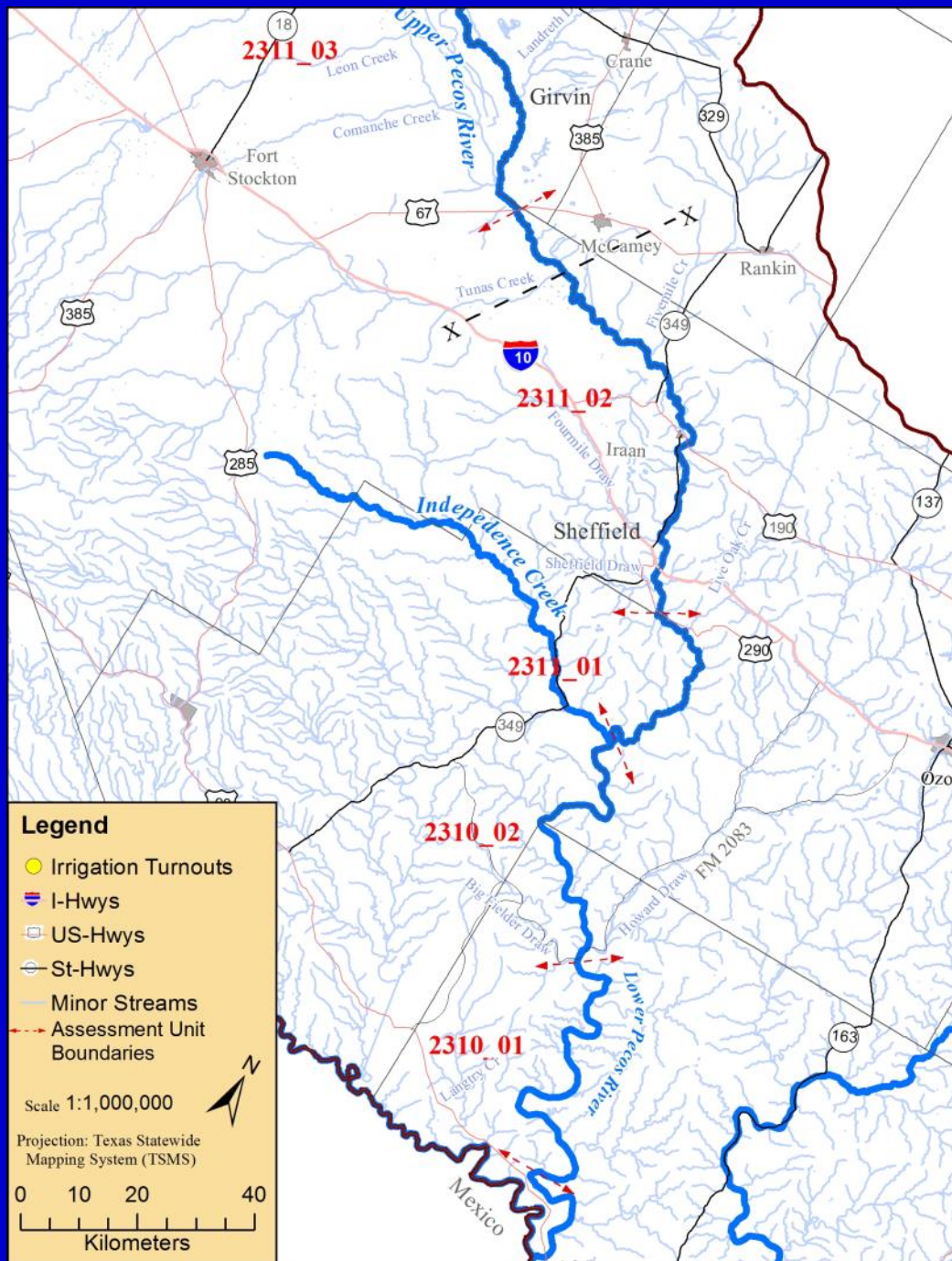
- Irrigation Turnouts
- ▬ I-Hwys
- ▬ US-Hwys
- ▬ St-Hwys
- ▬ Minor Streams
- ▬ Assessment Unit Boundaries

Scale 1:1,000,000

Projection: Texas Statewide Mapping System (TSMS)

