



WATER QUALITY OF ARID RIVERS: A 303(d) LIST CASE STUDY OF THE RIO GRANDE



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ABSTRACT

Streams in arid to semi-arid regions of the United States often experience seasonal periods of low flow conditions. Such low flow conditions can dramatically influence ambient toxicity, chemistry, and biosurvey monitoring activities. TCEQ selected two Rio Grande segments on the 1999 CWA 303(d) list for accelerated monitoring to support development of TMDLs. Over a twelve month period in 2001-2002, we evaluated ambient toxicity and instream chemistry of segment 2304, located downstream from Amistad Reservoir, and segment 2306, located upstream of Amistad Reservoir. Based on *Ceriodaphnia dubia* and *Pimephales promelas* toxicity testing and chemical parameters monitored, we recommended that the portions of segment 2304 downstream of Del Rio, Eagle Pass and Laredo were supporting aquatic life uses. Segment 2304, located downstream of Amistad Reservoir, does not benefit from continuous impoundment releases for flow; a portion of this segment recently became an intermittent stream. Although no *P. promelas* ambient toxicity or numeric criteria exceedances were observed during our study, *C. dubia* reproduction was significantly reduced on several sampling events. A TIE evaluation procedure identified TSS, not associated with point or non-point sources, as exerting physical toxicity on *C. dubia*. However, during this study, flow of segment 2306 was lower than 7Q2 conditions. Because of such low flows, Texas State Water Quality Standards disallow these data as inconclusive for determining aquatic life use attainment. Even if our findings indicated impairment of this segment 2306, TCEQ could only develop a TMDL for one half of the river since it is shared with Mexico.

INTRODUCTION

Two Rio Grande segments listed on the 1999 CWA 303(d) list were chosen for accelerated monitoring to support developments of TMDLs. Segments 2304 (5 sampling stations) and 2306 (3 sampling stations) are located downstream and upstream, respectively, of Amistad Reservoir in southwest Texas, USA (**Figures 1 and 2**).

Segment 2304 of the Rio Grande was identified on the State of Texas 1999 and draft 2000 §303(d) lists as “not supporting uses” for contact recreation due to bacteria levels in an area downstream of Laredo, Del Rio, and a small section near Eagle Pass, Texas. Segment 2304 is also listed as “partially supporting uses” for aquatic life due to ambient water toxicity in an area downstream of Eagle Pass; and “not supporting uses” due to the toxicity of ambient water in an area downstream of Del Rio.

Segment 2304 of the Rio Grande is a freshwater segment, 226 miles long which begins at Amistad Dam in Val Verde County (U.S.) and flows downstream to the confluence of the Arroyo Salado in Zapata County (U.S.) Segment 2304 receives pollutant loading from domestic and industrial point source discharges and non-point source storm water runoff from the U.S. and Mexico sides of the border.

Segment 2306 of the Rio Grande Basin is identified on the State of Texas 1999 and 2000, 303(d) lists as “partially supporting uses” for aquatic life due to the toxicity of ambient water in the upper 25-miles of the segment, and “not supporting uses” due to the levels of pathogens present downstream of Presidio. Segment 2306 of the Rio Grande Basin is a body of freshwater that spans from a point 1.8 kilometers (1.1 miles) downstream of the confluence of Ramsey Canyon in Val Verde County, to the confluence of the Rio Conchos (Mexico) in Presidio County. Segment 2306 receives pollutant loading from domestic and industrial discharges, with a smaller amount from agricultural sources.

The purpose of this assessment was to verify the presence of toxicity in water of the Rio Grande and if toxicity was found, to determine its cause(s) and source(s) in the segment and/or its tributaries.

