Lower Rio Grande Water Quality Monitoring Feasibility Assessment

by
David Buzan, Freese and Nichols, Inc.
Nick Landes, Freese and Nichols, Inc.
Pilar Corpus, SDI Engineering, LLC.
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December 7, 2015

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1.0 Executive Summary

McAllen Public Utility, representing the South Texas Water Utility Managers Association, received a grant from the Texas Water Development Board (TWDB) in the spring of 2014 to evaluate creating a water quality monitoring system for taste and odor compounds on the Rio Grande. After a chemical spill was reported in a Mexican tributary of the Rio Grande, the project expanded to address monitoring for potentially hazardous substances.

McAllen Public Utility contracted with Freese and Nichols, Inc. to:

- Document existing water quality monitoring infrastructure,
- Identify possible monitoring agencies, parameters locations, and costs, and
- Survey water treatment providers regarding current approaches to changing water quality.

The study area includes the Rio Grande from Falcon Dam downstream to the Brownsville Public Utility Board diversion from the river with emphasis on U. S. diversions for water supply.

There are about 226 river miles from Falcon to the Brownsville PUB water supply intake. When river flow is low, water travels that distance in about 9 days. Water travels the same distance in about 4.6 days when flow is high. A taste and odor or hazardous contaminant could travel from Falcon to Brownsville in the Rio Grande at high flow in less than 5 days. Time-of-travel in irrigation canals is unknown however some water supply withdrawal points may be 42 stream miles from the diversion point on the Rio Grande.

A matrix which water suppliers can use to help treat taste and odor problems in their raw water was created. Trigger levels for phycocyanin, chlorophyll α, conductivity, and pH are identified and treatment processes using chlorine dioxide, powdered activated carbon, hydrogen peroxide, and terminal storage reservoir management are suggested.

Three agencies monitor water quality in the lower Rio Grande Valley including the International Boundary and Water Commission, Texas Commission on Environmental Quality (TCEQ), and the U. S. Geological Survey. The TCEQ operates six continuous monitoring stations in the study area which may be adapted to a water quality monitoring program for water providers.

A conceptual monitoring system includes preliminary planning, funding opportunities, possible monitoring locations (five TCEQ continuous monitoring stations are suggested for considerations), suggested monitoring parameters (conductivity, temperature, dissolved oxygen, turbidity, pH and total algae) all of which can be monitored directly in the river with current technology and with data transmitted wirelessly in real time. Data management is a major step in the creation of any monitoring program and should be finalized two years after monitoring begins.

It is recommended the utility association establish a continuous monitoring program at 5 sites along the Rio Grande presently used by TCEQ. The estimated cost for this system is $488,400 for the first two years.

2.0 Background

McAllen Public Utility, representing the South Texas Water Utility Managers Association, received a grant from the Texas Water Development Board (TWDB) in the spring of 2014. The grant was made to evaluate the feasibility of creating a water quality monitoring system for taste and odor compounds on the Rio Grande. Effective monitoring of taste and odor compounds in the river is intended to help utilities minimize taste and odor issues in their treated water.

McAllen Public Utility contracted with Freese and Nichols, Inc. to perform three tasks required by the grant.

- Document existing water quality monitoring infrastructure,
- Identify possible monitoring agencies, parameters locations, and costs, and
- Survey water treatment providers regarding current approaches to handle upstream water quality changes.

At the project's onset, the importance of monitoring constituents beyond taste and odor causing compounds become relevant to the region. A spill of unknown pollutant(s) in April 2014 was reported in the Rio Salado, a Mexican tributary to Falcon Lake on the Rio Grande upstream of the Lower Rio Grande Valley (Valley Morning Star April 30, 2014; The Brownsville Herald May 2, 2014). Subsequent testing of water from Falcon Lake and the Rio Grande by the Texas Commission on Environmental Quality (TCEQ) and some municipal water suppliers failed to detect high concentrations of any potentially toxic contaminants. Anecdotal information suggests the state and some water providers spent more than $100,000 sampling the river in an attempt to identify the contaminant. Those analyses failed to reveal identify the contaminant.

Members of the public recommended increased focus on Rio Grande water quality to help protect the public from future spills (Rio Grande Guardian May 15, 2014; Valley Morning Star, June 14, 2014). Recognition of the Rio Grande's importance as a raw water supply combined with heightened concern about possible chemical discharges into the river, led to expansion of the original project to address monitoring potentially hazardous chemicals as well as taste and odor-causing compounds. This project evaluates expanding water quality monitoring to protect drinking water supplies on the lower Rio Grande.

Designing an effective monitoring program will ultimately involve collaboration between all agencies relying on clean water to identify:

- Who needs water quality information and why;
- Who could manage a monitoring program, conducting tasks that include:
    - Revising monitoring periodically to meet changing needs,
    - Monitoring, and
    - Making data available in a timely manner and in a useful format; and
- How the monitoring program be funded.

2.1 Early Warning Systems

A water quality monitoring system may enable agencies to detect changes in Rio Grande water quality more quickly. Terrorist attacks in the U.S. on September 11, 2001, combined with rapidly evolving water quality monitoring technology over the past decade, have increased emphasis on safeguarding the nation's drinking water. The U. S. Environmental Protection Agency (EPA) started the "Water Sentinel System" in 2005 to focus on securing public water supplies from accidental or intentional contamination (EPA, 2005). This program and subsequent efforts focus on protecting water supply distribution systems through the use of "early warning systems" or "contaminant warning systems".

Early warning system, or contamination warning system, is defined by Roberson and Morley (2005) as:

> Use of monitoring equipment and strategies to collect, analyze, and communicate information about possible water contamination incidents in enough time to respond and minimize public health impacts.

Early warning systems can be subdivided into four critical components: data collection, analysis and communication; and response to data.

Effective early warning systems could include:

- Online water quality monitoring,
- Water sampling and analysis,
- Protecting water supply infrastructure,
- Tracking consumer complaints, and
- Tracking public health (particularly related to potential water-borne illness).

The degree of data collection is often defined by the warning system's objective (Roberson and Morley, 2005):

- "Detect to protect" – Information is needed when incident is occurring, allowing the utility to respond and prevent exposure. Notice of incident is received instantaneously or in minutes.
- "Detect to warn" – The utility has time to prevent significant exposure. Notice of incident is received in hours.
- "Detect to treat" – Members of the public have gotten sick. Notice of incident is received days after it occurred.

2.1.1 *Water Quality Alerts*

Monitoring water quality is only part of the process. Alerting utility operators about a possible contamination event may be the most critical part of the system and is called "Event Detection." Event detection is the information generated for the operator's use from the monitoring data. EPA (2013) learned the following lessons about event detection systems:

- Factors to consider in selecting a system include:
  - Affordability,
  - Vendor availability to maintain equipment and train operators,
  - Ease of use, and
  - Expandability and modularity.
- Build the system using water quality data provided by the utilities.
- Identify procedures to review alerts.
- Identify who will review alerts. It usually takes less than 10 minutes to investigate alerts.
- Test the system before it is fully functional by artificially generating alerts. Operators practice using the system and dealing with alerts before it is fully operational. And,
- Review and update the system periodically.

2.1.2 *Alert Response*

Upon receiving an alert from the Event Detection System, water quality agencies must make an informed response. To this end, EPA developed the "Water Contaminant Information Tool" (WCIT) with information about chemical, biological, and radioactive contaminants, their behavior in water, and possible health effects (EPA, 2010a). The tool shows how to treat these pollutants and decontaminate infrastructure. Water utilities can register to use this tool at http://www.epa.gov/wcit. More information about water supply security can be found in EPA's "Water Security Handbook" and "Water Security Initiative: Interim Guidance on Developing Consequence Management Plans for Drinking Water Utilities" (EPA, 2008).

3.0 Study Area

The study area includes the Rio Grande from Falcon Dam downstream to the Brownsville Public Utility Board diversion from the river (Figures 1-4). Features evaluated in this reach:

- Sources of flow from Mexico and the U. S (as possible sources of contamination),
- Active water quality monitoring stations,
- Major U. S. diversions from the Rio Grande,
- U. S. water treatment plant locations,
- Flow paths from the Rio Grande to water treatment plants, and
- Wastewater discharges from the U.S. into the Rio Grande.

Flow paths from the Rio Grande to water treatment plants were estimated using data from the National Hydrography Dataset, review of aerial photography using Google Earth Pro, and information from the Irrigation Technology Center (Fipps, 2004).