0 10 20 40
Kilometers

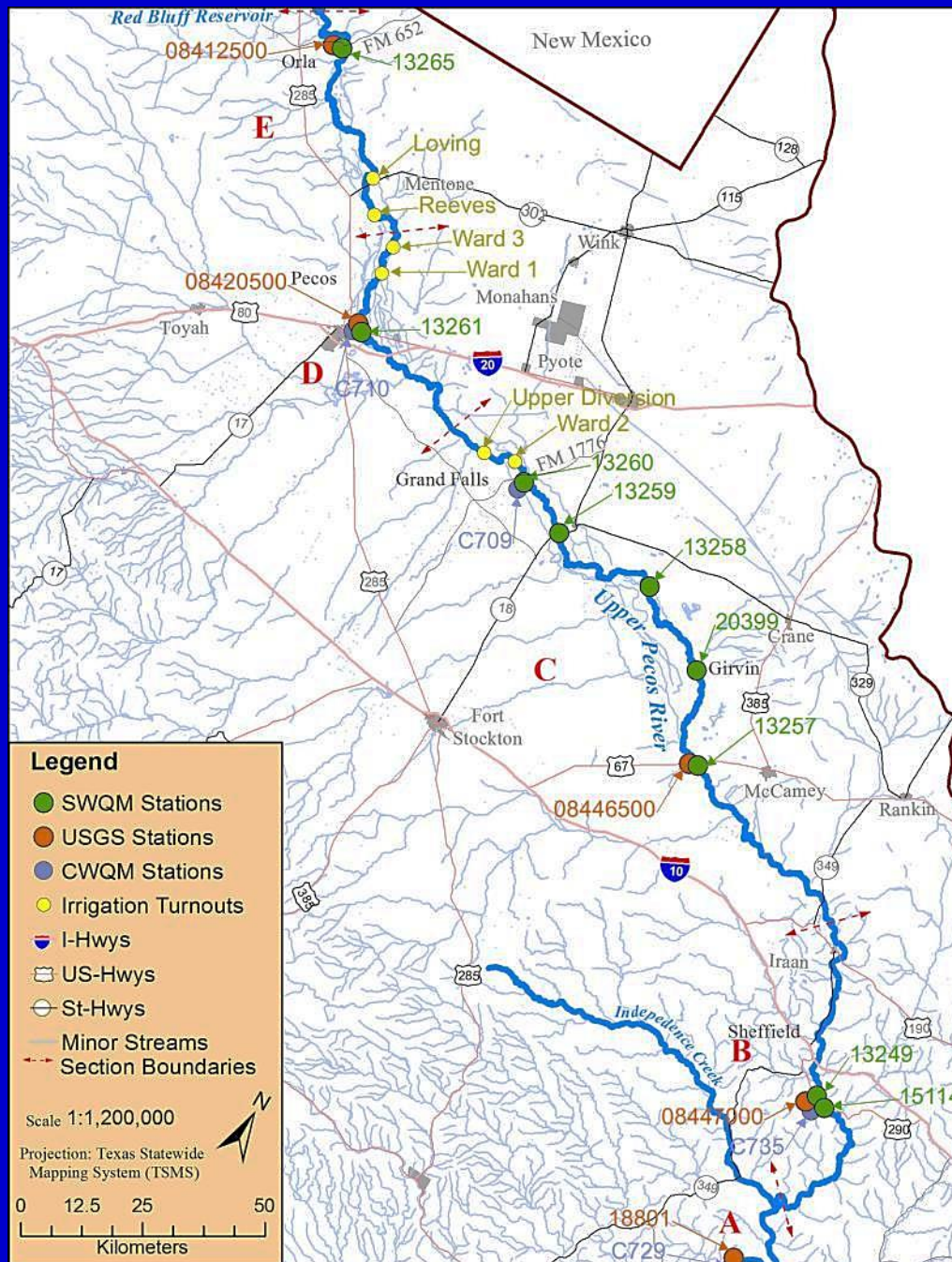




Upper Pecos River (Segment 2311) & Lower Pecos River (Segment 2310)

Texas Surface Water Quality Standards

- Designated Aquatic Life Use: High
- Protective dissolved oxygen criteria
 - 24-hour Period Concentrations
 - Average: 5.0 mg/L
 - Minimum: 3.0 mg/L
- Dissolved oxygen concentrations at or above the criteria concentrations need to occur at least 90 % of the time to be in support of designated use.



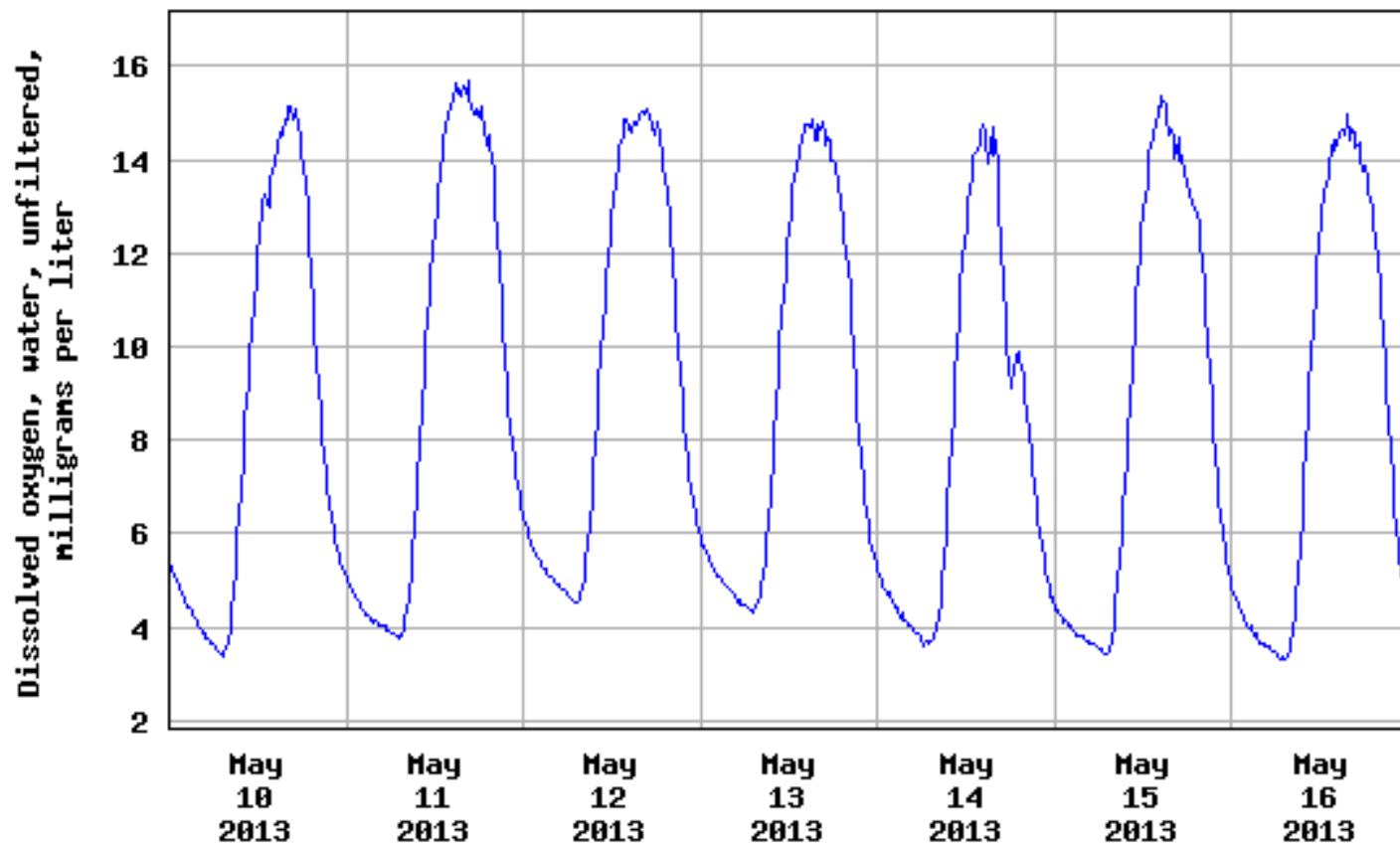
Upper Pecos River Showing Monitoring Stations