Figure 1

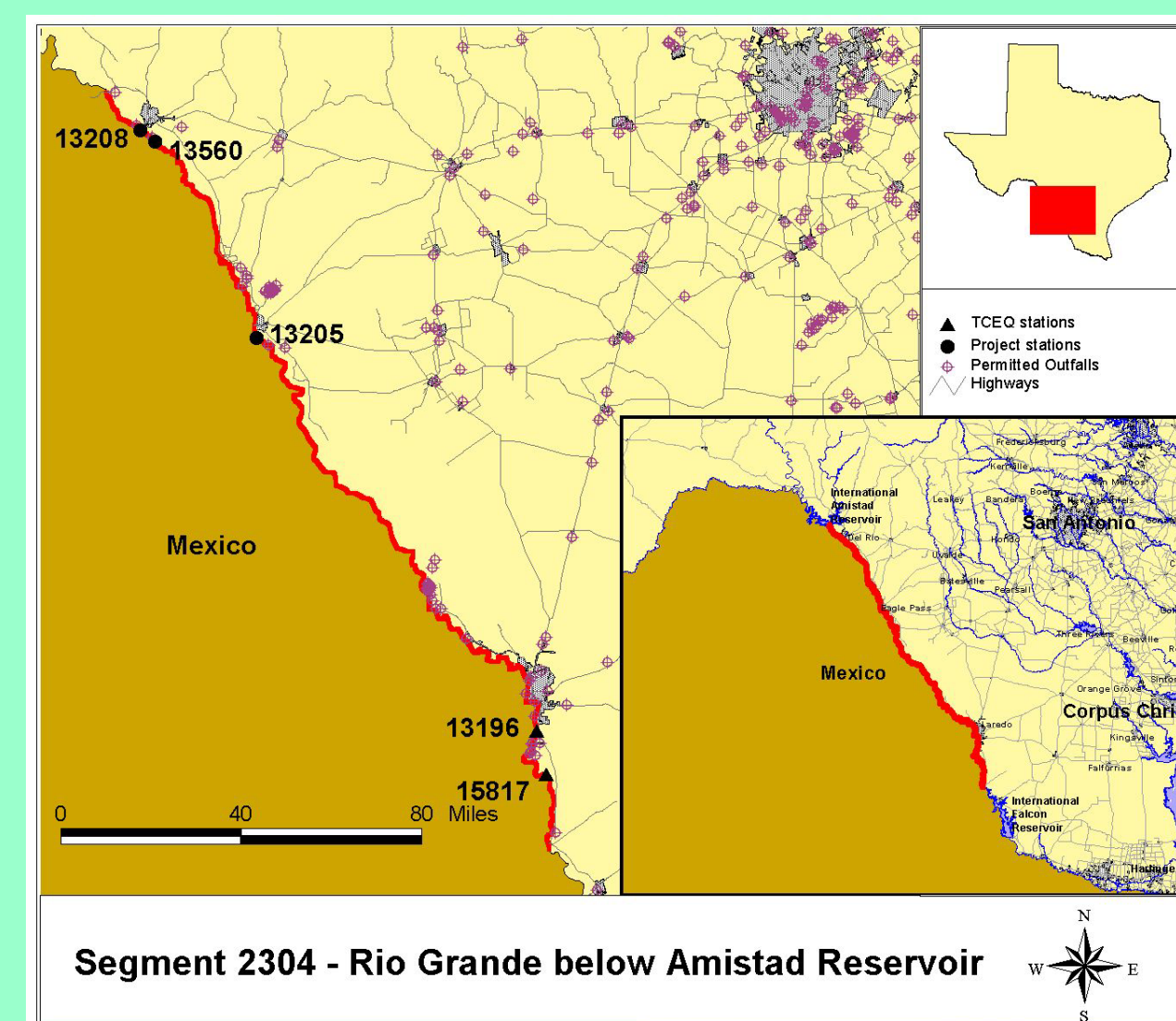