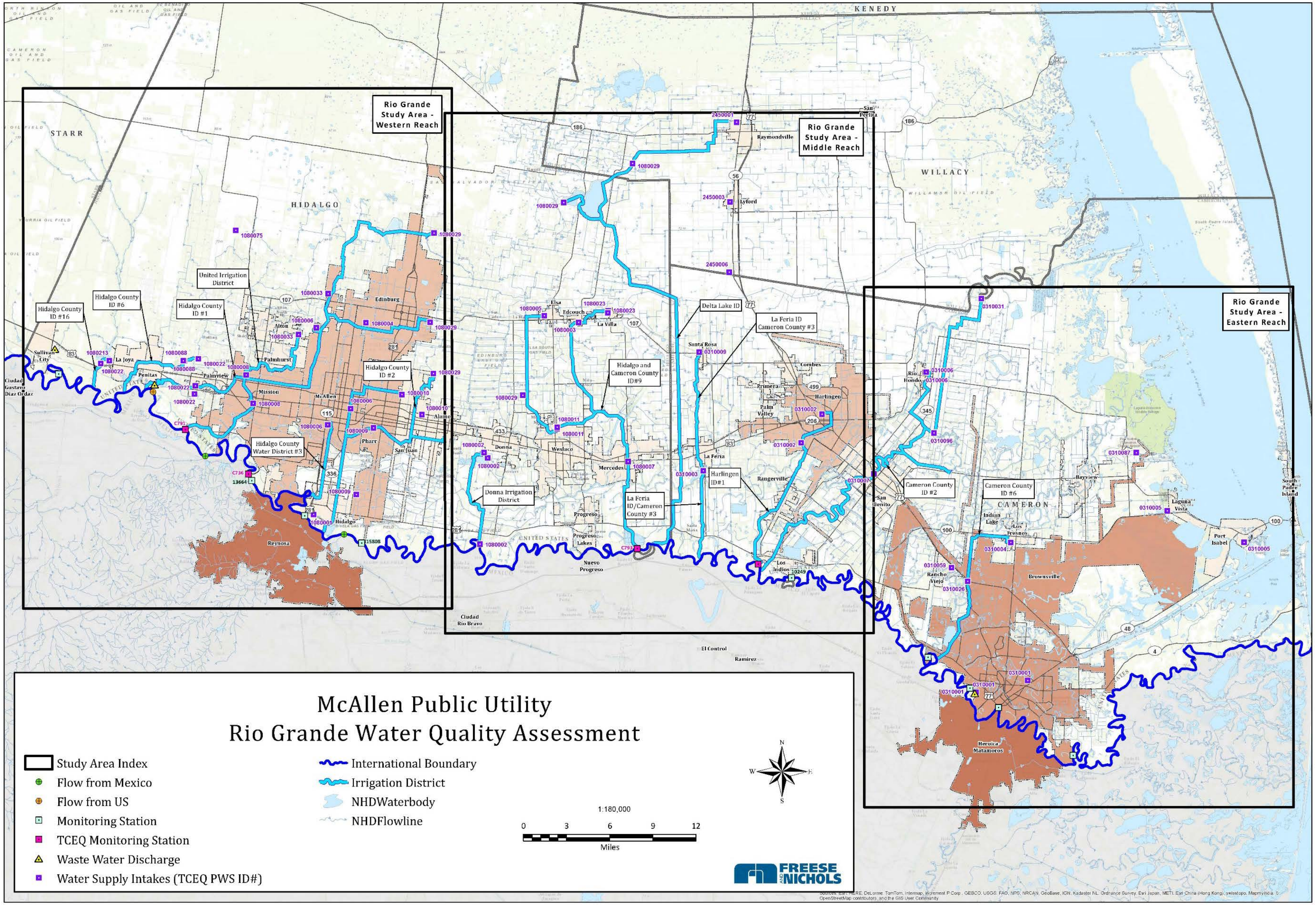

Figure 1. **Lower Rio Grande water quality monitoring study area.**

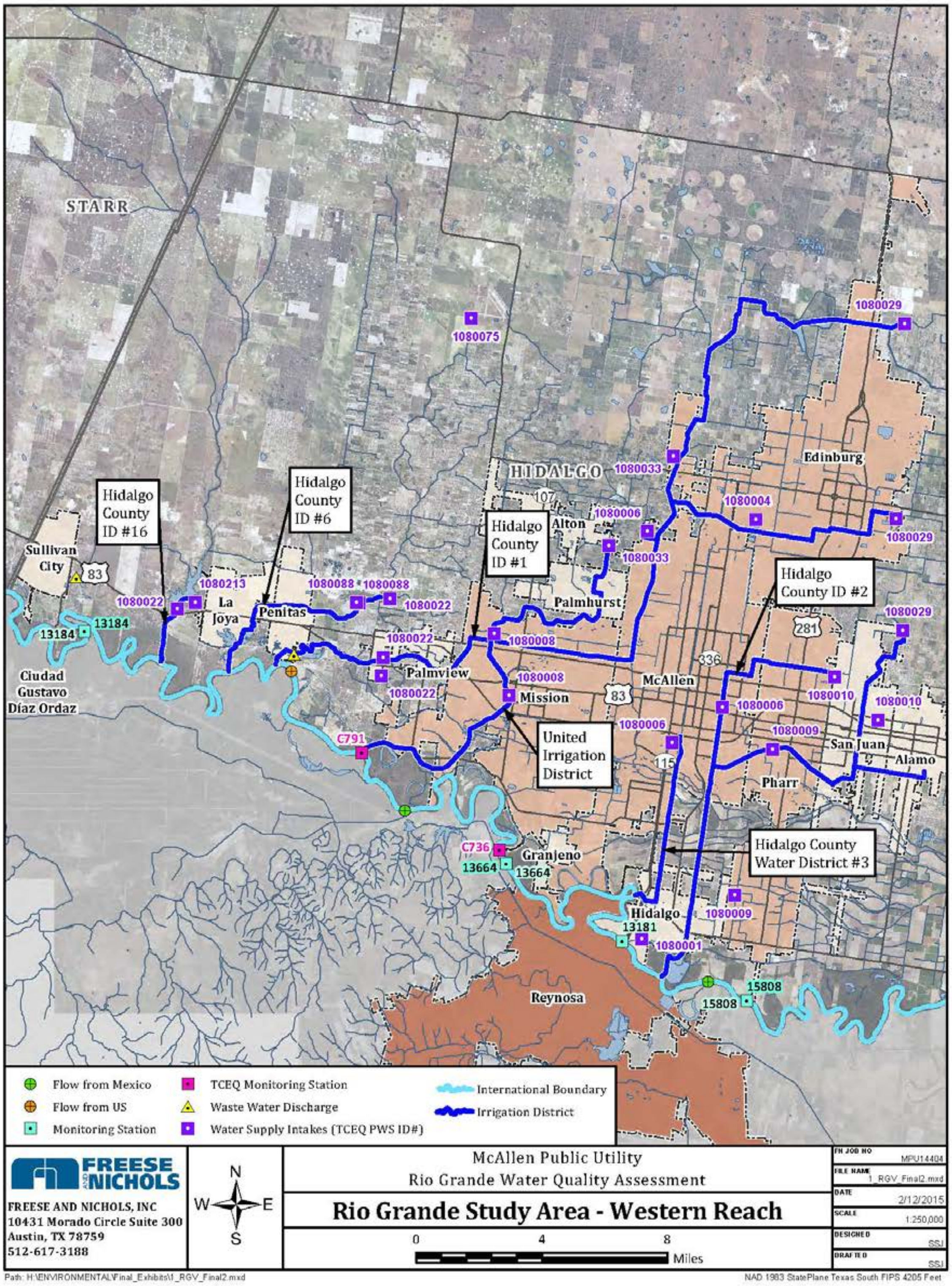

Figure 2. **Rio Grande study area, western reach.**

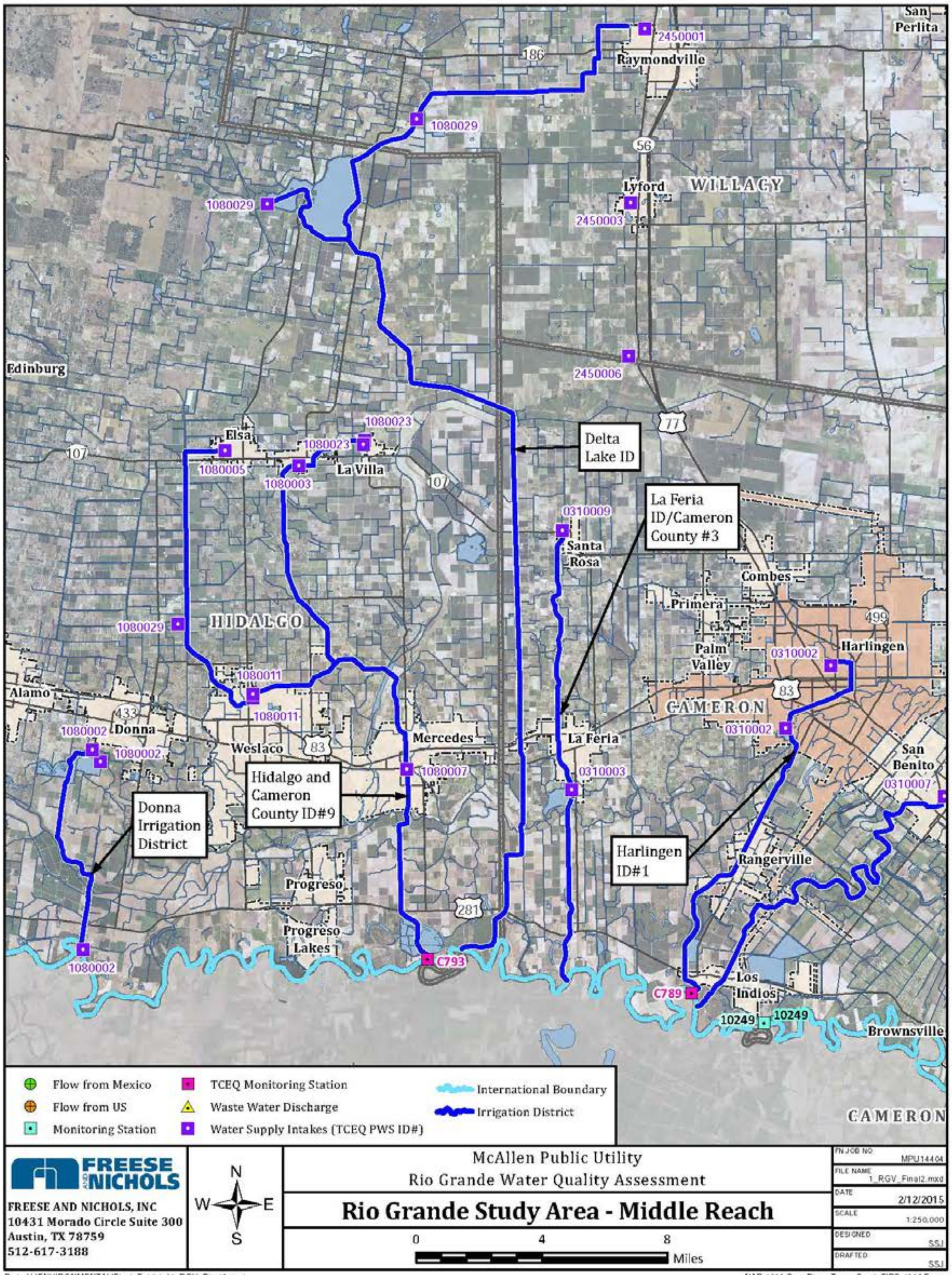

Figure 3. Rio Grande study area, middle reach.

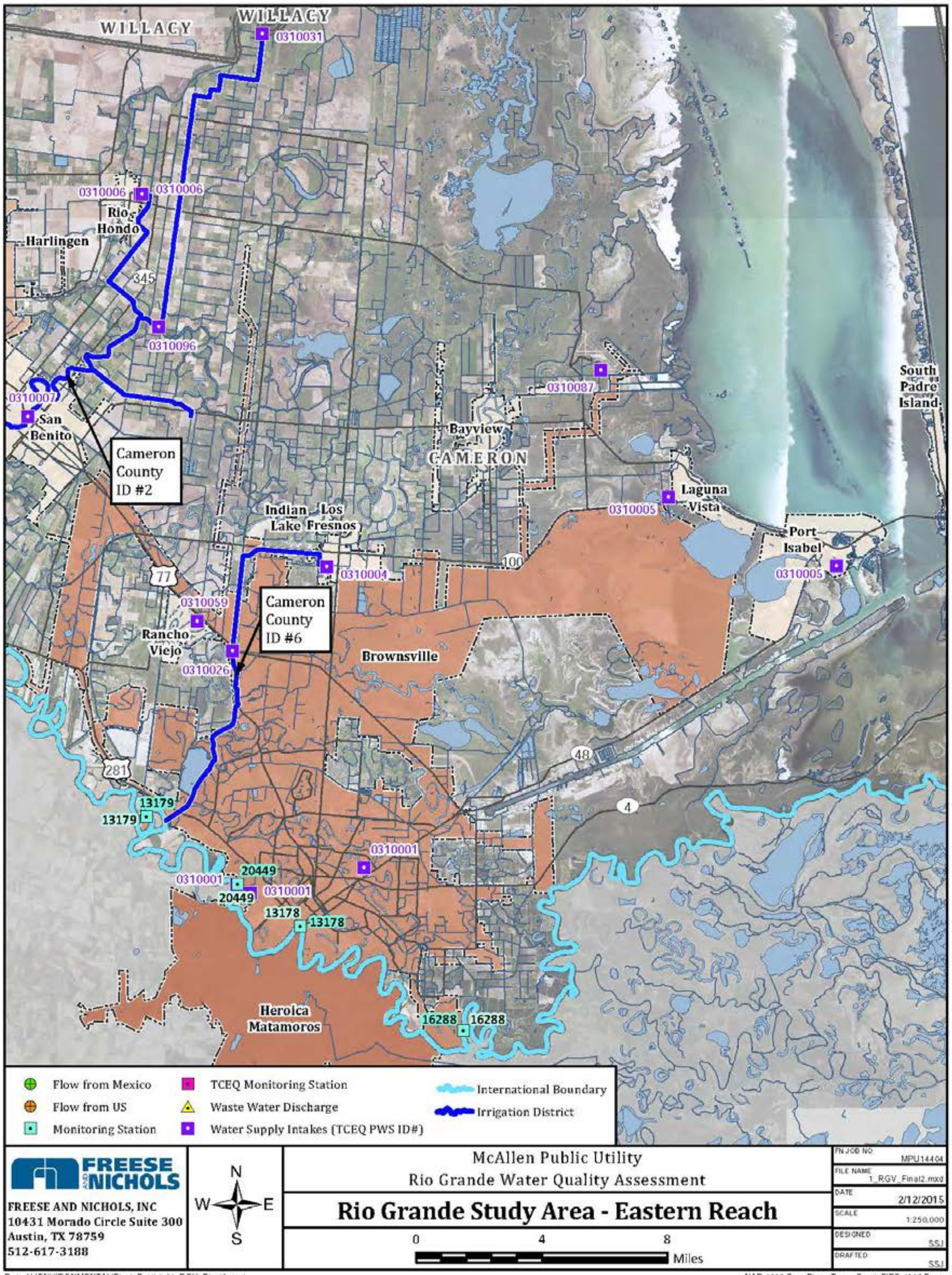

Figure 4. Rio Grande study area, eastern reach.

3.1 Rio Grande Travel Time

A major consideration in placing monitoring locations for taste and odor-causing substances and potentially hazardous materials is how long it may take those substances to travel down river to irrigation diversions. IBWC and TCEQ do not have time-of-travel data which could be used to estimate how long it may take taste and odor-causing compounds or potentially hazardous materials to travel down the Rio Grande. Calculation of time-of-travel for this reach of the Rio Grande is complicated by large diversions from both the U.S. and Mexican shores of the river, reservoir discharges from Mexico, wastewater discharges from Mexico and the U. S., and variation in rainfall and rainfall runoff along the 226 river miles from Falcon Dam to Brownsville.

Time-of-travel was based on calculation of the velocity of flow peak passage from the IBWC gage at Falcon (Gage # 08461300) to the IBWC gage at Los Ebanos (Gage # 08466300). The Los Ebanos gage is about 71 river miles downstream from the Falcon gage and about 19 river miles upstream of Peñitas. The calculated river velocity from Falcon to Los Ebanos was applied to the 90-mile reach from Falcon to Peñitas. This reach includes diversion points for Hidalgo County ID No. 16 and Hidalgo County ID No. 6.

From August 5 through October 11, 2015, eleven comparisons of flow peak passage were made (Table 3-1). Estimated river velocities ranged from 1.7 feet/second when the flow was 680 cubic feet per second at Los Ebanos up to 4.7 feet per second when the flow was 3,200 cubic feet per second. At a river velocity of 4.7 feet per second, contaminants entering the river at Falcon Dam may reach Peñitas in 28 hours. At a river velocity of 1.7 feet per second contaminants may take 78 hours to travel the same distance.

Table 3-1. Rio Grande time-of-travel estimates from Falcon Dam to Peñitas.

Time Peak Passage at Falcon Gage (#08461300)	Time Peak Passage at Los Ebanos Gage (#08466300)	Flow at Falcon Gage (cubic feet/second)	Flow at Los Ebanos Gage (cubic feet/second)	Stream Velocity (feet/second) [1]	Time-of-Travel (hours) [2]
8/5/2015 9:30	8/6/2015 9:30	2,900	4,200	4.3	30
8/7/2015 7:15	8/8/2015 14:30	1,700	2,800	3.3	40
8/8/2015 11:45	8/9/2015 10:00	2,600	3,200	4.7	28
8/11/2015 10:15	8/12/2015 14:00	1,900	2,300	3.8	35
8/12/2015 17:45	8/13/2015 20:30	3,600	2,800	3.9	34
8/14/2015 11:15	8/15/2015 12:30	2,000	2,400	4.1	32
8/15/2015 12:00	8/17/2015 11:30	2,600	3,000	2.2	60
10/1/2015 10:00	10/3/2015 17:30	700	390	1.9	70
10/4/2015 9:30	10/6/2015 23:30	1,000	670	1.7	79
10/7/2015 5:00	10/8/2015 10:15	1,700	1,600	2.3	57
10/10/2015 0:45	10/11/2015 21:30	1,700	810	3.6	37

[1]River velocity is the calculated velocity of water traveling down the river based on the time of pulse passage from Falcon to Los Ebanos.
[2]Time-of-travel is calculated by using the river velocity from Falcon to Los Ebanos applied to 90 stream miles (distance from Falcon to Peñitas)

Dr. Jungseok Ho, University of Texas Pan American, estimated Rio Grande travel times under three different flow regimes (Appendix A) using HEC-RAS modeling. He calculated river travel times to 12 diversions from Peñitas downstream to the Brownsville PUB diversion. Rio Grande flows at Rio Grande City were used to calculate low, median (typical), and high flows for estimating time-of-travel. The three flows were the 25th percentile flow (low flow exceeded by 75% of the flows), the median flow (the flow exceeded by half of the flow measurements), and the 75th percentile flow (flow higher than 75% of the flows).

There are about 130 river miles from Peñitas to the Brownsville PUB water supply intake. When river flow is low, water travels that distance in 140 hours (nearly 6 days) according to the HEC-RAS model. Water travels the same distance in 82 hours (3.4 days) when flow is high (Table 3-2). A taste and odor or hazardous contaminant could travel from Peñitas to Brownsville in the Rio Grande at high flow in less than 4 days. **When evaluating risks caused by contaminants traveling down the river, it is recommended that the fastest travel times shown in Table 3-2 be used to estimate when contaminants may arrive at a diversion point.**

Table 3-2. Rio Grande time-of-travel estimates.

Diversion	River miles below Falcon Dam	River miles below Peñitas	River travel time (hours) from Peñitas		
			25th percentile flow (1,130 ft³/s)	Median flow (2,179 ft³/s)	75th percentile flow (4,273 ft³/s)
Hidalgo Co. ID No. 16	81		No estimate		
Hidalgo Co. ID No. 6	88		No estimate		
Hidalgo Co. Irrigation District 1	90	2	2	1	1
United Irrigation District	94	5.7	7	5	3
Hidalgo Co. Water Improvement District 3	113	25	31	20	14
Hidalgo Co. Irrigation District 2	119	31	37	25	17
Donna Irrigation District	136	48	51	35	26
Hidalgo and Cameron Co. Irrigation District 9	158	70	75	53	42
Delta Irrigation District	159	71	77	54	42
La Feria Irrigation District	165	77	81	58	46
Harlingen Irrigation District No. 1	174	86	91	65	52
Cameron Co. Irrigation District 2	174.5	86.5	91	66	52
Cameron Co. Irrigation District 6	208	120	130	110	76
Brownsville Public Utility Board Water Supply Intake	218	130	140	120	82

Five comparisons of flow peak passage from July 28 through August 22, 2015 were made (Table 3-3) in order to compare time-of-travel estimated by HEC-RAS modeling to time-of-travel estimated by comparing flow peak passage. Flow peak passage at the Progreso gage (Gage #

08472530) was compared to flow peak passage at the Brownsville gage (Gage # 04875000). These two gages are 75 river miles apart.

Table 3-3. Rio Grande time-of-travel estimates from Peñitas to Brownsville.

Time Peak Passage at Progreso Gage (#08472530)	Time Peak Passage at Brownsville Gage (#08475000)	Flow at Progreso Gage (cubic feet/second)	Flow at Brownsville Gage (cubic feet/second)	River Velocity (feet/second) [1]	Time-of-Travel (hours) [2]
7/28/2015 6:00	7/29/2015 11:30	940	360	1.3	140
7/29/2015 7:00	7/31/2015 2:45	810	130	0.91	210
7/30/2015 9:15	7/31/2015 17:00	1,100	310	0.97	200
8/4/2015 3:45	8/5/2015 20:45	2,200	610	1.1	170
8/21/2015 12:30	8/22/2015 23:45	990	200	1.2	150

[1]River velocity is the calculated velocity of water moving down the river based on the time of pulse passage from Progreso to Brownsville.
[2]Time-of-travel is calculated by using the river velocity from Progress to Brownsville applied to 130 stream miles (distance from Peñitas to Brownsville).

Estimated river velocities ranged from 0.91 feet/second when the flow was 125 cubic feet per second at Brownsville up to 1.3 feet per second when the flow was 360 cubic feet per second. At a river velocity of 1.3 feet per second, contaminants in the river at Peñitas may reach Brownsville in 140 hours.

Additional information is needed to refine locations of monitoring sites, particularly within the irrigation systems, some information needs include:

- Rio Grande time-of-travel from Falcon Dam to Peñitas, and
- Time-of-travel estimates in irrigation canals from the Rio Grande diversion points to the water treatment plant intakes.

The time it takes water to travel along irrigation canals to water supply intakes varies with distance from the Rio Grande, shape of the channel, and diversion rates along the channel. Time-of-travel information along the irrigation canals to water supply intakes was not found (Table 3-4).

The distance from the Rio Grande is less than a tenth of a mile to the Brownsville PUB water supply reservoir at the Brownsville PUB diversion. Raymondville's raw water supply travels the furthest, about 42 miles along channels from the river to the intake. The further water travels from the Rio Grande, the greater the number of points for contaminants to enter raw water supply along its route to the water supply intake. If water velocities are relatively slow in the canals, algal blooms may develop and contribute to taste and odors in the water supply.

Table 3-4. Distances to water treatment plant intakes from the Rio Grande.

Diversion from Rio Grande[1]	Canal miles from Rio Grande
Hidalgo Co. ID No. 16	
Aqua Sud La Havana	1.9
La Joya	2.8
Hidalgo Co. ID No. 6	
Aqua Sud Abrams and Aqua Sud FM 492	7.0
Hidalgo Co. ID 1	
McAllen Northwest	18
Sharyland WSC	21
Edinburg West	22
North Alamo WSC	28
North Alamo WSC	33
United ID	
Mission	6.4
Mission North	8.4
Sharyland WSC	16
Hidalgo Co. Water Improvement District 3	
McAllen South	6.2
Hidalgo Co. ID 2	
Pharr	9.2
McAllen	9.2
Alamo	15
North Alamo WSC	18
Donna ID (population served=15,000)	
Donna	7.9
Hidalgo and Cameron Co. ID 9	
Mercedes	6.6
Weslaco	15
Ed Couch	19
La Villa	22
North Alamo WSC	19
Elsa	26
Delta Lake ID	
North Alamo WSC	32
North Alamo WSC	33
Raymondville	42
La Feria ID/Cameron Co. ID No. 3 (population served=10,304)	
La Feria	6.4
Santa Rosa	15
Harlingen ID, Cameron Co. ID No. 1 (population served=138,022)	
Harlingen Runnion	9.9
Harlingen Downtown	14
Cameron Co. ID No. 2 (population served=189,159)	
San Benito	16
East Rio Hondo WSC Nelson	25
East Rio Hondo WSC Simpson	24
Rio Hondo	29

Diversion from Rio Grande[1]		Canal miles from Rio Grande
	Arroyo Colorado	36
Cameron Co. ID No. 6 (population served=13,815)		
	Los Fresnos	13
	Olmito WSC	6.4
Brownsville WTP #1 (population served=191,580)		0.06

[1] Population numbers are from the TCEQ's online Central Registry for Public Water Systems, Drinking Water Watch Information.