Station 13260

Pecos River at RR 1776



USGS 08437710 Pecos Rv at RR 1776 nr Grandfalls, TX



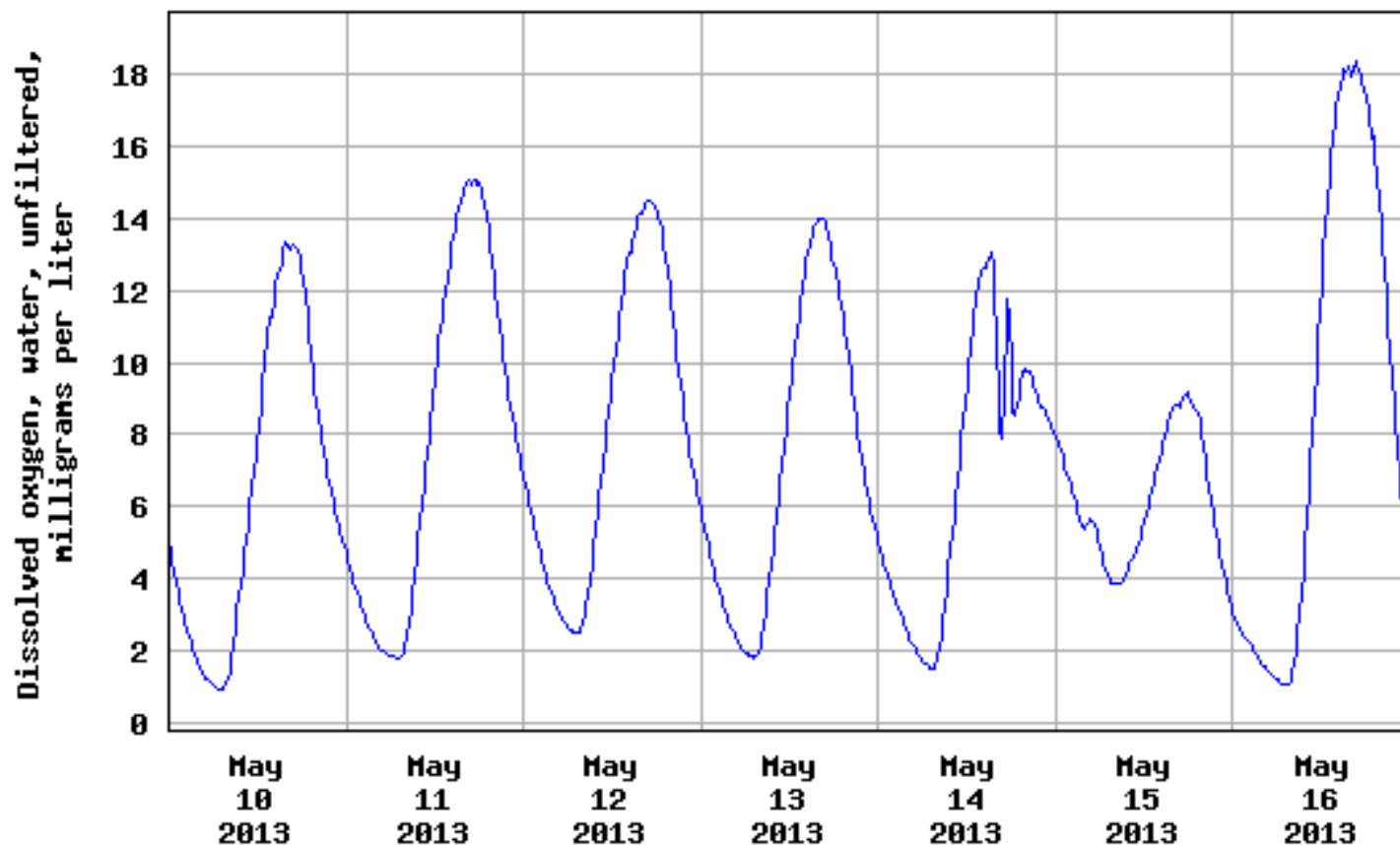
----- Provisional Data Subject to Revision -----