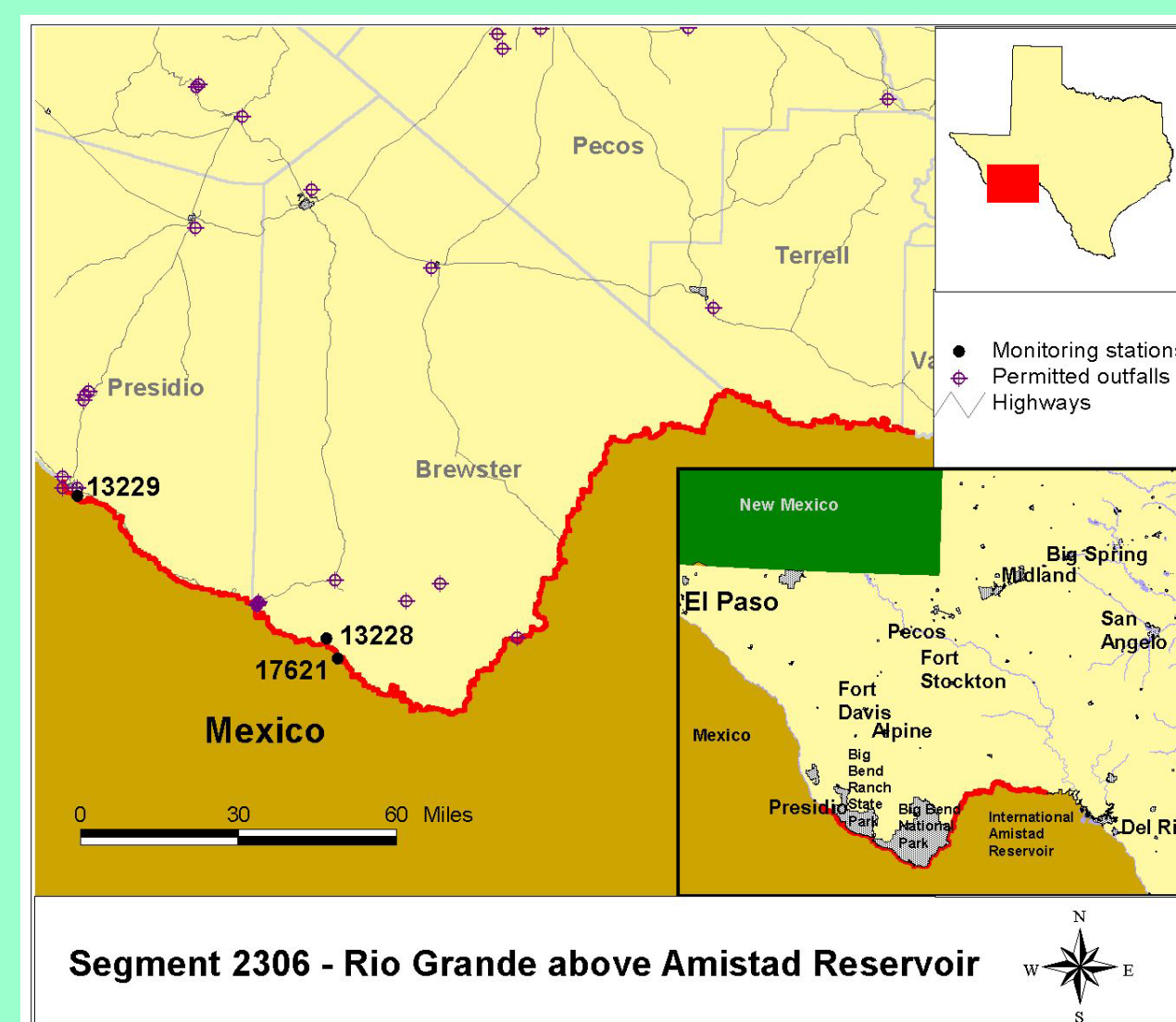