There are not "population served" totals for some of the Rio Grande diversions because the "population served" information is only available by water provider and not by irrigation canal providing the water. Water providers using water from multiple Rio Grande irrigation canals include:

- Aqua Sud, population served=48,078 (Hidalgo Co. ID's No. 16 and No. 6)
- McAllen, population served=226,827 (Hidalgo Co. ID No. 1, No. 2 and Hidalgo Co. Water Improvement District 3)
- North Alamo WSC, population served=203,978 (Hidalgo Co. ID No. 1, No. 2, Hidalgo and Cameron Co. ID No. 9, and Delta Lake ID)
- Mission, population served=272,235 (United ID)
- Alamo, population served=18,690 (Hidalgo Co. ID No. 2), and
- Sharyland WSC, population served=119,808 (Hidalgo Co. ID No. 1 and United ID)

4.0 Project Definition

In order to accomplish the three tasks required in the TWDB grant, Freese and Nichols, Inc. completed the following products as required in its contract with McAllen PUB and which are described in this report:

- Interviewed water treatment plant operators to identify water quality parameters representative of taste and odor episodes and which can be included in an early warning system. Evaluate the time needed to adjust treatment processes to deal with taste and odors.
- Reviewed customer complaints regarding the frequency and timing of taste and odor issues.
- Water quality monitoring review
- Evaluated minimum acceptable distances between monitoring sites and water treatment plant intakes which allow adequate time for operators to adjust treatment processes.
- Identified possible continuous water quality monitoring locations.
- Discussed continuous monitoring capabilities with different water quality monitoring organizations. And,
- Proposed an initial monitoring network and estimate costs for installation and annual operations and maintenance costs.

5.0 Public Water Supply Review: Tastes and Odors

Citizen complaints regarding public water supplies since 2002 were reviewed using TCEQ's online Central Registry Query system (TCEQ, 2015)., Odor complaints were 30% and taste complaints were 5% of the 104 complaints received about 27 different water providers. Fishy or chlorine odors were the most commonly identified odors. Metal and salty tastes were the taste complaints received. July and August were months with the highest number of odor complaints. Dr. Nick Landes, Freese and Nichols, Inc., interviewed water treatment plant managers for five water supply organizations in the Lower Rio Grande Valley (Appendix B). The following goals were established for the interviews:

1. Identify four treatment processes used by LRGV WTPs for taste and odor treatment, and
2. Determine four water quality parameters that would provide the most benefit for identifying potential upstream water quality changes affecting TASTE AND ODOR issues, plant operations, or hazardous contaminants.

Information from the interviews was subsequently used to create a treatment guidance matrix to inform operators of appropriate treatment responses to upstream water quality data. Chlorine dioxide and powdered activated carbon (PAC) were selected for inclusion in the guidance document since they are commonly used in the Lower Rio Grande Valley. Both methods have been used to control low odor threshold compounds with earthy/musty attributes (Huber et al., 2005; Mallevialle and Suffet, 1987).

Hydrogen peroxide was selected for inclusion in the guidance matrix since its application had promising results according to the interviewed water provider. Studies indicate that hydrogen peroxide's effectiveness is limited to cyanobacteria (Barrington et al., 2013; Bauzá et al., 2014). If dosed properly, hydrogen peroxide can inhibit cyanobacteria growth rates without lysing their cellular walls. If lysed, intracellular compounds such as phosphorus, cyanotoxins and MIB/geosmin may be released, effectively deteriorating, rather than improving, water quality.

Terminal storage reservoir management was also selected for inclusion in the matrix since the reservoirs provide operators with a heightened level of operational flexibility while also representing a point where water quality issues can develop/worsen (e.g. algal blooms). Management strategies included addition of algaecide (e.g. copper sulfate and potassium permanganate), sonication and water storage (i.e. discontinue raw water pumping). Kommineni et al. (2009) indicated that algaecides proved useful when algal counts were low, but resulted in deteriorated water quality at high algal counts due to cell lysing. Alternatively, sonication caused settling of algae without release of intra-cellular toxins (Lee et al., 2001).

Parameters included in the guidance matrix can be monitored using real-time instrumentation. Phycocyanin and chlorophyll-α were included since they correlate with cyanobacteria and algal growth, respectively. Byproducts produced during the growth of these organisms, namely geosmin and methyl isoborneal, may be responsible for the primary TASTE AND ODOR issues reported by interviewed WTPs. Algal growth also presents operational difficulties (e.g. filter clogging, flow disruption) and health risks due to the production of algal toxins.

Conductivity was selected due to its correlation with total dissolved solids (TDS) and the periodic TDS spikes that occur in the Rio Grande following high flow events. As a gross indicator of water quality, pH was included because it can be monitored reliably and economically. The absolute value of pH as well as pH trends can indicate water quality shifts.

Additionally, chemical treatment processes at a WTP often vary based upon the water's pH, and forewarning of pH shifts will allow operators to adjust chemical doses accordingly.
The guidance matrix is provided in Table 6-2. The trigger level for a treatment action, is based on deviations from normal concentrations or rates of change. Long-term water quality monitoring data provide the historical basis for normal concentrations and rates of change. Validity of trigger levels improves as the historical dataset increases. Multiple triggers could be associated with each water quality parameter based upon site specific conditions. In the same manner, the treatment recommendations will also be site specific even though general guidelines have been provided below.

An example application of the guidance matrix is shown as follows:

- **Event description:** Phycocyanin levels measured at the nearest monitoring station upstream of the WTP have increased by 115% over the past hour. The phycocyanin levels are within the 80th percentile of measurements over the course of the past year.
- **Trigger level initiated:** Trigger Level 1 (TL1) is initiated.
- **Treatment plant processes available:** The treatment plant doses chlorine dioxide at 0.8 mg/L as their primary disinfectant. They also have a terminal storage reservoir. The plant periodically doses copper sulfate into the terminal storage reservoir.
- **Treatment initiated:** The chlorine dioxide dose is increased from 0.8 mg/L to 1.2 mg/L and copper sulfate is dosed into the terminal storage reservoir at 1.5 mg/L.

Table 5-1. Taste and odor treatment guidance matrix.

<table>
<tr><td colspan="2"></td><td colspan="4">Monitored water quality parameters</td></tr>
<tr><td colspan="2"></td><td>Phycocyanin</td><td>Chlorophyll-α</td><td>Conductivity</td><td>pH</td></tr>
<tr><td colspan="2"></td><td colspan="3">TL1: Parameter value above the 50th percentile <u>and</u> value increases by 100% or more in 1 hour[1]
TL2: Parameter value increases above 95th percentile[1]</td><td>TL1: 6 ≥pH ≥9[1]
TL2: pH change > 1 unit in 1 hour[1]</td></tr>
<tr><td rowspan="4">Treatment Process</td><td>Chlorine Dioxide</td><td colspan="2">TL1: 1 – 1.5 mg/L dose</td><td>N/A</td><td>N/A</td></tr>
<tr><td>PAC</td><td colspan="2">TL1: 10 - 25 mg/L dose
TL2: 25 – 50 mg/L dose</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Hydrogen Peroxide</td><td colspan="2">If data suggests cyanobacteria are abundant, then
TL1: 1 – 1.5 mg/L dose
TL2: 2 – 5 mg/L dose

If data suggest cyanobacteria are minor, then increased dose from normal operation will not be effective.</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Terminal Storage Reservoir Management</td><td colspan="2">TL1: (1) initiate sonication
(2) initiate algaecide addition:
• 1 – 2 mg/L copper sulfate
• 3 – 10 mg/L potassium permanganate
TL2: (1) discontinue pumping raw water
(2) discontinue algaecide
(3) continue sonication</td><td>TL2: discontinue pumping raw water from canal/river into reservoir</td><td>TL1 & TL2: discontinue pumping raw water from canal/river into reservoir</td></tr>
<tr><td colspan="6">TL = Trigger Level
[1] Representation of potential trigger levels. Criterion for action will be better defined upon collection of site specific historical database.</td></tr>
</table>

6.0 Water Quality Monitoring Review

6.1 Existing Water Quality Monitoring

The International Boundary and Water Commission (IBWC), U. S. Geological Survey (USGS), and the TCEQ monitor water quality in the Rio Grande (Figure 1) (Table 6-1). Although many water quality variables are sampled by all three agencies, there are some differences in parameters monitored (Table 6-2). Additionally, University of Texas Pan American professors sample Rio Grande water quality for specific projects however their work is not long-term in nature. SDI Engineering, LLC. summarized water quality monitoring on the lower Rio Grande (Appendix C).

The IBWC monitors the Rio Grande at 13 locations and the USGS monitors one station. Monitoring helps to ensure the Rio Grande meets water quality standards and tracks long-term water quality. IBWC collects and analyzes grab samples from their 13 sampling locations two to four times annually for the water quality parameters detailed in Table 6-2. The USGS collects and analyzes grab samples monthly at one site downstream of Brownsville for the water quality parameters detailed in Table 6-2. The IBWC and USGS do not conduct continuous water quality monitoring at any stations.

TCEQ operates six continuous automated water quality stations (CAMS) on the Lower Rio Grande (TCEQ, 2014) (Figures 5-11). These stations were set to notify irrigators when salt levels were too high for irrigation. Each station consists of a:

- water quality meter,
- temperature and specific conductance probes,
- PVC pipe long enough to place the meter below the river's low water level,
- communication system for sending data wirelessly to TCEQ,
- solar panel for electricity, and
- battery to power instruments.

Salinity and total dissolved solids concentrations are calculated from temperature and specific conductance measurements. Measurements are made every 15 minutes and sent wirelessly to TCEQ headquarters. TCEQ's has been unable to maintain and calibrate the meters at its desired frequency.

Table 6-1. Lower Rio Grande Water Quality Monitoring Stations Actively Monitored (as of December 2014).

Station designation	Agency	Grab/continuous[1]	Period of record
C736	TCEQ	Continuous	7/6/11-present
C767	TCEQ	Continuous	7/8/09-present
C789	TCEQ	Continuous	6/16/10-present
C791	TCEQ	Continuous	12/2/10-present
C793	TCEQ	Continuous	6/15/10-present
C796	TCEQ	Continuous	7/6/11-present
13103	IBWC	Grab	7/11/95-2/26/14
13176	IBWC	Grab	2/1/95-3/27/14
13177	IBWC	Grab	1/19/94-3/5/14
13178	IBWC	Grab	10/15/08-3/27/14
13179	IBWC	Grab	1/25/93-3/27/14
13181	IBWC	Grab	1/31/95-3/5/14
13184	IBWC	Grab	1/31/95-3/5/14
13185	IBWC	Grab	1/20/95-3/26/14
13186	IBWC	Grab	1/31/95-3/26/14
13664	IBWC	Grab	1/18/95-3/5/14
15808	IBWC	Grab	11/24/97-3/5/14
16288	IBWC	Grab	10/23/03-3/27/14
20449	IBWC	Grab	12/29/04-6/03/14
08475000	USGS	Grab	2/15/66-11/18/14

[1]Grab samples are typically collected two to four times per year. Continuous samples are collected at intervals of 15 minutes and data transmitted wirelessly to TCEQ.

Table 6-2. Water quality variables currently monitored on the lower Rio Grande.

Variable	IBWC	USGS	TCEQ
Dissolved oxygen (mg/L)	Yes	Yes	
Temperature	Yes	Yes	Yes
pH (standard units)	Yes	Yes	
Specific conductance	Yes	Yes	Yes
Secchi disk transparency	Yes		
Turbidity		Yes	
Fecal coliform	Yes		
E. coli	Yes		
Chloride	Yes	Yes	
Sulfate	Yes	Yes	
Alkalinity	Yes	Yes	
Total hardness	Yes	Yes	
Total suspended solids	Yes	Yes	
Volatile suspended solids	Yes	Yes	
Total dissolved solids	Yes	Yes	Yes (calculated)
Total organic carbon	Yes	Yes	
Ammonia	Yes	Yes	
Nitrate and nitrite	Yes	Yes	
Phosphorus	Yes	Yes	
Chlorophyll α	Yes		
Pheophytin	Yes		
Calcium	Yes	Yes	
Magnesium	Yes	Yes	
Potassium	Yes	Yes	
Sodium	Yes	Yes	
Fluorides, total	Yes	Yes	
Silica	Yes	Yes	
Pesticides		Yes	
Metals		Yes	

Figure 5. CAMS 789, Rio Grande at the Harlingen Irrigation District (ID) Diversion. View downstream with the irrigation diversion to the left and the Rio Grande flowing from right to left. Photo by TCEQ.

Figure 6. CAMS 789. Retrieving the water quality meter from the Rio Grande. Photo by Freese and Nichols, Inc. September 29, 2014.

Figure 7. CAMS 789. YSI water quality meter immediately after retrieval from the river. Photo by Freese and Nichols, Inc. September 29, 2014.

Figure 8. CAMS 789. YSI water quality meter with fouling on probes. Photo by Freese and Nichols, Inc. September 29, 2014.

Figure 9. **CAMS 793. View downstream. Photo by Freese and Nichols, Inc. September 29, 2014.**

Figure 10. **CAMS 793. View of control box. Battery on bottom shelf and control/communication system on middle shelf. Photo by SDI Engineering, LLC. September 29, 2014.**

Figure 11. CAMS 791. Photo by TCEQ.

6.2 Monitoring Approaches Evaluated

Three remote, continuous monitoring approaches were considered:

- Water quality sensors inserted directly in the Rio Grande with data transmitted wirelessly to the user.
- Water quality monitoring instruments housed in a structure near the Rio Grande where water is pumped from the Rio Grande to the instruments for analyses. Data would be transmitted wirelessly to the user.
- Remote cameras set to capture images of the river and transmit those images wirelessly to the data user.

Each of these approaches has advantages and limitations (Table 6-3).

Table 6-3. Pros and cons of remote, continuous monitoring approaches.

Pros	Cons
Meters placed in the Rio Grande	
• Monitoring stations with this capability are already in place and operating on the river. Monitoring personnel in the area have experience using this type of equipment. • Maintenance and calibration is less frequent and time-consuming than more expensive lab-type instruments. • Equipment is less expensive to purchase and operate than lab-type instruments. • Much of the data can be screened and analyzed automatically with the user notified when alert levels are exceeded.	• Limited number of parameters which can be measured. • Cannot test all the parameters which may cause taste and odor problems or which may indicate the presence of potentially hazardous substances. • Potentially subject to flood damage.
Water pumped to meters from the Rio Grande	
• Can test more parameters than meters placed in the river • Much of the data can be screened and analyzed automatically with the user notified when alert levels are exceeded. • May be able to collect and store water samples for later analyses in a lab.	• Instrumentation is usually more expensive than meters placed in the river. • Instrumentation may require more frequent maintenance and calibration than instruments placed directly in the river. • Cannot test all the parameters which may cause taste and odor problems or which may indicate the presence of potentially hazardous substances. • Potentially subject to flood damage. • Physical installation is larger and therefore may be more visible and subject to vandalism.
Remote cameras	
• May be less expensive to install and operate than water quality meters. • May require less maintenance than water quality meters. • Provide visual indication of possible water quality problems (ex. dead or dying fish, sheens, scums) which cannot be measured by field or lab water quality meters.	• Do not measure any water quality parameters. • Requires more labor to observe images for potential indicators of problems. • Difficult to collect data when it is dark.

Characteristics of desired monitoring equipment should include (Roberson and Morley, 2005):

- Rapid detection of contaminants,
- Reliable data (few false positives, few false negatives, and detection limits that are helpful),
- Easy to operate and maintain,
- Tough,
- Rapid communication, near real-time, with data management system and information users, and
- Affordable

Selection of appropriate monitoring equipment and operation depends on many factors:

- Information needed,
- Location(s) to be monitored,
- Parameters, and
- Measurement frequency.

6.3 Monitoring Taste and Odor Substances

> "By the time customers begin to complain about unpleasant tastes or odors, the cause of the problem is likely to have intensified. Because of the narrow window of opportunity between detection and full-blown taste and odor episodes, a utility's best defense is to anticipate such problems and control them at the source." (WERF, 2014).

Substances causing undesirable tastes or odors in drinking water generally fall into two categories:

- Organic compounds, some of which are natural and some produced by humans, and
- Salts

Rapid, accurate, cost-effective techniques are not widely available for directly measuring specific compounds like geosmin and methyl isoborneal and their concentrations which cause taste and odors in raw water supplies. However there are a variety of rapid, cost-effective measurements of water quality or changes in water quality indicative of potential taste and odor conditions.

6.3.1 ***Organic Compounds***

A. Chlorophyll-α or Algae Sensors

Algae may cause taste and odor problems through their production of geosmin and methyl isoborneal (Wehr and Sheath, 2003). These substances are frequently produced by blue-green algae (ex. *Anabaena* and *Oscillatoria*) (Graham et al., 2008) but these and other taste and odor compounds may be generated by yellow-green algae (ex. *Dinobryon*), diatoms (ex. *Stephanodiscus*), and other types of algae. Several manufacturers (ex. Yellow Springs Instruments, Hydrolab, Turner Design) sell sensors that indirectly measure chlorophyll, common to all algae, or phycocyanin, a pigment characteristic of blue-green algae. When chlorophyll or phycocyanin levels are high, taste and odor compounds may be present in the water supply. Hambrook Berkman and Canova (2007) describes these probes and their use.

Substantial changes measured by these sensors may indicate a significant change in algal concentrations which in turn may lead to increased taste and odor compounds. The sensors could also indicate if a chlorophyll or phycocyanin trigger level were exceeded. These probes attach to water quality meters placed directly into the water being tested and may cost between $2,000 and $4,000 per sensor.