Station 13257

Pecos River at US Hwy 67



USGS 08446500 Pecos Rv nr Girvin, TX



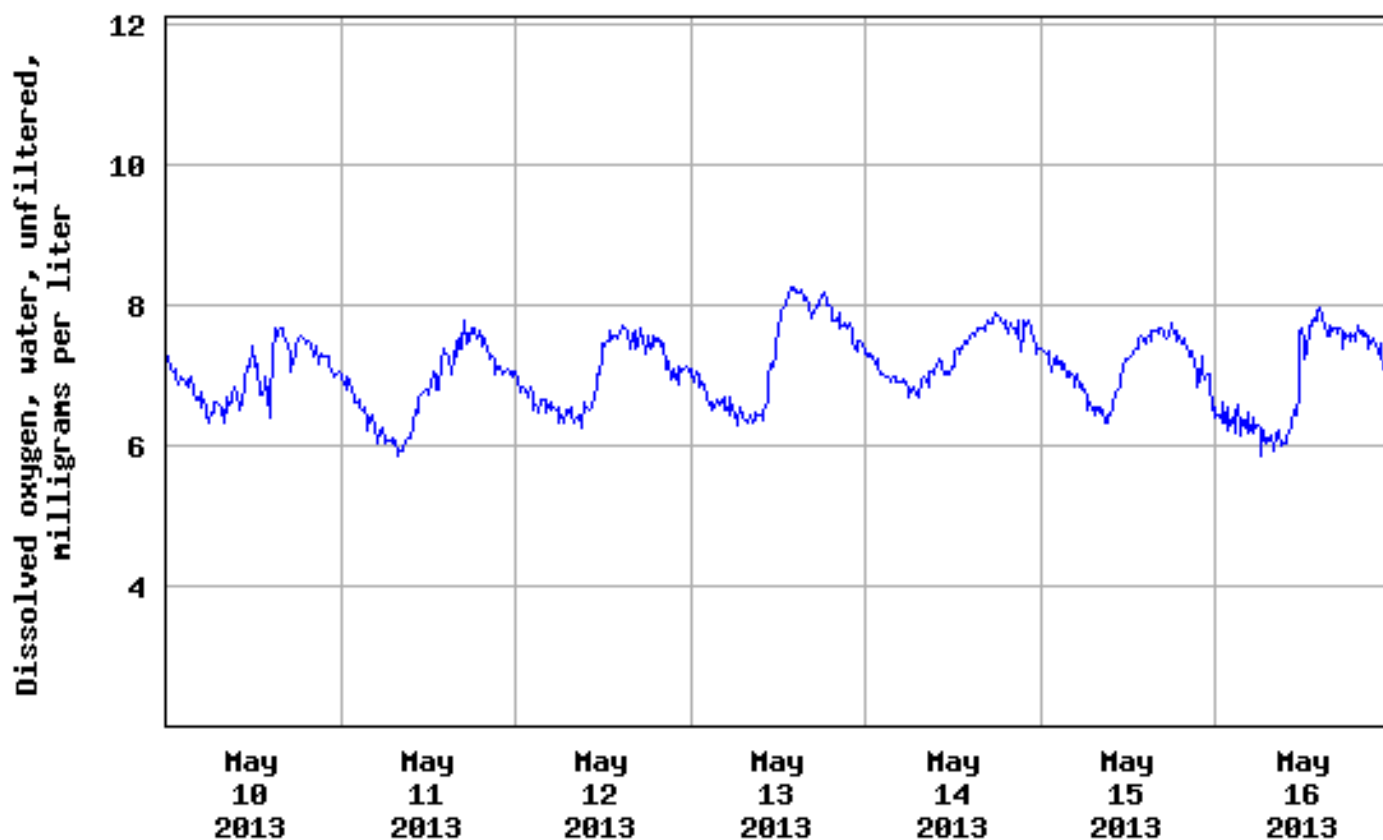
----- Provisional Data Subject to Revision -----

Station 13249

Pecos River nr. Sheffield, TX



USGS 08447000 Pecos Rv nr Sheffield, TX



----- Provisional Data Subject to Revision -----

Pecos Water Quality Dissolved Oxygen Issue

Source: TCEQ 2012 303(d) List

SegID: 2311

Upper Pecos River

From a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County to
Red Bluff Dam in Loving/Reeves County

Parameter(s)

Category

Year Segment First Listed

depressed dissolved oxygen

5c

2006

2311_03

From US Hwy 67 upstream to the Ward Two Irrigation Turnout

2010 Assessment – Dissolved Oxygen

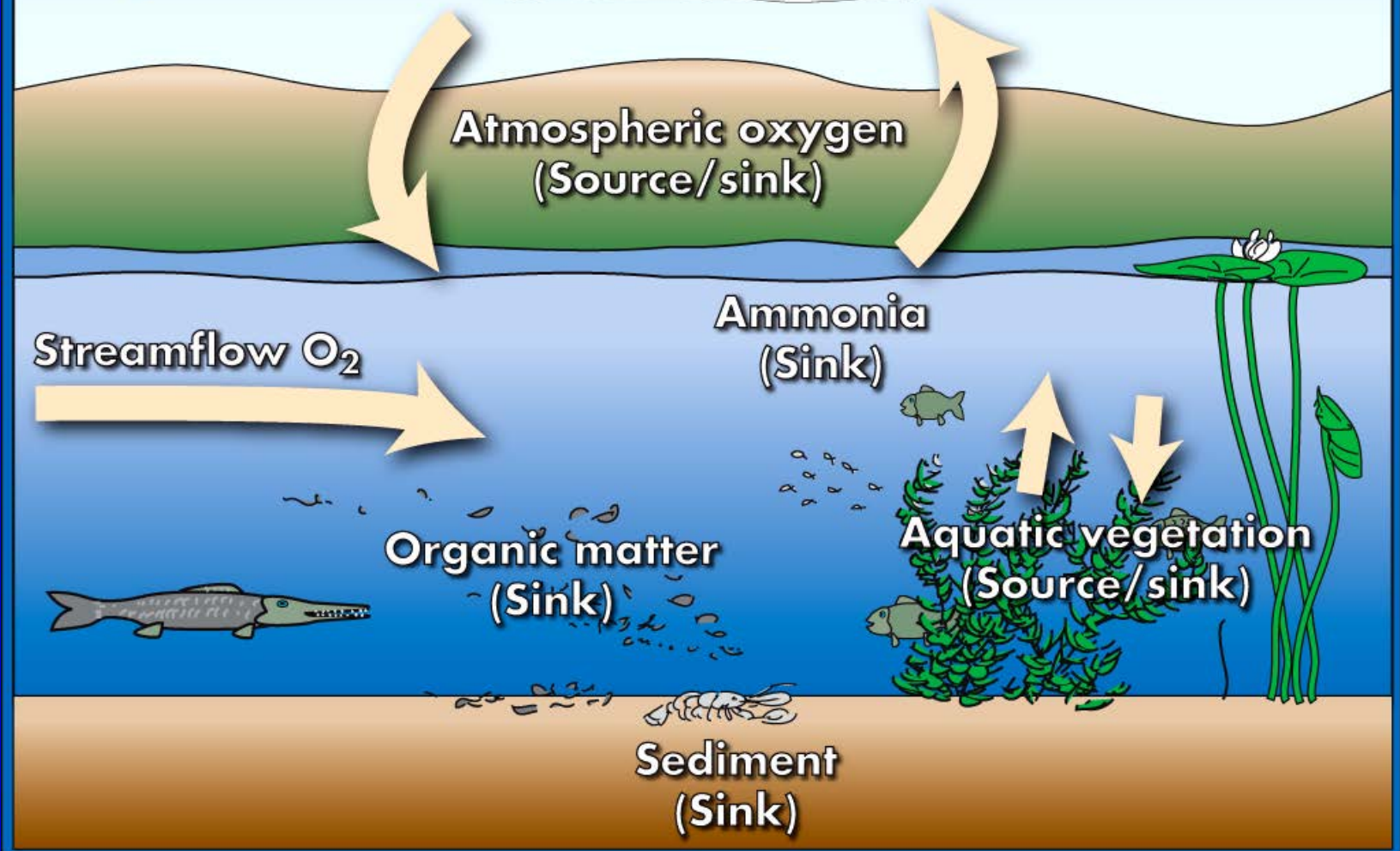
Parameter	Number Assessed	Number Exceed.	Mean Exceed.	Criterion
2311_04 FM 1776 upstream to US Hwy 80 (Bus 20)				
24-h DO Avg	12	1	4.9	5.0
24-h DO Min	12	7	1.6	3.0
2311__03 From US Hwy 67 up to FM 1776				
24-h DO Avg	10	0	—	5.0
24-h DO Min	10	5	1.3	3.0