Figure 2



METHODS

- Ceriodaphnia dubia* and *Pimephales promelas* were used as test organisms for aqueous toxicity testing.
- 7-day static-renewal aquatic toxicity tests with *C. dubia* and *P. promelas* were carried out according to USEPA (1994). Endpoints included survival and reproduction for *C. dubia* and survival and growth for *P. promelas*.
- Temperature, pH, DO, and specific conductance were measured using a sonde at the time of sample collection.
- Extensive chemical screening (metals, organics, inorganics, etc.) was performed at least 3 times per segment.
- Number of toxicity tests per station are given in **Table 1** for Segment 2304.
- There were 3 different sampling stations (13228, 13229, and 17621) as well as 11 sampling events and resultant toxicity tests for Segment 2306

CHEMICAL SCREEN RESULTS

Segment 2304

Mean chloride (124.6 ± 6.1 mg/L) and sulfate (184.7 ± 16.8 mg/L) concentrations were found to be below Texas State Water Quality Standards (TSWQS) chronic aquatic life standards of 200 and 300 mg/L, respectively. All other chemicals analyzed for were found to be at least an order of magnitude under limits set forth in TSWQS. Mean hardness for this segment was 271 mg/L as CaCO₃.

Segment 2306

Mean chloride (508.3 ± 143.5 mg/L) and sulfate (870.6 ± 172.9 mg/L) concentrations were found to be above TSWQS chronic aquatic life standards of 300 and 570 mg/L, respectively. All other chemicals analyzed for were found to be at least an order of magnitude under limits set forth in TSWQS. Mean hardness for this segment was 554.0 ± 223.4 mg/L as CaCO₃.

Table 1. Segment 2304 toxicity test results.

Station	Lethal				Sub-lethal			
	<i>P. promelas</i>		<i>C. dubia</i>		<i>P. promelas</i>		<i>C. dubia</i>	
	# tests	# toxic	# tests	# toxic	# tests	# toxic	# tests	# toxic
13205	6	0	9	0	6	0	9	1
13208	6	0	9	0	6	0	9	0
13560	6	0	9	0	6	0	9	0
13196	3	0	3	0	0	0	2	1
15817	3	0	3	0	0	0	2	1

TOXICITY TEST RESULTS

Segment 2304

- Results of Segment 2304 toxicity tests can be found in **Table 1**.

Segment 2306

- With one exception, neither *P. promelas* survival or growth was significantly affected at any station for any sampling event.
- C. dubia* survival was not significantly affected at any station for any sampling event.
- C. dubia* reproduction was significantly affected at stations 13228 and 13229 and not significantly affected at station 17621.

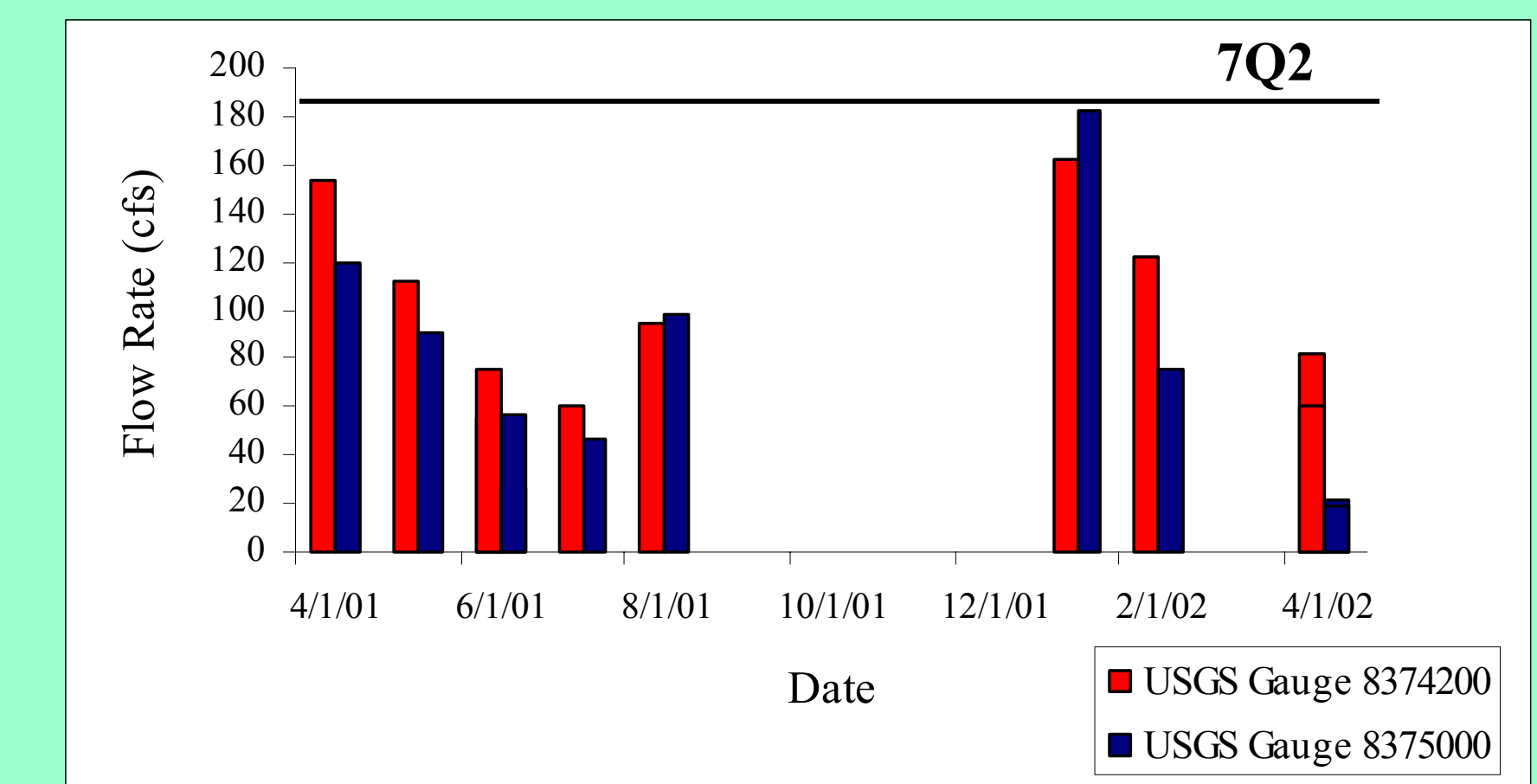
TIE (Segment 2304)