B. Dissolved Oxygen

Wide dissolved oxygen fluctuations may indicate conditions leading to taste and odors in raw water. Low dissolved oxygen particularly during daylight may indicate the presence of substantial organic matter being decomposed by bacteria. If oxygen levels are low during the day, bacterial respiration may be using oxygen faster than algae can produce it through photosynthesis. High concentrations of bacteria may produce taste and odor-causing compounds as they decompose. If dissolved oxygen exhibits wide swings from very high concentrations (greater than 12 mg/L) in the afternoon to very low concentrations (less than 2 mg/L) near dawn, very high concentrations of algae may be present which may produce taste and odor-causing compounds.

Optical dissolved oxygen sensors can be mounted on a variety of water quality meters and deployed for up to a month at a time without cleaning or recalibration. These sensors may cost in the range of $2,000-$3,000 per sensor.

C. Fluorescence Dissolved Organic Matter

Sensors are now available which measure dissolved organic matter using fluorescence, abbreviated fDOM. Like dissolved oxygen sensors, these probes can be placed on water quality meters in the river and can collect data at intervals less than a minute apart (Bergamaschi et al., 2009). A number of manufacturers produce these sensors (ex. WET Labs, Turner Design, Yellow Spring Instruments) which may range in price from $3,000 to $6,000. Although these sensors cannot identify a specific dissolved organic compound, laboratory studies indicate the values they measure can be directly related to concentrations of dissolved organic compounds like trihalomethanes and methyl mercury (Bergamaschi et al., 2009).

D. Turbidity

Turbidity measures the transparency of water and substantial increases in turbidity are frequently associated with rainfall runoff transporting sediments into a stream. Rapid, wide changes in turbidity may indicate the presence of soils, wastes, manures being washed into a stream by rainfall runoff. Turbidity sensors are available which can be attached to water quality meters and placed directly into the river being measured. In one case, the USGS has developed an equation using data from turbidity and conductivity probes to reliably estimate geosmin concentrations (Christensen et al., 2006). The Salt River Project in Arizona uses data from real-time turbidity sensors to switch from canals with turbid rainfall runoff to less turbid water supply canals (Elliott, personal communication). A number of water quality meter manufacturers sell turbidity probes which may cost between $1,000 and $3,000 per sensor.

E. Total Organic Carbon Analyzers

Total organic carbon (TOC) analyzers estimate concentrations of total organic carbon however they do not have the capability to identify specific organic compounds.

These instruments may measure total organic carbon to levels as low as 2 mg/L (USEPA, 1999) and as frequently as every 8 minutes (HACH). HACH's GuardianBlue system includes a TOC analyzer in the system. In at least one case, use of the online TOC analyzer to monitor treated water was discontinued because of difficulty in keeping it operating (Allgeier, personal communication). Maintenance of TOC analyzers in the field has been described as "challenging" (EPA, 2010b). Online TOC analyzers may have difficulty monitoring raw water supplies like the Rio Grande without prefiltering water before it enters the TOC analyzer (Allgeier, personal communication).

6.3.2 *Salts*

Different minerals and concentrations of minerals can affect taste of treated water. Sensors measuring salt concentrations are widely available (ex. Yellow Springs Instruments, Hydrolab, In-Situ, Inc.) and almost universally include a temperature probe. These sensors are sometimes referred to as C/T sensors because they measure conductivity and temperature. Generally available for under $1,000, conductivity sensors measure the ability of the water to conduct electricity. Conductivity is determined by the amount of salt in the water.

A sharp increase in conductivity reflects a sharp rise in salt concentrations. Data are reported as microSiemens per centimeter (µS/cm) or salinity (parts per thousand). Total dissolved solids (measured as milligrams per liter) is a standard laboratory test for levels of salt in freshwater. TCEQ considers total dissolved solids (mg/L) to approximately equal 0.65 times the conductivity value (TCEQ, 2012). For example, if the conductivity measured by the sensor is 1,000 microSiemens per centimeter, total dissolved solids is estimated to be 650 mg/L. Some water quality meters report conductivity as total dissolved solids or salinity. Although conductivity measurement does not show how much of the conductivity is due to chlorides, sulfates, or other salts, it is considered a reliable indicator of changing concentrations of salts.

6.4 Monitoring Hazardous Materials

Hazardous materials may be toxic to humans and may include a wide variety of agricultural or industrial chemicals as well as natural toxins like microcystin, produced by blue-green algae. Analysis of water samples for potentially hazardous materials usually involves specialized collection of water samples followed by laboratory analyses using a variety of relatively expensive laboratory equipment and techniques like gas chromatography and mass spectrometry. Sensors monitoring taste and odor-causing substances may also help detect presence of hazardous materials. For example, algae sensors described above may be able to detect levels of phycocyanin, a pigment produced by blue-green algae. Some blue-green algae produce algal like microcystin and anatoxin. These toxins can cause skin irritation, damage livers, and impact neurological function. High concentrations of phycocyanin indicate the possible elevated concentrations of those algal toxins.

Some manufacturers have field versions of lab instruments like gas chromatographs. For example, Advance Field Systems, Inc. and Agilent Technologies, market field gas chromatography instruments which can be taken to the work site for measuring samples in the field. These instruments may cost more than $30,000 and to date, there is little information on their use in remote, continuous operated applications. In one application, on-line gas chromatography-mass spectrometry was tried and discontinued because maintenance was relatively expensive (Allgeier, personal communication).

The chlorophyll/algae and fluorescence dissolved organic matter sensors and the TOC analyzer in HACH's GuardianBlue may provide indirect measures of the possible presence of potentially hazardous organic compounds. Additional sensors and methods may help identify the presence of potentially hazardous materials.

6.4.1 *pH Sensor*

Sensors for pH are widely used and available from a variety of manufacturers. The pH can indicate whether an acid or caustic spill has occurred and its extent of impact, both by measuring how much the pH is changed and for what amount of time it remains low. The pH of the water also provides an indication of plant and algae concentrations in the water. When pH increases above 9 standard units in the afternoon and returns to a level between 7.5 and 8.5 in the morning, it is indicative of algal blooms occurring in the water.

6.4.2 *Biological Tests*

At the time of this report, there are no known biological tests which are continuous operating and remotely deployed. The German company, bbe Moldaenke Gmbh, manufacturers a variety of biological tests which can be used to reveal toxicity in water (Green et al., 2003). These tests use:

- Algae ("Algae Toximeter II") which is reported effective in detecting presence of herbicides,
- Water fleas ("DaphToxII"), and
- Fish ("Fish Toximeter" and "*Tox*Protect64"), both of which use fish.

These instruments are typically installed in a laboratory where raw water could be pumped through their systems. Variables like swimming speed and swimming pattern are continuously measured by video linked to a computer. These tests can detect toxicity caused by different substances or combinations of toxic substances many of which are difficult measured with laboratory equipment. A handful of utilities around the U.S. are using these types of biomonitoring (Allgeier, personal communication).

Kokkali and van Delft (2014) evaluated 60 different biologically-based tests, devices, and technologies for identifying toxicity in water. Disadvantages of these systems include the relatively high costs associated with maintaining test animal populations and subjectivity associated with measuring changes in behavior of organisms. At least one utility in the lower Rio Grande Valley operates a simplified version of this system by maintaining and observing fish in an aquarium in the lab.

6.5 Remote Cameras

It may be possible to deploy remote cameras in secure locations to image the river. The U.S. Border Patrol has been contacted to explore collaborating with their current operation of remote cameras. Because the Border Patrol is watching the river at different points, it may be possible to notify the water supply utilities when unusual river conditions are observed, i.e. large numbers of dead fish, unusual water colors, or unusual surface scums or sheens. These unusual conditions may result from potentially hazardous materials or situations that may also generate taste and odors causing substances. The Border Patrol has responded by requesting more information about this project.

If it is not possible to collaborate with Border Patrol camera observations, it may be possible for the Border Patrol to share information about what camera systems work best. A wide variety of cameras are available for less than $1,000 per camera and technology in this field is rapidly evolving. The city of Calgary, Canada, uses a series of four cameras to watch the Bow and Elbow rivers (Calgary City News Blog, 2011). The cameras provide information about river flooding, debris buildup, and ice conditions.

6.6 Sensor Comparison

There are many different vendors and styles of sensors. Water quality sensor technology continues to advance at a rapid rate. Table 6-4 summarizes price ranges and estimates of reliability and maintenance frequency based on the best information available at the time this report was produced. When the partners in this project move forward, they should investigate this information because it should be expected to change at a relatively rapid rate.

Table 6-4. Comparison of Different Probes.

Sensor	Cost per unit	Reliability	Maintenance frequency and ease
Algal sensor	$2,000-$4,000	High	Low
Dissolved oxygen	$2,000-$3,000	High	Low
fDissolved organic matter	$3,000-$6,000	High	Low
Turbidity	$1,000-$3,000	High	Low
Conductivity	Less than $1,000	High	Low
pH	Less than $1,000	Moderate	Moderate
TOC analyzer	More than $5,000	Moderate	High
Biological assays	Unknown, but expected to exceed $5,000	Moderate	Highest
Cameras	$1,000	High	Low

6.7 Monitoring Lessons Learned

In order to obtain information about existing monitoring programs and technologies, several individuals were interviewed by telephone.

- Steve Allgeier, EPA's Office of Ground Water and Drinking Water/Water Security Division in Cincinnati, OH, on November 10, 2014. Mr. Allgeier has been a leader in EPA's Water Security Initiative for the past 10 years.
- Alex Barabanov, City of Corpus Christi, August 19, 2014. Corpus Christi purchased and installed a HACH GuardianBlue system in 2013.
- Charles Dvorsky, TCEQ's Continuous Water Quality Monitoring Network Coordinator. Fall 2014.
- Greg Elliott, Salt River Project, Phoenix, AZ, on December 16, 2014. The Salt River Project uses water quality meters in canals to manage raw water supply quality.
- Johnny Partain, City of Dallas, November 11, 2014. Dallas is one of the pilot cities in EPA's Water Security Initiative. Dallas monitors 14 locations in its water distribution system with s::can technology. And,

Lessons learned from those conversations include the following:

- The greatest challenge in establishing a monitoring program is identifying:
  - Monitoring sites,
  - How much warning time is needed, and
  - How confident you need to be in the information generated before you respond to alerts.
- Most monitoring programs use sensors for temperature, pH, and conductivity. Other probes used may include dissolved oxygen, chlorine (particularly in distribution systems), and turbidity. These probes are generally considered reliable and relatively low cost to purchase and maintain. However none of these probes directly measure specific taste and odor substances or potentially hazardous materials. Temperature is a fundamental parameter to measure. The Salt River Project monitors temperature in part because of its relation to trihalomethane formation (Elliott, personal communication).
- Instrumentation requiring water to be pumped from the river through analytical devices is more expensive to purchase and generally requires more labor-intensive maintenance than water quality meters with sensors placed in the river (Allgeier, personal communication). This instrumentation may be 3 to 6 times more expensive to purchase and install than installation of a water quality meter with probes.
- Development of trigger levels, data management, and communication will take a year or more.
- Cost of the data management and communication system may range from 10% to 200% of the purchase price of the monitoring instruments.
- Online biological tests for toxicity are not widely used.
- Expect to maintain equipment at least monthly.

7.0 Possible Monitoring Scenario

The following scenario illustrates how an early warning system to monitor taste and odor substances and potentially hazardous materials in the Rio Grande may be approached (Figure 12). <u>It is a conceptual example, not a recommendation</u>. This scenario is a phased approach, providing utilities an opportunity to build the program in steps rather than build a major program from the start with a major investment. It is a cyclic approach which encourages partners to return periodically to the planning phase to reevaluate objectives, partnership agreements, and set future directions. Cincinnati Ohio's water system spent $2.5 million to implement the sampling analysis component of its water security initiative (EPA, 2014). Lessons learned from Cincinnati and other pilot projects should save money and effort building future early warning systems.

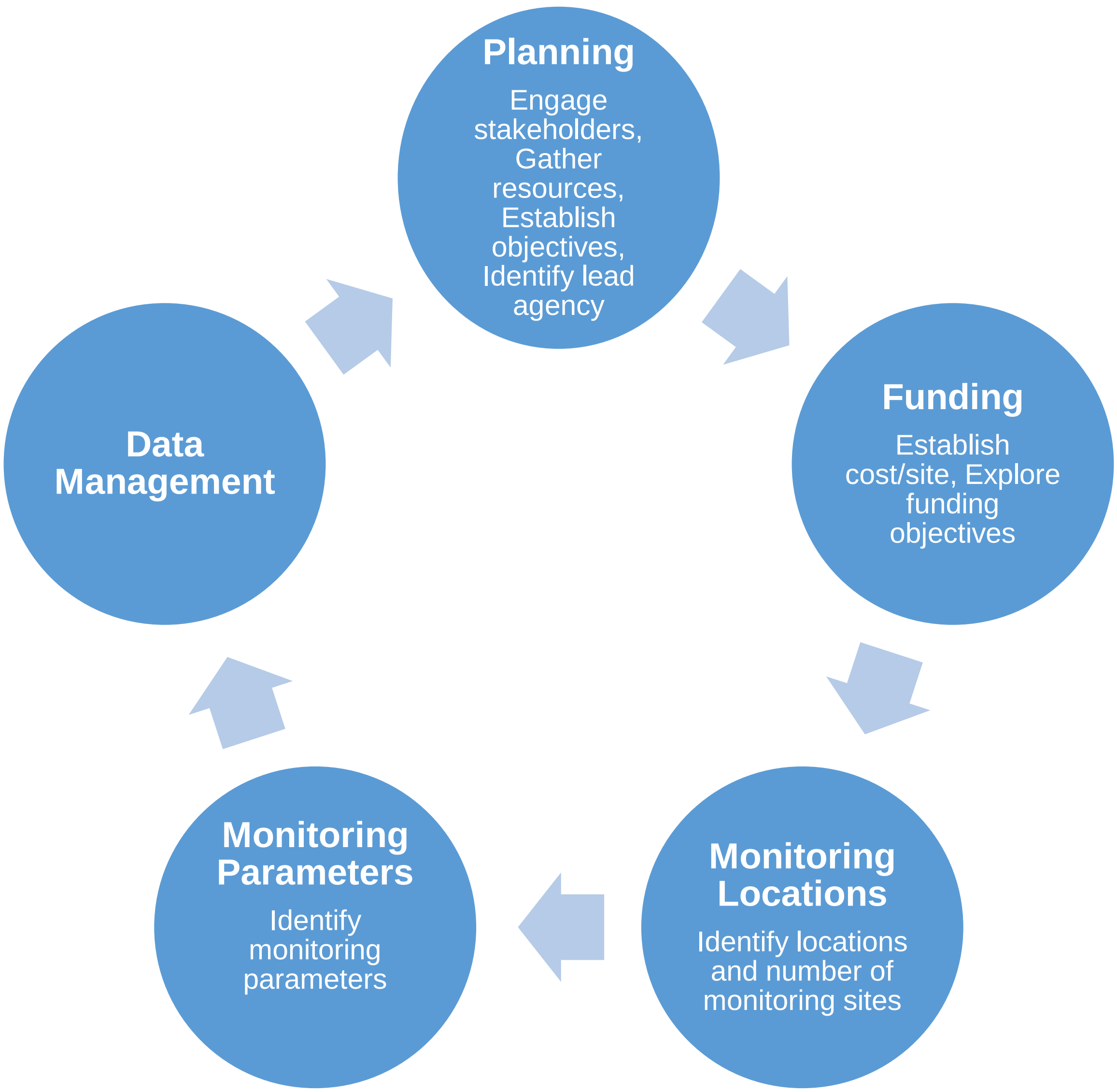

Figure 12. Scenario for development and operation of an early warning system.

7.1 Step 1: Planning and Collaboration with Monitoring Agencies

Planning an early warning system is the first and most important step. This could be the most time-consuming aspect of the project. Discussions about a monitoring program could begin with the IBWC, TCEQ, and the USGS at the annual Clean Rivers Program monitoring meeting for the Rio Grande. The agencies monitor the river and convene at the annual meeting to discuss monitoring needs. It may be possible to shift some ongoing monitoring to an early warning system. This shift of resources would be most acceptable if it could be shown to support all the agencies' monitoring objectives. Objectives of the Clean River Program include:

- Provide quality-assured data to the TCEQ for use in decision-making,
- Identify and evaluate water quality issues,
- Promote cooperative watershed planning,
- Recommend management strategies,
- Inform and engage stakeholders, and
- Maintain efficient use of public funds.

Continuous monitoring locations on the river can support these objectives in addition to meeting TCEQ's objective of providing irrigators information about salt concentrations in the river. The new objective of protecting the region's raw water supply meets the Clean River Program's goals.

7.2 Step 2: Funding

Discussions with monitoring agencies should help identify funding needs. Water providers and monitoring agencies can begin seeking funding. Grant funding may be available from EPA's Border 2020 program (http://www2.epa.gov/border2020), EPA's Water Security Initiative (http://water.epa.gov/infrastructure/watersecurity/lawsregs/initiative.cfm), U. S. Department of Homeland Security, and Texas Water Development Board. Other funding sources may be available.