Tool to Address Dissolved Oxygen – QUAL2K

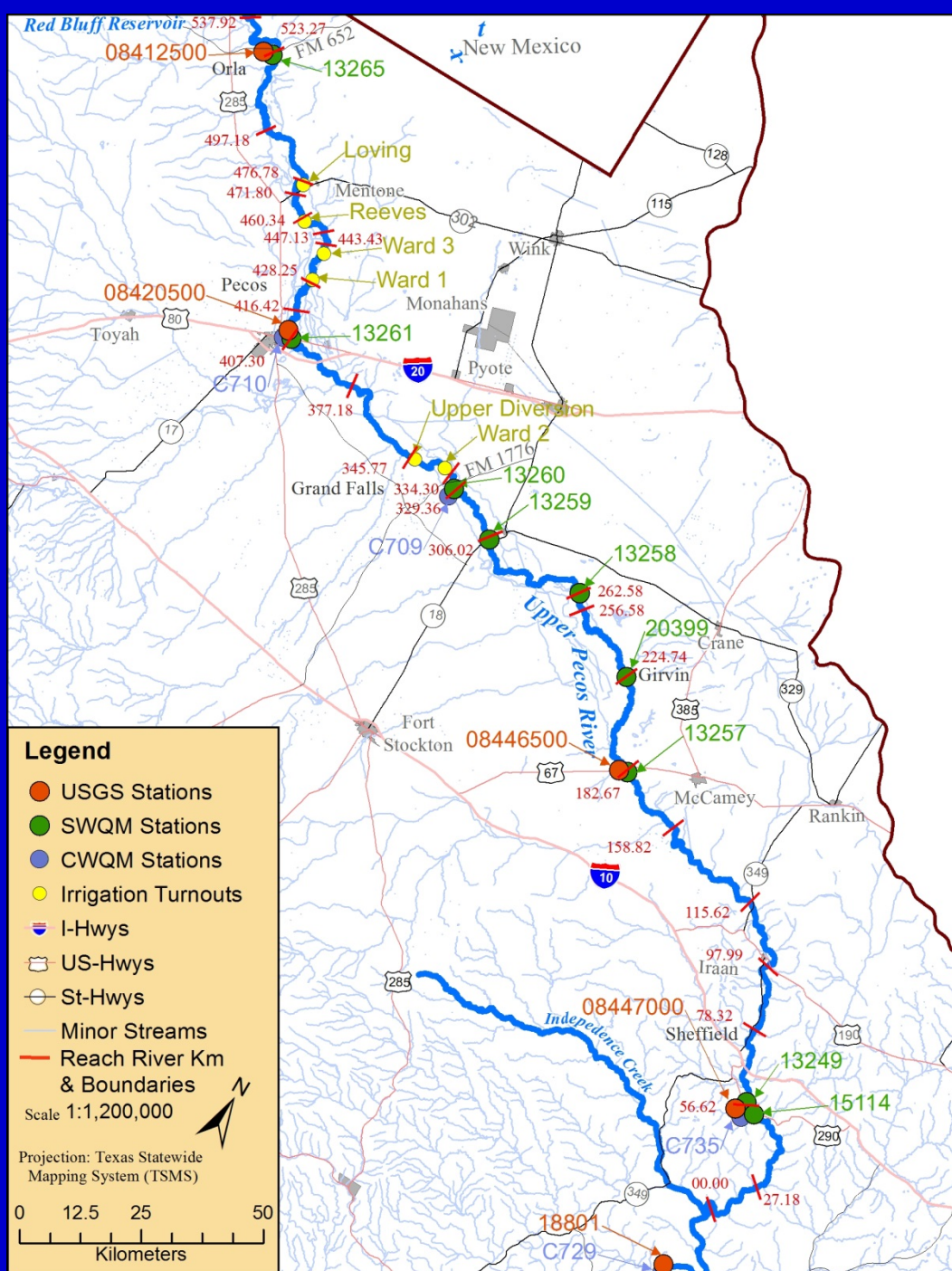
- QUAL2K is a stream water quality model. It is one-dimensional* and operates under steady-state flow.
- All water quality variables are simulated on a diurnal (24-hour) time scale, including dissolved oxygen.

* One-dimensional means the model divides the Upper Pecos River into computation elements along the river's length.