- No toxicity identification evaluation (TIE) was initiated since no significant acute (lethal) toxicity was observed.

TIE (Segment 2306)

- Because river water collected from stations 13228 and 13229 were highly turbid, (TSS = 194 ± 65.9 mg/L, n = 3) it was suspected that suspended solids may be the source of significant differences from controls in *C. dubia* reproduction for these two sites.
- To determine if suspended solids were the source of toxicity, additional samples were taken from stations 13228 and 13229 and side-by-side toxicity tests were performed with centrifuged (8,500 rpm; 20 minutes; 5-10 °C) and uncentrifuged river water.
- The sub-lethal toxic effect was reproduced in only one of six additional samples. Centrifugation removed toxicity in this case.
- Another sampling station (17621) was added 5 miles downstream of 13228. Station 17621 follows a deeper pooled area and provided water samples with lower suspended solids.
- Toxicity tests on water samples collected at Station 17621 correlated with results of toxicity testing on samples from Station 13228. Therefore, the effects of natural pool settling did not have an impact on toxicity results.

Figure 3 - Measured flow rates in Segment 2306. Horizontal line shows 7Q2 flow level



CONCLUSIONS

Segment 2304

Recommendation - The authors recommend de-listing segment 2304 as the waters were supporting aquatic life uses based on ambient water toxicity tests and three events of chemical sampling.

Segment 2306

Results suggest that the finer suspended particles removed with a centrifuge are the cause of sub-lethal toxicity to *C. dubia* reproduction. More tests are needed to confirm this hypothesis.

Flow

TSWQS indicate the 7-day average, 2 year frequency flow rate (7Q2) for Segment 2306 is 191.3 cfs.

According to TSWQS, because all samples on which chronic toxicity analyses were performed were collected on dates where the flow for Segment 2306 was below the 7Q2 (**Figure 3**), all chronic toxicity testing results are deemed **inconclusive** and do not disprove or prove TSWQS attainment.

Recommendation - The authors recommend further investigation of segment 2306 when flow values are above critical limits.

REFERENCE

USEPA. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms, 3rd edition. EPA/600/4-91/002. Environmental Monitoring Systems Laboratory, Cincinnati, OH.

ACKNOWLEDGEMENTS

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