A phased approach allows certain parts of the monitoring system to be constructed and operated as funds become available.

The Water Sentinel Program in Dallas, Texas cost millions of dollars and individual monitoring sites cost about $100,000 per site (Partain, personal communication). Based on interviews with water treatment plant operators for this project, there does not appear to be an immediate need for a major investment in early detection system monitoring.

Brisbane, Australia installed monitoring systems somewhat similar to TCEQ's continuous water monitoring stations (WERF, 2014). Meters measured dissolved oxygen, temperature, pH, turbidity, and oxidation-reduction potential. The approximate cost to build the housing, provide all the materials, and purchase the water quality meter and sensors was $27,000 per site with $5,000 estimated per year to maintain each site (14 trips per year).

7.3 Step 3: Monitoring Locations

Some of TCEQ's existing continuous monitoring locations could be used, thus avoiding the cost of identifying and constructing new locations. Four locations are spread along the length of the river downstream of Falcon Dam (Table 7-1). Each of these locations is already equipped with a solar panel; metal housing for communication and data storage devices, and a battery; and a PVC pipe mounted in the river to accommodate a water quality meter and cable. This equipment has been in place since June 2010 (the Rio Grande City meter was put in place in July 2011) and has withstood floods since then.

Table 7-1. Possible Monitoring Stations on the Rio Grande.

Station	River miles downstream of Falcon Dam	Travel time from Peñitas at normal flow (hours)	Considerations[1]
C796, Rio Grande downstream of the Arroyo Los Olmos and Rio Grande City	43	15 (travel time downstream to Peñitas at flow above median flow)	This location is about 40 river miles upstream of the major irrigation district diversions. Flow from 8 points in Mexico and 6 points in the U.S. may enter the river upstream from this site. There are relatively small wastewater discharges from Roma and Rio Grande City to the Rio Grande upstream of this reach. Times-of-travel in this reach are unknown.
C791, Rio Grande at United ID Intake	94	5	Flow from 2 points in Mexico and 1 point in the U. S. may enter the river upstream of this site and downstream of C796, the Rio Grande City station. Most of the water diverted for public water supply is diverted downstream of this reach.
C736, Rio Grande at Anzalduas Dam	105	14	Water velocity upstream of the dam should be substantially slower, increasing response time to any contamination incident upstream of the dam. Slow velocities may also allow development of noxious algal blooms. This is an easily accessed, relatively secure point.
C793, Rio Grande at Hidalgo and Cameron Co. ID No. 9	158	53	Flow from 2 points in Mexico may enter the river between this location and the upstream C791, at the United ID diversion.
C789, Rio Grande at Harlingen ID No. 1	174	65	There are no apparent points where flow may enter from Mexico or the U. S. between this location and the upstream station. The Brownsville PUB diversion is downstream of this point however there appear to be few points where flow would enter the river from Mexico or the U. S. between this station and the Brownsville PUB diversion.

[1] Points along the Mexico and U. S. shore where flow may enter the river were identified by intensive review of aerial photography in Google Earth Pro covering the period from 1995 to 2014.

7.4 Step 4: Monitoring Parameters

The existing structures at the four suggested locations would accommodate water quality meters equipped with conductivity/temperature, dissolved oxygen, turbidity, and total algae. Measurements could be made every 15 minutes or quicker. Early warning systems in public water distribution systems usually collect data more frequently, however since the Rio Grande locations are on the raw water supply and not in the distribution system, and since most of the water supply intakes are miles from the river diversion, there is less need for more frequent data.

Some early warning systems use Total Organic Carbon analyzers however the analyzers require a larger structure to house them and a pump to bring water from the river. These analyzers and other tests requiring water to be pumped from the river have typically been used on treated water in distribution systems. There is less experience with their use with river water. Prefiltration may be required for their use in these environments. Technology is rapidly evolving and the early warning system could be upgraded with new sensors as they are developed.

7.5 Step 5: Data Management

Participants could begin developing a system for storing and quality assuring data. This process will improve participants' understanding of Rio Grande water quality and its variability. This understanding will provide the foundation for the process of identifying trigger concentrations and rates of change in water quality that may signal threats to raw water quality. There are data management software packages designed to help analyze monitoring data, evaluate data for indications of taste and odor compounds and possible hazardous compounds, and send alerts to data users.

7.6 Estimated Cost

The estimated cost of installing and operating this suggested monitoring system through the first year is $327,000. The second year of operation is expected to cost about $80,000. A 20% contingency ($81,400) should also be allowed (Table 7-2). Actual costs may be lower if the monitoring effort can become a collaborative effort, with monitoring resources available from the existing monitoring programs of the IBWC and TCEQ.

During the first two years, participants could meet three times a year to review summaries of the data and lessons learned. These meetings would also involve discussions about future monitoring program development and coordination of efforts to seek funding for the program. Costs after the second year would depend on the direction set by the program participants.

Table 7-2. Estimated cost to implement the conceptual monitoring program.

Item	Cost	Number of Units	Total
Water quality meter with conductivity/temperature, dissolved oxygen, total algae, pH, and turbidity.	$12,000	6 (5 deployed and one for calibration and replacement)	$72,000
Cameras	$1,000	5 (4 deployed and one kept as a backup)	$5,000
Monitoring station infrastructure (to upgrade or replace, power and communication systems).	$20,000	5	$100,000
Annual maintenance	$6,000	4	$20,000
Data management (labor and technology associated with collecting, reviewing, analyzing, and communicating data)	$35,000	1	$30,000
Overhead (rent, supplies, hiring, communication, coordination with Border Patrol, etc.)	$100,000		$100,000
Total (first year)			$327,000
Total (second year) – equipment replacement, maintenance, expanded data analysis and communication, initiation early warning system development)	$80,000		$80,000
Total (first two years)			**$407,000**
20% contingency (inflation, cost-of living increases, unexpected costs)			**$81,400**
Total			**$488,400**

8.0 Summary

The main question addressed in this project is:

> Is it feasible to establish an early warning system along the Rio Grande to monitor for the presence of taste and odor and potentially hazardous substances?

Factors that influence consideration of feasibility include:

<u>Is funding available to support water quality monitoring?</u>

A. Three agencies use state and federal funds to monitor Rio Grande water quality. This effort does not include monitoring conducted by local universities or public utilities. Coordination between monitoring agencies and data users could shift some effort to early warning monitoring that meets information needs for state and federal agencies, public utilities, and irrigators.

B. TCEQ has monitoring infrastructure at 5 sites on the river:
   1. The existing infrastructure can be modified to include 6 or more sensors for monitoring different substances.

2. Sites have electrical power, capability to monitor every minute, and transmit data wirelessly.
3. Some sites have been in use since 2009 and withstood natural impacts (heat, wildlife, and flood) and vandalism during that time.
4. Use of some or all of these sites can minimize the costs of finding monitoring sites and installing the hardware.

Is technology available to monitor water for taste and odor and potentially hazardous substances? A number of durable, affordable, and reliable sensors can provide information about possible taste and odor and hazardous substance incidents. Some of these sensors are already being used by TCEQ's continuous automated monitoring of the river.

A. Available sensors can be relatively easily incorporated into TCEQ's existing continuous monitoring infrastructure on the river.
B. Technology that will monitor all known potential contaminants will not be developed

How can other systems serve as models for similar monitoring on the Rio Grande? For example,

A. Corpus Christi recently purchased a HACH GuardianBlue system for monitoring the Nueces River.
B. Five major cities; Cincinnati, OH, Philadelphia, PA, New York, NY, San Francisco, CA, and Dallas, TX, are testing different online monitoring instruments and communication software at multiple points within their public water supply distribution system.
C. Salt River Project, Arizona, has been using water quality meters with sensors in different raw water supply canals for about 10 years.
D. Susquehanna River Basin Commission (Harrisburg, PA) operates its Remote Water Quality Monitoring Network which it established in 2010 with water quality meters and sensors deployed at 58 sites to determine if the natural gas industry or other activities are impacting stream water quality.

9.0 Recommendations

The South Texas Utility Managers Association should consider establishing a continuous water quality monitoring program along the Rio Grande by reactivating five continuous monitoring stations along the Rio Grande (Rio Grande City, Anzalduas Dam, Harlingen ID, United ID, and Hidalgo Co. and Cameron Co. ID #9) previously established by the TCEQ. In order to accomplish this, the association should establish a workgroup to guide the effort and identify one organization to lead it.

The following steps could be taken:

1. Begin seeking funding for the continuous water quality monitoring program. Funding may be available through legislative appropriation from the state of Texas or state or federal grants.

2. Start attending the Rio Grande Clean River annual monitoring coordination meeting, communicate to TCEQ, IBWC, and USGS the intent to reactivate the five stations, and start developing a collaborative monitoring relationship with those agencies.
3. Replace and repair existing continuous monitoring infrastructure at the 5 sites as necessary.
4. Install continuous water quality meters at each location equipped to monitor conductivity, temperature, dissolved oxygen, total algae, pH, and turbidity.
5. Install remote-sensing cameras at each station.
6. Set up a data management system to receive, analyze, store and communicate monitoring information.
7. Water providers with large reservoirs that store Rio Grande water before treatment may consider installing in-reservoir water quality monitoring and treatment capacity like that provided by LG Sonic (www.lgsonic.com) to manage taste and odor-causing algal blooms.

The estimated cost of the first two years including upgrading existing infrastructure, purchasing and maintaining meters, establishing a data management program, overhead and contingencies is $488,400 (Table 7-2).

10.0 Acknowledgments

This project was supported by the South Texas Utility Managers Association, the Honorable Representative Eddie Lucio, lll, the Honorable Representative Sergio Munoz, Jr. and facilitation of Thomas Barnett, TWDB. Project funding was provided by the TWDB, McAllen, and Freese and Nichols, Inc.

11.0 References

Allgeier, Steve. U. S. Environmental Protection Agency, Cincinnati, Ohio. Water Security Division. Personal communication on November 10, 2014.

Barrington, D.J., A.Ghadouani, and G.N. Ivey. 2013. Cyanobacterial and microsystins dynamics following the application of hydrogen peroxide to waste stabilization ponds, Hydrology and Earth System Sciences, **17**, 2097-2105.

Bergamaschi, B., B. Downing, B. Pellerin, and J. Saraceno. 2009. *In Situ* Sensors for Dissolved Organic Matter Fluorescence: Bringing the Lab to the Field. U. S. Geological Survey, Water Resources Discipline Instrument News, Issue No. 125. Winter 2009. 2 pp.

Bauzá, L., A. Aguilera, R. Echenique, D. Andrinolo, and L. Giannuzzi, 2014. Application of Hydrogen Peroxide to the Control of Eutrophic Lake Systems in Laboratory Assays, Toxins, 6, 2657-2675.

Calgary City News Blog. August 18, 2011. "Calgary water surveillance cameras detect dangerous water levels." 4 pp. http://www.calgarycitynews.com/2011/08/calgary-water-surveillance-cameras.html.

Christensen, V.G., J.L. Graham, C.R. Milligan, L.M. Pope, and A.C., Ziegler. 2006, Water quality and relation to taste-and-odor compounds in the North Fork Ninnescah River and Cheney Reservoir, south-central Kansas, 1997–2003: U.S. Geological Survey Scientific Investigations Report 2006–5095, 43 p.

Elliot, Greg. Salt River Project. Personal communication on December 16, 2014.

Fipps, G. 2004. The Municipal Water Supply Network of the Lower Rio Grande Valley. Irrigation District Program, Irrigation Technology Center, Texas Cooperative Extension – Texas Agricultural Experimental Station. 19 pp.

Graham, J.L., Loftin, K.A., Ziegler, A.C., and M. T. Meyer. 2008. Guidelines for design and sampling for cyanobacterial toxin and taste-and-odor studies in lakes and reservoirs: U.S. Geological Survey Scientific Investigations Report 2008–5038, 39 p.

Green, U., J. H. Kremer, M. Zillmer, and C. Moldaenke. 2003. Detection of Chemical Threat Agents in Drinking Water by an Early Warning Real-Time Biomonitor. Published online in Wiley InterScience (www.interscience.wiley.com). 7 pp. DOI 10.1002/tox.10138

HACH. GuardianBlue Early Warning System. Product Brochure. 20 pp. Accessed January 2015.

Hambrook Berkman, J.A., and Canova, M.G., 2007, Algal biomass indicators (ver. 1.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, section 7.4, August, available online only from http://pubs.water.usgs.gov/twri9A/.

Huber, M.M., S. Korhonen, T.A. Ternes, U. von Gunten. 2005. Oxidation of Pharmaceuticals during Water Treatment with Chlorine Dioxide, Water Research, 39(15), 3607-3617.

Kokkali, V. and W. van Delft. 2014. Overview of commercially available bioassays for assessing chemical toxicity in aqueous samples. Trends in Analytical Chemistry Vol. 61. Pp. 133-155.

Kommineni, S., K. Amante, B. Karnik, M. Sommerfeld, and T. Dempster. 2009. Strategies for Controlling and Mitigating Algal Growth within Water Treatment Plants. Denver, CO: Water Research Foundation.

Lee, T.J., K. Nakano, and M. Matsumara. 2001. Ultrasonic irradiation for blue-green algae bloom control, Environmental Technology, **22**, 383-390.

Mallevialle, J., and I. H. Suffet, eds. 1987. Identification and Treatment of Tastes and Odors in Drinking Water. Denver, CO: AWWA Research Foundation and American Water Works Association.

Partain, John. City of Dallas. Personal communication on November 11, 2014.

Rio Grande Guardian. May 15, 2014. Darling: Fish Kill Highlights Need for Rio Grande Emergency Plan.
http://www.riograndeguardian.org/community/green-guardian/darling-fish-kill-highlights-need-for-rio-grande-emergency-plan/

Roberson, J. A., and K. M. Morley. 2005. Contamination Warning Systems for Water: An Approach for Providing Actionable Information to Decision-makers. American Water Works Association. 30 pp.

Texas Commission on Environmental Quality. 2012. 2012 Guidance for Assessing and Reporting Surface Water Quality in Texas. 139 pp.

Texas Commission on Environmental Quality. 2014. Quality Assurance Project Plan for Continuous Water Quality Monitoring Network Program. April 2014 Rev. 8. http://www.tceq.texas.gov/waterquality/monitoring/swqm_realtime.html/#quality

Texas Commission on Environmental Quality. 2015. Central Registry Query. http://www15.tceq.texas.gov/crpub/index.cfm.

The Brownsville Herald. May 2, 2014. Fish kill prompted water investigation. http://www.brownsvilleherald.com/news/local/article_80a6a8b8-d26f-11e3-bed0-001a4bcf6878.html

U. S. Environmental Protection Agency. A Water Security Handbook: Planning for and Responding to Drinking Water Contamination Threats and Incidents. 72 pp.

U. S. Environmental Protection Agency. 1999. Total Organic Carbon in Water. EPA Method 415.1. 6 pp. www.epa.gov/region9/qa/pdfs/415_1dqi.pdf.

U. S. Environmental Protection Agency. 2005. Water Sentinel System Architecture. Draft, Version 1.0, December 12, 2005. EPA 817-D-05-003. 151 pp.

U. S. Environmental Protection Agency. 2008. Water Security Initiative: Interim Guidance on Developing Consequence Management Plans for Drinking Water Utilities. EPA 817-R-08-001. 101 pp.

U. S. Environmental Protection Agency. 2010a. Water Contaminant Information Tool Factsheet. EPA 817-F-10-016. 2 pp.

U. S. Environmental Protection Agency. 2010b. Sensor Network Design for Drinking Water Contamination. A Compendium of Research Results and Case Studies using the TEVA-SPOT Software. EPA/600/R-09/141. 92 pp.

U. S. Environmental Protection Agency. 2013. Water Quality Event Detection System Challenge: Methodology and Findings. Office of Water (MC-140), EPA 817-R-13-002. 98 pp.

U. S. Environmental Protection Agency. 2014. Water Security Initiative: Evaluation of the Sampling and Analysis Component of the Cincinnati Contamination Warning System Pilot Monitoring and Surveillance Response. Office of Water (MC-140). EPA-817-R-14-001G. 79 pp.

Valley Morning Star. April 30, 2014. "'Bad material could affect Rio Grande; Mexico oil giant Pemex believed to be source. http://www.themonitor.com/news/local/bad-material-could-affect-rio-grande-mexico-oil-giant-pemex/article_c88264a6-d0e9-11e3-ac3f-001a4bcf6878.html.

Valley Morning Star. June 14, 2014. "River Water Scare Prompts Push for Real-time Data." By Dave Hendricks.

Water Environment Research Federation. 2014. Final Report. Compendium of Sensors and Monitors and Their Use in the Global Water Industry. 432 pp.

Water Research Federation. 2014. Advancing the Science of Water: WRF and Research on Taste and Odor in Drinking Water.

Wehr, J., and R. Sheath. 2003. Freshwater Algae of North America. Ecology and Classification. Academic Press, Elsevier. 918 pp.