Stream Dissolved Oxygen (O_2) Factors



QUAL2K Segment- ation of Upper Pecos River

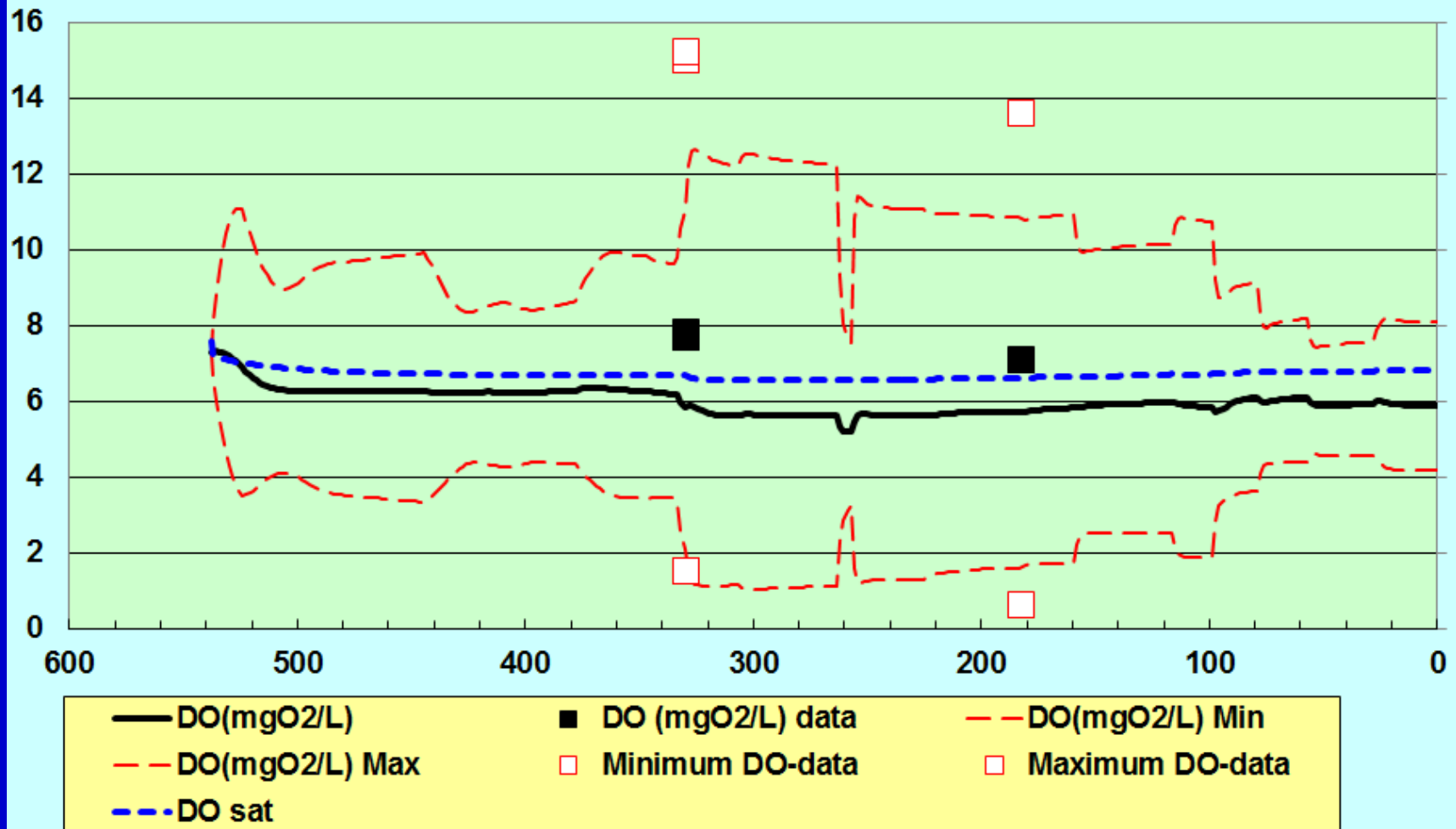


Model Verification

- Calibration Step – adjust input “kinetic” parameters and compare model predictions to observed data.
- Validation Step – hold “kinetic” parameters at calibration values and compare model predictions to observed data.

Typical DO Calibration – Warm Season

Central Standard Time (7/23/2008) Mainstem



BMP Evaluation Approach

- Use 12 scenarios from June 2006 – November 2009
- Run QUAL2K for 12 scenarios for baseline (existing) conditions and with selected BMPs
- Use Station 13260 as reference location (RR 1776)
- Modify historical 24-hr DO data at Station 13260 based on differences between baseline and BMP conditions

Management Option	Brief Description
None	Existing baseline conditions
1	Malaga Bend Project (decreased salinity in Red Bluff Reservoir releases)
2	BBEST 50 th percentile environmental flows applied April – October
3	BBEST 50 th & 75 th percentile flow selectively applied April – October
4	Decrease algal biomass 25% in summer in zone of impairment
5	Decreased sediment-water fluxes by 25%
6	Decreased Red Bluff Reservoir nutrients 50%
7	Added riffle 1.5 km (1 mile) above FM 1776 crossing of Pecos River
8	Combination of Management Options 3, 4 & 6
9	Combination of Management Options 3, 4, 5 & 6

Option 1: Malaga Bend Project

- Control of brine intrusion above Red Bluff Reservoir.
- Assumed decreased salinity of 1.6 ppt in Red Bluff Reservoir releases (Miyamoto et al., 2007).
- Benefit – lower salinities slightly increase saturation level of DO in water.

Option 2: Increased Streamflow

- Increased streamflow in zone of impairment during April - October.
- Increased flow based on 50th percentile flows of local basin and bay expert science team (BBEST). Reports (BBEST, 2012a & 2012b)
- Used recommended flows for Grandfalls and Girvin.
- Issue: Does not consider where water would come from.

**BBEST recommended 50th percentile base flows
in warm months (all flows in cfs; blue font
values are the flows implemented in QUAL2K)**

**Girvin flows used as minimum flows from RR 1776
/Ward 2 Turnout continuing downstream.**

Location	April	May	June	July	August	Sept.	October
Orla	15	15	15	33	33	33	33
Pecos	16	16	16	30	30	30	30
Girvin	19	19	19	18	18	18	18

Option 3: Increased Streamflow

- Increased streamflow in zone of impairment during April - October.
- Increased flow based on 50th and 75th percentile flows of local BBEST. Reports (BBEST, 2012a & 2012b)
- Used recommended flows for Grandfalls and Girvin.
- Issue: Does not consider where water would come from.

**Recommended 50th percentile base flows (cfs)
(Blue Text) and 75th percentile base flows (cfs)
(Red text) in warm months from BBEST Report**

**Girvin flows used as minimum flows from RR 1776
/Ward 2 Turnout continuing downstream.**

Location	April	May	June	July	August	Sept.	October
Orla	15	15	44	69	69	33	33
Pecos	16	16	78	104	104	30	30
Girvin	19	19	25	27	27	18	18

Option 4: Decrease Periphyton 25%

- Implemented in QUAL2K by increasing die-off rate of bottom algae until biomass decreased by 25%.
- In practice accomplished by chemical or biological means.
- Issue: Could cause environmental concerns and consequences.

Option 5: Decrease Sediment-Water Fluxes 25%

- Implemented in QUAL2K by reducing prescribed sediment oxygen demand and nutrient fluxes from sediments by 25%.
- In practice land management practices and scouring pulses of water could bring this change.
- Issues: Source of water for pulses & unknown efficacy of land management practices in arid region.

Option 6: Decrease Nutrients in Red Bluff Reservoir 50%

- This option results from a desire for better water quality in the water delivered to Texas.
- Could be implemented through a mechanism similar to Pecos River Compact.
- Issue: No ongoing action to bring this about at this time.

Option 7: Add Riffle Area Above RR 1776 Crossing of Pecos River

- Implemented in QUAL2K by adding a 3-foot high broad crested weir 1 mile above the crossing.
- To be effective for entire depressed zone would require a series riffles/dams.
- Issue: Gradual gradient along Pecos River may limit number of units and increase spacing & length of Pecos being improved is limited.

Option 8: Combine Options 3, 4 & 6

- 50th and 75th percentile BBEST flows.
- 25% decrease in bottom algae biomass.
- 50% reduction in nutrients in releases from Red Bluff Reservoir

Option 9: Combine Options 3, 4, 5 & 6

- 50th and 75th percentile BBEST flows.
- 25% decrease in bottom algae biomass.
- 50% decrease in sediment-water fluxes.
- 50% reduction in nutrients in releases from Red Bluff Reservoir

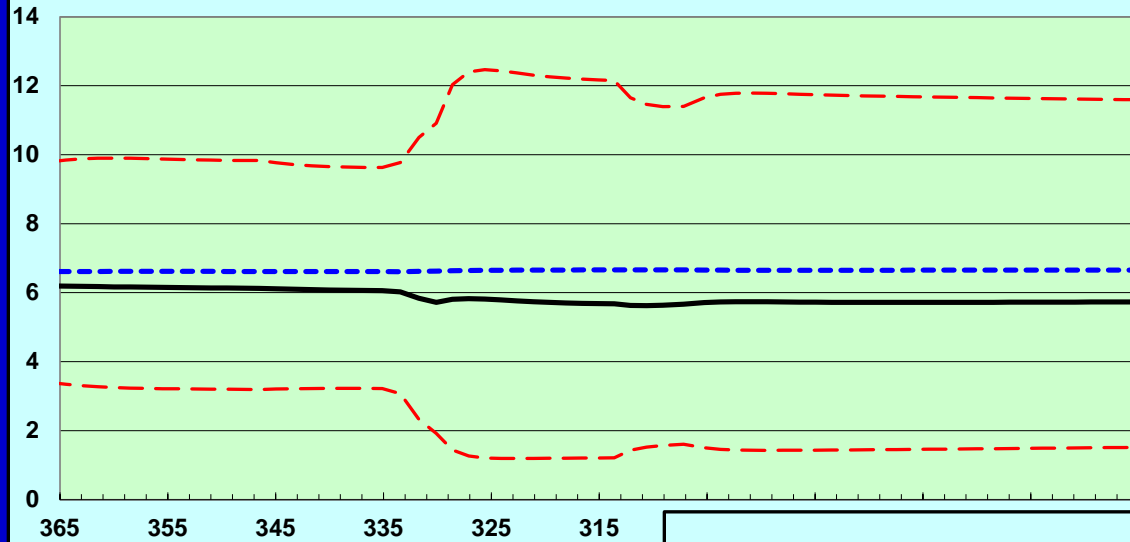
Not Considered: Saltcedar Control

- Difficulty in quantifying water quantity benefits.
- Scientists suggest that long-term benefits decrease as native riparian vegetation matures in size.

Management Option	Brief Description	Percent time 24-hr minimum DO \geq 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 50 th percentile environmental flows applied April – October	83.6
3	BBEST 50 th & 75 th 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 3, 4, 5 & 6	96.0

Upper Pecos River (7/23/2008)

[Above FM 1053 upstream to Below Hwy US 80 nr. Pecos, TX]