Appendix A.
Rio Grande Time-of-Travel Analysis

October 28, 2014

Freese and Nichols, Inc.
Attn: Dr. Nick Landes
4055 International Plaza, Suite 200
Fort Worth, TX 76109

Subject: Estimation of Travel Time to Major River Intakes along the Lower Rio Grande

Dr. Landes et al.:

This memorandum provides a summary of the estimation of travel times to the major river intakes sections along the Lower Rio Grande (LRG). The travel times were estimated by velocities computed using HEC-RAS model multiplied by river distance to each intake section from Penitas (26º13'34.67", 98º27'41.59"), which is the most upstream section of the model geometry.

The travel times were determined at three different river flows: median, 0.25 percentile, and 0.75 percentile of the historical mean daily discharge data of the Rio Grande City gage station obtained from the US International Boundary and Water Commission (USIBWC). The table below presents the travel times of the 12 major river intakes. Please note that I was unable to determine travel time to HCID6, since the intake is located in the most upstream section of the model.

River Intakes	Travel Time (hour)			River Intakes	Travel Time (hour)		
	Median	0.25 perc.	0.75 perc.		Median	0.25 perc.	0.75 perc.
HCID1	1	2	1	**DELTAID**	54	77	42
United	5	7	3	**LAFERIA**	58	81	46
HCWID3	20	31	14	**HARLINGEN**	65	91	52
HCID2	25	37	17	**CCID2**	66	91	52
DONNAID	35	51	26	**CCID6**	106	127	76
HCCID9	53	75	42	**BPUB**	115	136	82

I have included detailed information associated with the HEC-RAS model and determination of the travel times.

Respectfully submitted,

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APPENDIX A: HEC-RAS model for river hydraulics of the reach

- Geometric data: originally developed by USIBWC in 2003 for the LRG Flood Control Project; 158 river miles from Penitas to Brownsville; 2 diversion dams and 6 bridges.
- Flow boundary conditions: three different flowrates as upstream boundary condition and the normal depth (channel bed slope = 0.00015) as the downstream boundary condition
  - Median, 0.25 percentile, and 0.75 percentile flowrates of the historical mean daily discharge at the Rio Grande City gage station recorded from 1/1/1955 to 12/31/2011 (Figure A1)

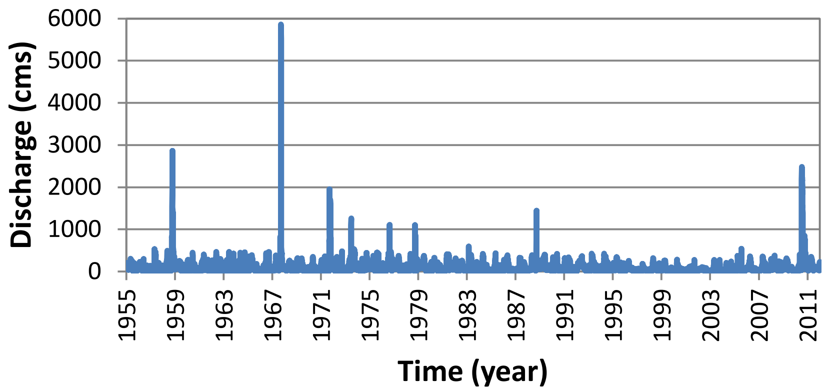


Figure A1. Mean daily discharge at the Rio Grande City gage station

  - About 6% flow reduction (USIBWC, 2003[1]) along the 49.0 river miles between the Rio Grande City and Penitas. Table A1 shows the percentile flowrates and the upstream flow boundary conditions after the flow reduction.

Table A1. Percentile flowrates and model flow boundary conditions

Percentile	Flow rate (ft^3/s)	Model BC (ft^3/s)
Median	2,179	2,048
0.25 percentile	1,130	1,063
0.75 percentile	4,273	4,015

  - Due to the flow reduction/addition along the model reach of the Lower Rio Grande, I assigned a total of four flow boundary conditions at the sections as shown in Table A2. The model flow boundary conditions of Reynosa, San Benito, and Brownsville were selected from the historical data corresponding flow of Penitas.

[1] USIBWC (United State International Boundary and Water Commission), 2003. *Hydraulic Model of the Rio Grande and Floodways within the Lower Rio Grande Flood Control Project*, El Paso, TX.

Table A2. Model flow boundary conditions

Location	Section (river mile)	Model flow boundary conditions (ft^3/s)		
		Median	0.25 percentile	0.75 percentile
Penitas	186	2,049	1,063	4,016
Reynosa	156.93	1,773	925	3,295
San Benito	100.1	565	703	2,815
Brownsville	49.6	325	812	1,854

- Figures A2 and A3 shows the computed water surface profiles (WSPs) of the model reach and cross sectional views of the selected River Intakes.

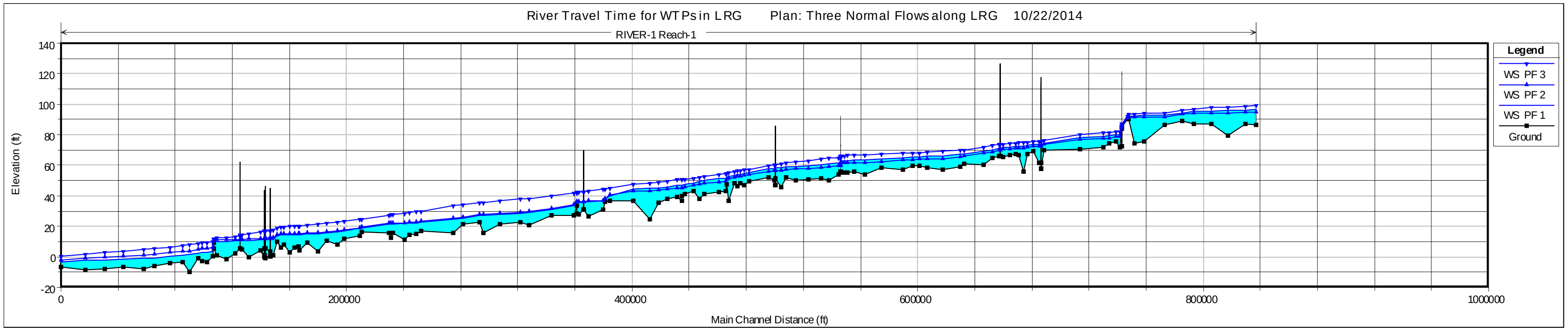
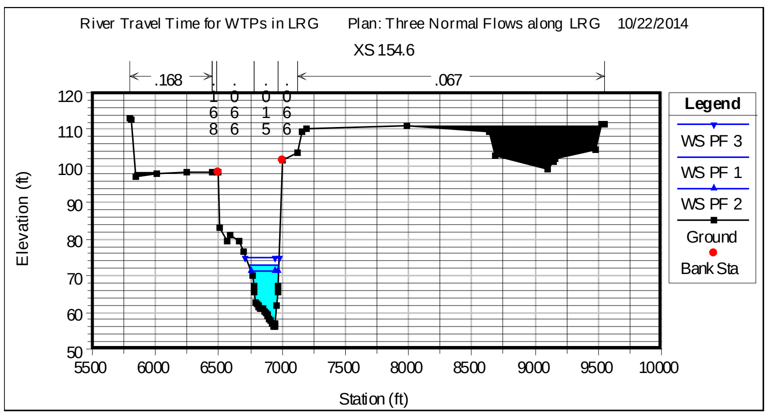
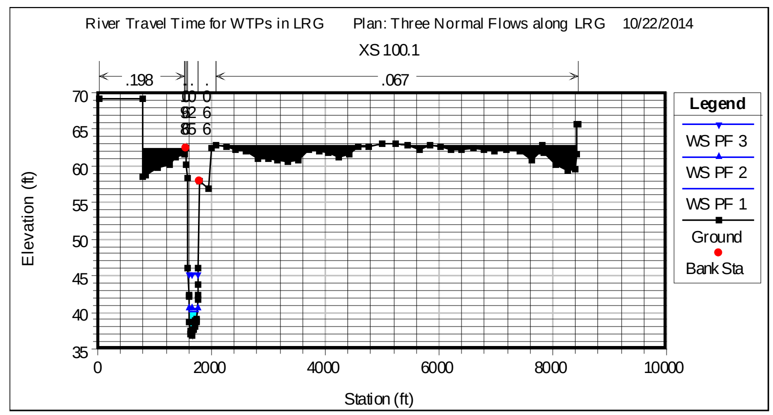


Figure A2. WSPs along the model reach from Penitas to Brownsville, TX.



(a) HCUD2



(b) Harlingen ID

Figure A3. Water surface level in cross sections at (a) HCID2 and (b) Harlingen ID

APPENDIX B: Determination of the travel time HEC-RAS modeling results (part)

River Sta	Profile	Vel Chnl (ft/s)	WTP	Distance (miles)	Distance (ft)	T_{travel} (sec)	T_{travel} (hr)	Total T_{travel} (hr)
186	PF 1	2.05						
186	PF 2	1.53						
186	PF 3	2.58						
184	PF 1	2.28	HCID1	2	10560	4632	1.3	**1**
184	PF 2	1.8				5867	1.6	**2**
184	PF 3	2.9				3641	1.0	**1**
182.4	PF 1	1.33		1.6	8448	6352	1.8	3
182.4	PF 2	0.86				9823	2.7	4
182.4	PF 3	2.03				4162	1.2	2
180.3	PF 1	1.74	United	2.1	11088	6372	1.8	**5**
180.3	PF 2	1.22				9089	2.5	**7**
180.3	PF 3	2.42				4582	1.3	**3**
116.1	PF 1	1.92	HCCID9	0.4	2112	1100	0.3	**53**
116.1	PF 2	1.36				1553	0.4	**75**
116.1	PF 3	2.39				884	0.2	**42**
115.7	PF 1	2.99		0.4	2112	706	0.2	54
115.7	PF 2	2.45				862	0.2	75
115.7	PF 3	3.21				658	0.2	42
115	PF 1	1.42	DELTAID	0.7	3696	2603	0.7	**54**
115	PF 2	0.86				4298	1.2	**77**
115	PF 3	2.01				1839	0.5	**42**
59	PF 1	1.18	BPUB	0.9	4752	4027	1.1	**115**
59	PF 2	1.33				3573	1.0	**136**
59	PF 3	2.49				1908	0.5	**82**
31.2	PF 1	0.92		2.8	14784	16070	4.5	162
31.2	PF 2	1.45				10196	2.8	168
31.2	PF 3	2.1				7040	2.0	101
28	PF 1	1.35		3.2	16896	12516	3.5	166
28	PF 2	1.88				8987	2.5	171
28	PF 3	2.52				6705	1.9	103

Appendix B.
Water Treatment Plant Taste and Odor Guidance Document

1.0 Introduction

In order to help Lower Rio Grande Valley (LRGV) water treatment plants (WTP) adjust plant operations given foreknowledge of upstream water quality changes in the Rio Grande, a guidance matrix with recommended operational adjustments was developed for selected water quality parameters. This study considered three possible impacts of upstream water quality changes: (1) taste and odor (T&O) impacts, (2) operational impacts and (3) release of hazardous contaminants. It should be noted that T&O was the primary concern associated with this study.

2.0 Guidance Matrix Development

WTP manager interviews were used to shortlist processes and parameters for inclusion in the guidance matrix. A literature review was then used to investigate different operational responses in order to address the selected water quality parameters.

2.1 Selected Processes and Parameters for Guidance Matrix

Water treatment processes and water quality parameters were selected for inclusion in the guidance matrix based upon interviews conducted with five municipal water providers that treat surface water from the Rio Grande. The interviews are summarized in Appendix A.
The following goals were established for the interviews:

1. Identify four treatment processes used by LRGV WTPs for T&O treatment, and
2. Determine four water quality parameters that would provide the most benefit for identifying potential upstream water quality changes affecting T&O issues, plant operations, or hazardous contaminants.

Table summarizes the processes and parameters that were selected for inclusion of the guidance matrix.

Table 1. Selected processes and parameters for incorporation into Guidance Document

Selected Treatment Processes	Selected Water Quality Parameters
Chlorine dioxide	Phycocyanin/turbidity (T&O/operational/safety related)
Powdered Activated Carbon (PAC)	Turbidity (operational related)
Hydrogen Peroxide	Conductivity (T&O related)
Terminal storage reservoir management Copper sulfate Potassium/sodium permanganate Sonication Storage	pH (operational/safety related)

2.1.1 *Selected Treatment Processes*

Both chlorine dioxide and powdered activated carbon (PAC) were selected for inclusion in the guidance document since they are common treatment processes found in the LGRV. Both methods of treatment have been used to control low odor threshold compounds with earthy/musty attributes (Huber et al., 2005; Malleville and Suffet, 1987). Although not common, hydrogen peroxide was selected for inclusion in the guidance matrix since its application had promising results according to the interviewed water provider. Studies indicate that hydrogen peroxide's effectiveness is limited to cyanobacteria (Barrington et al., 2013; Bauzá et al., 2014). If dosed properly, hydrogen peroxide can inhibit cyanobacteria growth rates without lysing their cellular walls. If lysed, intracellular compounds such as phosphorus, cyanotoxins and MIB/geosmin may be released, effectively deteriorating, rather than improving, water quality. Terminal storage reservoir management was also selected for inclusion in the matrix since the reservoirs provide operators with a heightened level of operational flexibility while also representing a point where water quality issues can develop/worsen (e.g. algal blooms). Management strategies included in the matrix include addition of algaecide (e.g. copper sulfate and potassium permanganate), sonication and water storage (i.e. discontinue raw water pumping). Kommineni et al. (2009) indicated that algaecides proved useful when algal counts were low, but resulted in deteriorated water quality at high algal counts due to cell lysing. Alternatively, sonication caused settling of algae without release of intra-cellular toxins (Lee et al., 2001).

2.1.2 *Selected Water Quality Parameters*

All of the parameters selected for inclusion in the guidance matrix can be monitored using real-time instrumentation. Three T&O related water quality parameters and one operational/water safety parameter was included in the guidance matrix.

Phycocyanin and chlorophyll-α were selected for inclusion since they correlate with cyanobacteria and algal growth, respectively. Byproducts produced during the growth of these organisms may be responsible for the primary T&O issues reported by interviewed WTPs, which were earthy/musty (geosmin/MIB) and fishy odors. Algal growth also presents operational difficulties (e.g. filter clogging, flow disruption) and health risks due to the production of algal toxins. Conductivity was selected due to its correlation with total dissolved solids (TDS) and the periodic TDS spikes that occur in the Rio Grande following high flow events.

As a gross indicator of water quality, pH was selected for inclusion because it can be monitored reliably and economically. The absolute value of pH as well as pH trends can indicate whether water quality has shifted. Extreme pH values ($6 \geq pH \geq 9$) and pH shifts (ex. pH change > 1 over the course of 1 hour) would indicate a significant water quality shift has occurred, and a heightened level of attention needs to be paid to the WTP's incoming water quality. Unusual rates of pH depression from one station to the next may also be used to indicate decreased buffering capacity, or alkalinity. Additionally, chemical treatment processes at a WTP often vary based upon the water's pH value, and forewarning of pH shifts will allow operators to adjust chemical doses accordingly.

2.2 Literature Review

In order to evaluate treatment strategies for the selected processes based upon data from the selected water quality parameters, a literature review was conducted. Information from the literature has been cited in this technical memorandum.

3.0 Guidance Matrix

The guidance matrix is provided in Table 22. The trigger level, or criterion that initiates a treatment action, is based upon deviations from normal concentrations or rates of change. As such, these triggers are contingent upon the deployment of a water quality monitoring station in order to develop a historical basis for the "typical" water quality. The validity of the trigger levels will improve as the historical dataset increases. Multiple triggers could be associated with each water quality parameter based upon site specific conditions. In the same manner, the treatment recommendations will also be site specific even though general guidelines have been provided below.

An example application of the guidance matrix is shown as follows:

- **Event description:** Phycocyanin levels measured at the nearest monitoring station upstream of the WTP have increased by 115% over the past hour. The phycocyanin levels are within the 80th percentile of measurements over the past year.
- **Trigger level initiated:** Trigger Level 1 (TL1) is initiated.
- **Treatment plant processes available:** The treatment plant doses chlorine dioxide at 0.8 mg/L as their primary disinfectant. They also have a terminal storage reservoir. The plant periodically doses copper sulfate into the terminal storage reservoir.
- **Treatment initiated:** The chlorine dioxide dose is increased from 0.8 mg/L to 1.2 mg/L and copper sulfate is dosed into the terminal storage reservoir at 1.5 mg/L.