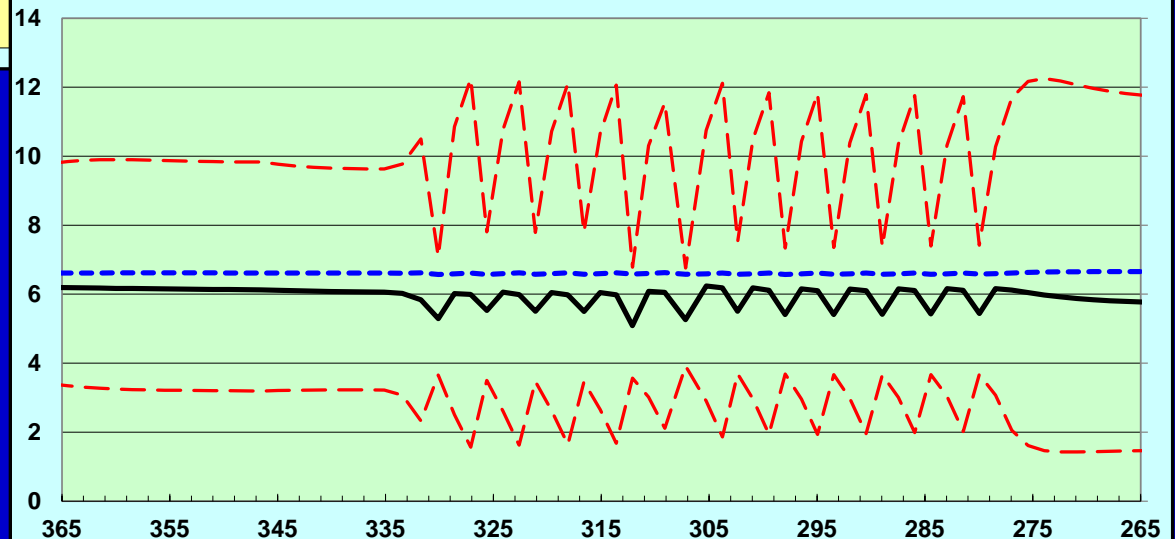


— DO(mgO₂/L) - - DO(mgO₂/L) Min

Option 7 (Riffles)

Upper Pecos River (7/23/2008)

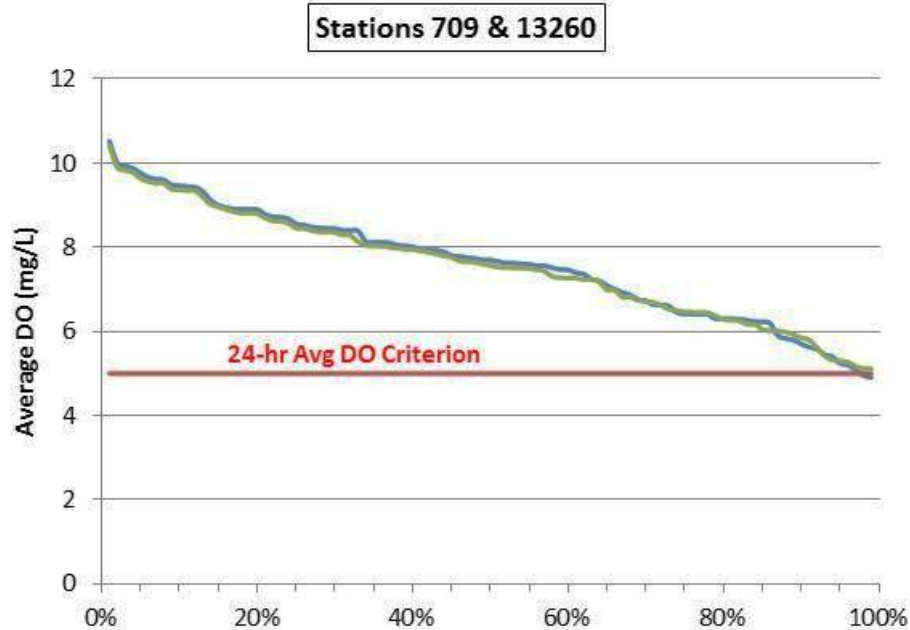
[Above FM 1053 upstream to Below Hwy US 80 nr. Pecos, TX]



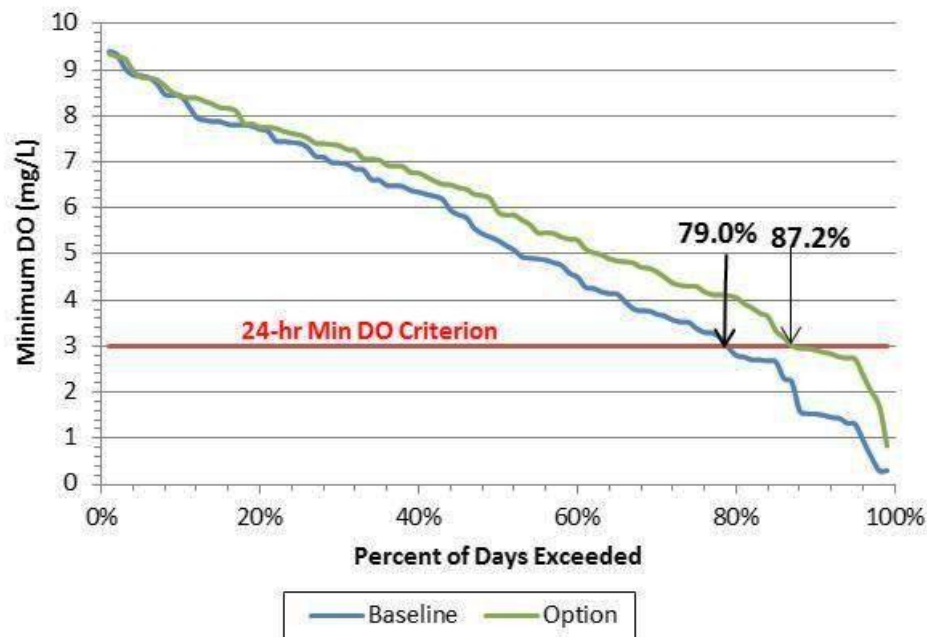
— DO(mgO₂/L) - - DO(mgO₂/L) Min - - DO(mgO₂/L) Max - - DO sat

Option 8 (Example DO Exceedance Curve)

A



B



Conclusions

- Challenges will be faced to restore DO in the Upper Pecos River.
- No single management option will likely bring about restoration.
- Finding viable management options is another serious constraint.

Thank You

Questions??

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