Table 2. **Guidance Matrix**

<table>
<tr><th colspan="2" rowspan="3"></th><th colspan="4">Monitored Water Quality Parameters</th></tr>
<tr><th>Phycocyanin</th><th>Chlorophyll-α</th><th>Conductivity</th><th>pH</th></tr>
<tr><td colspan="3">TL1: Parameter value above the 50^{th} percentile <u>and</u> value increases by 100% or more in 1 hour[1]
TL2: Parameter value increases above 95^{th} percentile[1]</td><td>TL1: $6 \geq pH \geq 9$[1]
TL2: pH change > 1 unit in 1 hour[1]</td></tr>
<tr><td rowspan="4">Treatment Processes</td><td>Chlorine Dioxide</td><td colspan="2">TL1: 1 – 1.5 mg/L dose</td><td>N/A</td><td>N/A</td></tr>
<tr><td>PAC</td><td colspan="2">TL1: 10 - 25 mg/L dose
TL2: 25 – 50 mg/L dose</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Hydrogen Peroxide</td><td colspan="2">If data suggests cyanobacteria are abundant, then
TL1: 1 – 1.5 mg/L dose
TL2: 2 – 5 mg/L dose
If data suggests cyanobacteria are minor, then increased dose from normal operation will not be effective.</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Terminal Storage Reservoir Management</td><td colspan="2">TL1: (1) initiate sonication
(2) initiate algaecide addition:
1 – 2 mg/L copper sulfate
3 – 10 mg/L potassium permanganate
TL2: (1) discontinue pumping raw water
(2) discontinue algaecide
(3) continue sonication</td><td>TL2: discontinue pumping raw water from canal/river into reservoir</td><td>TL1 & TL2: discontinue pumping raw water from canal/river into reservoir</td></tr>
</table>

TL = Trigger Level

[1] Representation of potential trigger levels. Criterion for action will be better defined upon collection of site specific historical database.

4.0 References

Barrington, D.J., Ghadouani, A., Ivey, G.N. 2013. Cyanobacterial and microsystins dynamics following the application of hydrogen peroxide to waste stabilization ponds, Hydrology and Earth System Sciences, **17**, 2097-2105.

Bauzá, L., Aguilera, A., Echenique, R., Andrinolo, D., Giannuzzi, L. 2014. Application of Hydrogen Peroxide to the Control of Eutrophic Lake Systems in Laboratory Assays, Toxins, **6**, 2657-2675.

Huber, M.M., Korhonen, S., Ternes, T.A., von Gunten, U. 2005. Oxidation of Pharmaceuticals during Water Treatment with Chlorine Dioxide, Water Research, **39**(15), 3607-3617.

Kommineni, S., Amante, K., Karnik, B., Sommerfeld, M., Dempster, T. 2009. *Strategies for Controlling and Mitigating Algal Growth within Water Treatment Plants*. Denver, CO: Water Research Foundation.

Lalezary, S. Pirbazari, M., McGuire, M.J. 1986. Oxidation of Five Earth-Musty Taste and Odor Compounds, Journal AWWA, **78**(3), 62-69.

Lee, T.J., Nakano, K., Matsumara, M. 2001. Ultrasonic irradiation for blue-green algae bloom control, Environmental Technology, **22**, 383-390.

Mallevialle, J., Suffet, I.H. eds. 1987. *Identification and Treatment of Tastes and Odors in Drinking Water*. Denver, CO: AWWA Research Foundation and American Water Works Association.

Appendix A:
WTP Interview Summaries

Water Provider: McAllen Public Utility
Persons Interviewed: Javier Santiago, Joe Solis, Jose Salinas, JD Ibarra and Gary Garcia
Date: August 20, 2014

WATER TREATMENT PLANT DESCRIPTION(S):

	South WTP	North WTP
Capacity (MGD)	47.25	11.25
Average Demand (MGD)	~24	~1
Surface Water Provider(s)	HCWID No. 3 (64%) HCID No. 2 (36%)	United ID (65%) HCID No. 1 (23%) Brownsville ID (12%)
Other Water Source(s)	Groundwater (1 MGD)	No
Terminal Storage	New South Reservoir – 300 MG Old Boeye Reservoir – 180 MG	North Plant Reservoir – 200 MG
Process Flow Desc.	Chlorine dioxide (0.6-0.8 mg/L); PAC; Rapid Mix; Flocculation; Sedimentation; Chloramination; Dual Media Filtration; Clearwells	

TASTE AND ODOR:

Does the water have T&O issues?	Yes, complaints about once/month
Description of T&O issues	Dirty/earthy/musty Fishy / wet dog Salty (TDS increases during heavy rain events)
Seasonality of T&O issues	N/A
Methods to Minimize T&O issues	• Continuous chlorine dioxide addition • Periodically apply PAC • Reservoir operating procedure: o 5-day detention time o Keep reservoir mixed using multiple intakes o Add copper sulfate when algal cell counts show increasing trends

RAW WATER QUALITY ISSUES:

Most Problematic Water Quality Changes	TDS: increase following heavy rains Sulfate: increases with TDS pH/Alkalinity: changes seasonally and affects coagulant Unknown discharges into river Known discharges into river • Sulfuric acid from copper mine on Mexico side • Undersized WWTPs on Mexico side

Water Provider: Brownsville Public Utilities Board
Persons Interviewed: Jose Armando Garza, Sergio Espinoza
Date: August 21, 2014

WATER TREATMENT PLANT DESCRIPTION(S):

	WTP #1	WTP #2	Southmost Regional Water Authority
Capacity (MGD)	20	20	7.5
Average Demand (MGD)	~10-14	~10-14	~3
Surface Water Provider(s)	BPUB River Intake (29,285 acre-ft + 40,000 acre-ft surplus water)		N/A
Other Water Sources(s)	Resaca de la Guerra (up to 20% blend)	No	20 Brackish Groundwater Wells
Terminal Storage	Reservoir 1 – 36 MG Reservoir 2 – 95 MG		N/A
Process Flow Desc.	Chlorine dioxide (0.25-0.75 mg/L); PAC (4 mg/L); Rapid Mix (PACl w/ 2% Cu); Flocculation; Sedimentation; Chloramination; Dual Media Filtration; Clearwells (6.84 MG total)		Cartridge filters; 85% of flow treated by RO operated at 75% recovery; Caustic and CaCl addition; Chloramination; Clearwell (0.75 MG)

TASTE AND ODOR:

Does the water have T&O issues?	Yes. Majority of complaints primarily related to sulfurous odors. Areas serviced by SRWA have improved water quality.
Description of T&O issues	Dirty/earthy/musty Fishy Salty
Seasonality of T&O issues	N/A
Methods to Minimize T&O issues	• Continuous chlorine dioxide addition at 0.25 – 0.75 mg/L • Continuous PAC addition at 4 ppm • Continuous copper sulfate addition at 100 mL/min after river pump station • Reservoir operating procedure: o 5-day detention time o Keep reservoir mixed using multiple intakes o Add copper sulfate when algal cell counts show increasing trends

RAW WATER QUALITY ISSUES:

Most Problematic Water Quality Changes	Turbidity/TOC: increase when alkalinity and temperatures are lower

Water Provider: Harlingen WaterWorks System
Persons Interviewed: David Sanchez, Juan Morales
Date: August 21, 2014

WATER TREATMENT PLANT DESCRIPTION(S):

	Downtown WTP	Runnion WTP
Capacity (MGD)	18.6	20
Average Demand (MGD)	15	
Surface Water Provider(s)	Harlingen ID No. 1	
Other Water Sources(s)	No	No
Terminal Storage	Lake Harlingen – 30 MG	City of Harlingen Reservoir – 295 MG
Process Flow Desc.	Hydrogen peroxide (2 ppm); Chloramination; Actiflo; Sedimentation; Rapid Sand Filtration; Clearwells	Hydrogen peroxide (2 ppm); Chloramination; Rapid Mix (Alum/$CuSO_4$ blend); Flocculation; Sedimentation; Rapid Sand Filtration; Clearwells (12 MG)

TASTE AND ODOR:

Does the water have T&O issues?	Minor. T&O issues have significantly decreased since converting to hydrogen peroxide.
Description of T&O issues	None mentioned
Seasonality of T&O issues	N/A
Methods to Minimize T&O issues	• Continuous hydrogen peroxide addition at 2 mg/L

RAW WATER QUALITY ISSUES:

Most Problematic Water Quality Changes	None mentioned.

Water Provider: Olmito WSC
Persons Interviewed: Victor Trevino
Date: August 21, 2014

WATER TREATMENT PLANT DESCRIPTION(S):

	Downtown WTP
Capacity (MGD)	2
Average Demand (MGD)	1.3
Surface Water Provider(s)	Cameron County ID No. 6
Other Water Sources(s)	No
Terminal Storage	6.5 MG
Process Flow Desc.	Chlorine dioxide (1 mg/L); Rapid Mix (100-130 ppm Alum w/ 5% Cu); Flocculation; Sedimentation; Chloramination; Dual Media Filtration; Clearwells (0.5 MG total)

TASTE AND ODOR:

Does the water have T&O issues?	Minor. Majority of complaints primarily related to sulfurous odors.
Description of T&O issues	Dirty/earthy/musty Fishy
Seasonality of T&O issues	Summer (warm temperatures) During lake turnover (Summer to Fall)
Methods to Minimize T&O issues	• Continuous chlorine dioxide addition at 1 mg/L • Dose Copper Sulfate at terminal storage reservoir • If raw water pH < 7.3, add Potassium Permanganate to terminal storage reservoir

RAW WATER QUALITY ISSUES:

Most Problematic Water Quality Changes	

Water Provider: East Rio Hondo Water Supply Corporation
Persons Interviewed: Felipe Zamora
Date: August 22, 2014

WATER TREATMENT PLANT DESCRIPTION(S):

	Martha Ann Simpson WTP	Nelson Road WTP	North Cameron Regional WTP
Capacity (MGD)	8	3.2	1 (~30% of WTP's 2.5 MGD capacity)
Average Demand (MGD)	~10-14	~10-14	1
Surface Water Provider(s)	Cameron County ID No. 2		N/A
Other Water Sources(s)	No	No	Brackish Groundwater Wells
Terminal Storage	26 MG	No	N/A
Process Flow Desc.	Chlorine dioxide (1-2 mg/L); Chloramination; Rapid Mix (100 mg/L Alum); Contact Clarification; Dual Media Filtration; Clearwell (2 MG)	Not documented	Brackish Water RO Desalination

TASTE AND ODOR:

Does the water have T&O issues?	Yes, complaints primarily during burnouts but also receive 1-2 non-chlorine related complaints
Description of T&O issues	Musky Chemical-like
Seasonality of T&O issues	N/A

Methods to Minimize T&O issues	• Continuous sonication in terminal storage reservoir
	• Continuous addition of Sodium Permanganate at Raw Water PS
	    o 2 ppm normally; 7 ppm with poor WQ
	• Conduct algae counts of reservoir
	    o Shock reservoir with Potassium Permanganate when algae counts are high
	• Continuous chlorine dioxide addition

RAW WATER QUALITY ISSUES:

Most Problematic Water Quality Changes	TDS: increase following heavy rains Ammonia: see increase in ammonia w/ poor WQ

Appendix C.
Existing Water Quality Monitoring Review

ABANDONED STATION

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: location not visited

Monitoring station number (or identifier): 10249

Monitoring station name and description: Rio Grande River Near San Benito

Latitude (decimal degrees): 26.030556 **Longitude (decimal degrees:** -97.727776

*Need to verify coordinates as they are in Mexico. There is a road on the north of coordinates leading to river.

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on site
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: N/A

Additional comments: Location of Station via Google Earth shows location of collection point in Mexico.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: flow, water depth, air temp. water temp. DO, pH, Secci Disc, Fecal Coliform, e coli, Specific Conductance, chloride, sulfate, alkalinity, total hardness, TSS, Volatile SS, TDS, Total Organic Carbon, Amonia, Nitrate+Nitrite, Total Phosphorus, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica.

Date of construction: Monitoring since: 04/11/2001

Is the station currently operating? Yes or ✓No. **If no, when was the station abandoned?** Last monitoring done in 12/2012

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:**
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Data is uploaded to website

Additional comments:

This is only a location for sampling. There is no permanent station on the ground.

Date of last monitoring: 11/28/2012 - This location is not being used at this time.

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit done

Monitoring station number (or identifier): 13103

Monitoring station name and description: Arroyo Los Olmos Bridge on US 83 Rio Grande City

Latitude (decimal degrees): 26.361666 **Longitude (decimal degrees:** -98.786667

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on ground
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? n/a

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: n/a

Additional comments:

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, Water Depth, Air Temp, Water Temp, Disoslved Oxygen, pH, Secchi Disc, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, Total Dissolved Solids, Total Organic Carbin, Ammonia, Nitrate+Nitrite, Total Phosphorous, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica

Date of construction: Monitoring since: 7/11/1995

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** ______
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Results uploaded to website

Additional comments:

Last monitoring date: 2/26/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit done

Monitoring station number (or identifier): 13176

Monitoring station name and description: Rio Grande River at Rio Grande Dr. off off S.H. 4

Latitude (decimal degrees): 25.959611 **Longitude (decimal degrees:** -97.227694

coordinates revised as per e-mail from Ms. Grijalva

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing? Yes or No. If yes, describe:** No infrastructure on ground
- **Electricity? Yes or No. If yes, describe:**
- **Water supply? Yes or No. If yes, describe:**
- **Sewer connection/septic? Yes or No. If yes, describe:**
- **Signs of vandalism? Yes or No. If yes, describe:**
- **Signs of natural damage? Yes or No. If yes, describe:**

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? n/a

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: n/a

Additional comments:
Closes possible access on US side, take Boca Chica Blvd., turn right on Richardson, then right on Rio Grande Right by first house on left.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, Water Depth, Air Temp, Water Temp, Disoslved Oxygen, pH, Secchi Disc, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, Total Dissolved Solids, Total Organic Carbin, Ammonia, Nitrate+Nitrite, Total Phosphorous, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica

Date of construction: Monitoring since: 2/01/1995

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** ______
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Results uploaded to website

Additional comments:

Last monitoring date: 3/27/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit performed

Monitoring station number (or identifier): 13177

Monitoring station name and description: Rio Grande River at El Jardin Pumping Station - Brownsville

Latitude (decimal degrees): 25.877705 **Longitude (decimal degrees:** -97.454982

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on ground, only a monitoring location
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? n/a

Is the station on private or public property? Private Property owned by Brownsville PUB

Describe the line of sight for signals: n/a

Additional comments:

Possibly contact Brownsville PUB for entrance authorization.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, Water Depth, Air Temp, Water Temp, DO, pH, Secchi, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, T Dissolved Solids, T Organic Carbon, Ammonia, Nitrate+Nitrite, T Phosphorus, Chlorophylla, Pheophytina, T Calcium

T Magnesium, T Potassium, T Sodium, T Flouride, T Silica

Date of construction: Monitoring since: 01/19/1994

Is the station currently operating? Yes ✓ or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** samples manually taken
- **Who uses the data from the station?** Public and IBWC
- **How do users obtain the data?** Results are located on website

Additional comments:

Last monitoring date: 03/15/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was done

Monitoring station number (or identifier): 13178

Monitoring station name and description: Rio Grande International Bridge on US 77 at Brownsville

Latitude (decimal degrees): 25.898611 **Longitude (decimal degrees:** -97.497498

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on ground. Samples taken at this location
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: N/A

Additional comments:

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, water depth, air temp, water temp, DO, pH, Secchi Disc, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, Total Suspended Solids, Volatile Suspended Solids, T Dissolved Solids, T Organic Carbon, Ammonia, Nitrate+Nitrite, T Phosphorus, Ortho Phosphorus, Chlorophyll, Pheophytin, Total Calcium T Magnesium, T Potassium, T Sodium, T Flouride, T Silica

Date of construction: Monitoring since: 10/15/2008

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** samples taken at site.
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Results uploaded to website

Additional comments:

Date of last monitoring: 3/27/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was done

Monitoring station number (or identifier): 13179

Monitoring station name and description: River Bend Resort South of Rancho Viejo (S. of Old Military Highway)

Latitude (decimal degrees): 25.950001 **Longitude (decimal degrees:** -97.575554

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **Yes or No. If yes, describe:** No infrastructure on ground. Samples taken at this location
- **Electricity?** **Yes or No. If yes, describe:**
- **Water supply?** **Yes or No. If yes, describe:**
- **Sewer connection/septic?** **Yes or No. If yes, describe:**
- **Signs of vandalism?** **Yes or No. If yes, describe:**
- **Signs of natural damage?** **Yes or No. If yes, describe:**

Photographs taken:

- **All sides** **Yes or No**
- **Interior** **Yes or No**
- **Location of instruments in the water** **Yes or No**
- **View towards the upstream from the station** **Yes or No**
- **View towards the downstream from the station** **Yes or No**
- **Access to station** **Yes or No**

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: N/A

Additional comments:

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, water depth, air temp, water temp, DO, pH, Secchi Disc, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, Total Suspended Solids, Volatile Suspended Solids, T Dissolved Solids, T Organic Carbon, Ammonia, Nitrate+Nitrite, T Phosphorus, Ortho Phosphorus, Chlorophyll, Pheophytin, Total Calcium T Magnesium, T Potassium, T Sodium, T Flouride, T Silica

Date of construction: Monitoring since: 11/24/1997

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** samples taken at site.
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Results uploaded to website

Additional comments:

Date of last monitoring: 3/27/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was performed

Monitoring station number (or identifier): 13181

Monitoring station name and description: Rio Grande at International Bridge S. 23rd St. - McAllen

Latitude (decimal degrees): 26.095833 **Longitude (decimal degrees:** -98.271667

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing? Yes or No. If yes, describe:** ~~No infrastructure on ground. Only a monitorin~~g location.
- **Electricity? Yes or No. If yes, describe:**
- **Water supply? Yes or No. If yes, describe:**
- **Sewer connection/septic? Yes or No. If yes, describe:**
- **Signs of vandalism? Yes or No. If yes, describe:**
- **Signs of natural damage? Yes or No. If yes, describe:**

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Public - Beneath International Bridge

Describe the line of sight for signals: N/A

Additional comments:

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: flow, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, Total Organic Carbon, Ammonia, Nitrate + Nitrite, Total Phosphorus, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica

Date of construction: Monitoring since: 1/31/1995

Is the station currently operating? **Yes** **or** **No.** **If no, when was the station abandoned?** ______

Is the station regularly maintained? **Yes** **or** **No.** **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** **Yes or No.**
  If yes, describe: N/A
- **Sent when queried electronically?** **Yes or No.**
- **Downloaded manually from the station?** **Yes or No.**
- **Other method?** **Yes or No. Describe:** ______
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Uploaded to website

Additional comments:

This is only a location for sampling. There is no permanent station on the ground.

Last monitoring date: 3/05/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was performed

Monitoring station number (or identifier): 13184

Monitoring station name and description: Rio Grande at SH 886 near Los Ebanos

Latitude (decimal degrees): 26.239313 **Longitude (decimal degrees:** -98.546903

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **Yes or No. If yes, describe:** No infrastructure on ground. Only a monitoring location.
- **Electricity?** **Yes or No. If yes, describe:**
- **Water supply?** **Yes or No. If yes, describe:**
- **Sewer connection/septic?** **Yes or No. If yes, describe:**
- **Signs of vandalism?** **Yes or No. If yes, describe:**
- **Signs of natural damage?** **Yes or No. If yes, describe:**

Photographs taken:

- **All sides** **Yes or No**
- **Interior** **Yes or No**
- **Location of instruments in the water** **Yes or No**
- **View towards the upstream from the station** **Yes or No**
- **View towards the downstream from the station** **Yes or No**
- **Access to station** **Yes or No**

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: N/A

Additional comments:

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: flow, water temp., pH, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, VSS, TDS, Total Organic Carbon, Ammonia, Nitrate & Nitrite, Total Phosphorous, ~~Chlorophyll, Pheophytin, Calcium, Magnesium, Potassium, Sodium, Floride, Silica~~

Date of construction: Monitoring since: 12/20/2011

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** N/A
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Data is uploaded to website

Additional comments:

This is only a location for sampling. There is no permanent station on the ground.

Last monitoring date: 3/5/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was performed

Monitoring station number (or identifier): 13185

Monitoring station name and description: Rio Grande City at Ft. Ringold

Latitude (decimal degrees): 26.368055 **Longitude (decimal degrees:** -98.805557

Coordinates verified with IBWC samples taken from middle of the Rio Grande River

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **Yes or No. If yes, describe:** No infrastructure on ground. Only a monitoring location.
- **Electricity?** **Yes or No. If yes, describe:**
- **Water supply?** **Yes or No. If yes, describe:**
- **Sewer connection/septic?** **Yes or No. If yes, describe:**
- **Signs of vandalism?** **Yes or No. If yes, describe:**
- **Signs of natural damage?** **Yes or No. If yes, describe:**

Photographs taken:

- **All sides** **Yes or No**
- **Interior** **Yes or No**
- **Location of instruments in the water** **Yes or No**
- **View towards the upstream from the station** **Yes or No**
- **View towards the downstream from the station** **Yes or No**
- **Access to station** **Yes or No**

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: N/A

Additional comments:

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: flow, water temp., pH, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Calcium, Total Magnesium, Total Potasium, Total Sodium, Total Flouride, Total Silica

Date of construction: Monitoring since: 1/20/1995

Is the station currently operating? ✓Yes or No. **If no, when was the station abandoned?** ____

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** N/A
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Data is uploaded to website

Additional comments:

This is only a location for sampling. There is no permanent station on the ground.

Last monitoring date: 3/26/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit performed

Monitoring station number (or identifier): 13186

Monitoring station name and description: Rio Grande below Rio Alamo near Fronton

Latitude (decimal degrees): 26.393333 **Longitude (decimal degrees:** -99.08506389

*** Coordinates corrected from what is online as per Leslie Grijalda IBWC***

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: ______
- **Electricity?** Yes or No. If yes, describe: ______
- **Water supply?** Yes or No. If yes, describe: ______
- **Sewer connection/septic?** Yes or No. If yes, describe: ______
- **Signs of vandalism?** Yes or No. If yes, describe: ______
- **Signs of natural damage?** Yes or No. If yes, describe: ______

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? n/a

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: n/a

Additional comments: Location of Station via Google Earth still shows location of collection point in Los Guerra Mexico.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: flow, water depth, air temp. water temp. DO, pH, Secci Disc, Fecal Coliform, e coli, Specific Conductance, chloride, sulfate, alkalinity, total hardness, TSS, Volatile SS, TDS, Total Organic Carbon, Amonia, Nitrate+Nitrite, Total Phosphorus, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica.

Date of construction: Monitoring since: 01/31/1995

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** N/A
- **Who uses the data from the station?** Data is uploaded to website for public viewing
- **How do users obtain the data?** Data is collected by IBWC Falcon Dam Field Office

Additional comments:

This is only a location for sampling. There is no permanent station on the ground.

Last monitoring date: 3/26/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: Site visit not done

Monitoring station number (or identifier): 13189

Monitoring station name and description: Falcon Lake at International Bounday Monument I

Latitude (decimal degrees): 25.58 **Longitude (decimal degrees:** -99.170555

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on ground
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Public Property

Describe the line of sight for signals: n/a

Additional comments: This is just a location where water samples are taken.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Water Depth, Air Temp, Water Temp, Dissolved Oxygen, pH, Enterococci, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, Total Dissolved Solids, Total Organic Carbon, Ammonia ad N, Nitrate+Nitrite, T Phosphorous, Chlorophylla, Pheophytin-a, T Calcium, T Magnesium, T Potassium, T Sodium, T Flouride, T Silica

Date of construction: Monitoring since: 6/5/1995

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** ______
- **Who uses the data from the station?** IBWC and the general public
- **How do users obtain the data?** Data uploaded to website

Additional comments:

Last monitoring date: 3/26/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was performed

Monitoring station number (or identifier): 13664

Monitoring station name and description: Rio Grande below 0.5 miles below Anzalduas Dam

Latitude (decimal degrees): 26.131551 **Longitude (decimal degrees:** -98.330925

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on the ground, just a monitoring location
- **Electricity?** Yes or No. If yes, describe: ____
- **Water supply?** Yes or No. If yes, describe: ____
- **Sewer connection/septic?** Yes or No. If yes, describe: ____
- **Signs of vandalism?** Yes or No. If yes, describe: ____
- **Signs of natural damage?** Yes or No. If yes, describe: ____

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? n/a

Is the station on private or public property? Station located near Hidalgo County & Cameron County ID #9 intake structure.

Describe the line of sight for signals: ____

Additional comments: Location can be accessed through Old Rio Rico Rd. and then through a private dirt road owned by HD&CC #9.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - quarterly and sometimes monthly

Water quality parameters sampled: flow, water depth, air temp. water temp. DO, pH, Secci Disc, Fecal Coliform, e coli, Specific Conductance, chloride, sulfate, alkalinity, total hardness, TSS, Volatile SS, TDS, Total Organic Carbon, Amonia, Nitrate+Nitrite, Total Phosphorus, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica.

Date of construction: Monitoring since: 01/18/1995

Is the station currently operating? ✓ Yes **or** No. **If no, when was the station abandoned?** ________

Is the station regularly maintained? Yes **or** No. **If yes, how frequent is maintenance?** ________

How are data accessed?

- **Sent continuously by wireless signal?** **Yes or No.**
  If yes, describe: Water samples taken by personnel at location.
- **Sent when queried electronically?** **Yes or No.**
- **Downloaded manually from the station?** **Yes or No.**
- **Other method?** **Yes or No. Describe:** ________
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Results uploaded to website

Additional comments:

This is only a location for sampling. There is no permanent station on the ground.

Last monitoring date: 3/5/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was performed

Monitoring station number (or identifier): 15808

Monitoring station name and description: Rio Grande River .18 miles NW of Pharr International Bridge

Latitude (decimal degrees): 26.068195 **Longitude (decimal degrees:** -98.207939

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on ground. Only a monitoring location.
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: N/A

Additional comments:

to access take dirt road before international bridge take right and head north .18 of a mile to a clearing.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, Water Depth, Air Temp, Water Temp, Disoslved Oxygen, pH, Secchi Disc, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, Total Dissolved Solids, Total Organic Carbin, Ammonia, Nitrate+Nitrite, Total Phosphorous, Chlorophyll, Pheophytin, Total Calcium, Total Magnesium, Total Potassium, Total Sodium, Total Flouride, Total Silica

Date of construction: Monitoring since: 11/24/1997

Is the station currently operating? Yes ✓ **or** No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes **or** No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** **Yes or No.**
  If yes, describe: N/A
- **Sent when queried electronically?** **Yes or No.**
- **Downloaded manually from the station?** **Yes or No.**
- **Other method?** **Yes or No. Describe:** ______
- **Who uses the data from the station?** Data is used by IBWC and general public
- **How do users obtain the data?** Data is uploaded to website

Additional comments:

Google Earth shows a structure at this location although it does not belong to IBWC.

Last monitoring date: 3/05/2014

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: Site visit not done

Monitoring station number (or identifier): 16288

Monitoring station name and description: Rio Grande River - East of Sabal Palm Grove Road

Latitude (decimal degrees): 25.85 **Longitude (decimal degrees:** -97.414467

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing? Yes or No. If yes, describe:** No infrastructure on ground
- **Electricity? Yes or No. If yes, describe:**
- **Water supply? Yes or No. If yes, describe:**
- **Sewer connection/septic? Yes or No. If yes, describe:**
- **Signs of vandalism? Yes or No. If yes, describe:**
- **Signs of natural damage? Yes or No. If yes, describe:**

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? N/A

Is the station on private or public property? Public Property

Describe the line of sight for signals: n/a

Additional comments: This is just a location where water samples are taken.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Water Depth, Air Temp, Water Temp, Dissolved Oxygen, pH, Enterococci, Specific Conductance, Chloride, Sulfate, Alkalinity, Total Hardness, BOD, TSS, Volatile Suspended Solids, Total Dissolved Solids, Total Organic Carbon, Ammonia ad N, Nitrate+Nitrite, T Phosphorous, Chlorophylla, Pheophytin-a, T Calcium, T Magnesium, T Potassium, T Sodium, T Flouride, T Silica

Date of construction: Monitoring since: 6/5/1995

Is the station currently operating? ✓ Yes or No. **If no, when was the station abandoned?** ____

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:** ____
- **Who uses the data from the station?** IBWC and the general public
- **How do users obtain the data?** Data uploaded to website

Additional comments:

Last monitoring date: 3/26/2014

ABANDONED STATION

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was done

Monitoring station number (or identifier): 17247

Monitoring station name and description: Rio Grande River at NW of La Flores Bridge, Progresso, Tx.

Latitude (decimal degrees): 26.062222 **Longitude (decimal degrees:** -97.951805

Verify Coordinates as they are located in the middle of the Rio Grande River*

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: No infrastructure on ground
- **Electricity?** Yes or No. If yes, describe:
- **Water supply?** Yes or No. If yes, describe:
- **Sewer connection/septic?** Yes or No. If yes, describe:
- **Signs of vandalism?** Yes or No. If yes, describe:
- **Signs of natural damage?** Yes or No. If yes, describe:

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? Testing location only

Is the station on private or public property? Unknown at this time.

Describe the line of sight for signals: Unknown at this time

Additional comments:

Closest possible access on US side, turn right on road right after Car Dealership and before white barn structure while on F.M. 1015 before bridge. Go down to the Water tower and turn left on road after water tower. Follow road to river and turn left to coordinates.

Station does not appear to be in operation since 2011

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Flow, Water Depth, Air Temp, Water Temp, Disoslved Oxygen, pH, Secchi Disc, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, Alkalinity, TSS, Volatile, Suspended Solids Total Dissolved Solids, Total Organic Carbin, Ammonia, Nitrate+Nitrite, Total Phosphorous, Cholorphyll Total Silica

Date of construction: Monitoring since: 1/29/2002

Is the station currently operating? Yes or No. ✓ **If no, when was the station abandoned?** Last monitoring: 05/11/2011

Is the station regularly maintained? Yes or No. **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** Yes or No.
  If yes, describe: N/A
- **Sent when queried electronically?** Yes or No.
- **Downloaded manually from the station?** Yes or No.
- **Other method?** Yes or No. **Describe:**
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** Data is uploaded to website

Additional comments:

Last monitoring date: 5/11/2011

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: No site visit was done

Monitoring station number (or identifier): 20449

Monitoring station name and description: Rio Grande River at Rio Grande River Brownsville PUB Water Treatment Plant No. 1 Intake

Latitude (decimal degrees): 25.918628 **Longitude (decimal degrees:** -97.529077

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **Yes or No. If yes, describe:** No infrastructure - only a monitoring location
- **Electricity?** **Yes or No. If yes, describe:**
- **Water supply?** **Yes or No. If yes, describe:**
- **Sewer connection/septic?** **Yes or No. If yes, describe:**
- **Signs of vandalism?** **Yes or No. If yes, describe:**
- **Signs of natural damage?** **Yes or No. If yes, describe:**

Photographs taken:

- **All sides** **Yes or No**
- **Interior** **Yes or No**
- **Location of instruments in the water** **Yes or No**
- **View towards the upstream from the station** **Yes or No**
- **View towards the downstream from the station** **Yes or No**
- **Access to station** **Yes or No**

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? n/a

Is the station on private or public property? Private Property owned by Brownsville PUB

Describe the line of sight for signals: n/a

Additional comments:

Possibly contact Brownsville PUB for entrance authorization.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: USIBWC

- **Person to contact at monitoring agency:** Leslie Grijalva
- **Phone and email:** (915) 832-4770 leslie.grijalva@ibwc.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? varies - monthly or quarterly

Water quality parameters sampled: Temp DO, pH, Fecal Coliform, E. Coli, Specific Conductance, Chloride, Sulfate, TDS

Date of construction: Monitoring since: 12/29/2007

Is the station currently operating? **Yes** or **No.** **If no, when was the station abandoned?** Last monitoring: 06/03/2014

Is the station regularly maintained? **Yes** or **No.** **If yes, how frequent is maintenance?** N/A

How are data accessed?

- **Sent continuously by wireless signal?** **Yes or No.**
  If yes, describe: N/A
- **Sent when queried electronically?** **Yes or No.**
- **Downloaded manually from the station?** **Yes or No.**
- **Other method?** **Yes or No. Describe:** N/A
- **Who uses the data from the station?** IBWC and general public
- **How do users obtain the data?** through website access

Additional comments:

Testing at this station has dwindled to few tests compared to previous years.

Last monitoring date: 6/03/14

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: September 29, 2014 4:30 p.m.

Monitoring station number (or identifier): C736

Monitoring station name and description: Anzalduas Dam

Latitude (decimal degrees): 26.138028 **Longitude (decimal degrees:** -98.334447

*Coordinates corrected during site visit**

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **[Yes]** or No. **If yes, describe:** Complete Aluminum housing
- **Electricity?** **[Yes]** or No. **If yes, describe:** Conduit from building and battery backup
- **Water supply?** **[Yes]** or No. **If yes, describe:** Water available at building
- **Sewer connection/septic?** **[Yes]** or No. **If yes, describe:** Available at building
- **Signs of vandalism?** Yes or **[No.]** **If yes, describe:**
- **Signs of natural damage?** Yes or **[No.]** **If yes, describe:**

Photographs taken:

- **All sides** **[Yes]** or No
- **Interior** **[Yes]** or No
- **Location of instruments in the water** **[Yes]** or No
- **View towards the upstream from the station** **[Yes]** or No
- **View towards the downstream from the station** **[Yes]** or No
- **Access to station** **[Yes]** or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? Yes

Is the station on private or public property? Station located directly on the Dam

Describe the line of sight for signals: Line of sight clear. Station located on concrete pad by parking area.

Additional comments: Station secured on Dam. Access through keypad lock for access gate.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: TCEQ - Austin

- **Person to contact at monitoring agency:** Charles Dvorsky
- **Phone and email:** (512) 239-5550 charlesdvorsky@tceq.texas.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? Unit has telemetry which transmits continuously every 15 minutes.

Water quality parameters sampled: surface water temperature, surface specific conductance, total dissolved solids

Date of construction: July 6, 2011

Is the station currently operating? [Yes] or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or [No.] **If yes, how frequent is maintenance?** Last maintenance 5 months ago. Maintenance will be done today.

How are data accessed?

- **Sent continuously by wireless signal?** [Yes] or No.
  If yes, describe: telemetry every 15 minutes
- **Sent when queried electronically?** [Yes] or No.
- **Downloaded manually from the station?** Yes or [No.]
- **Other method?** Yes or [No.] **Describe:** N/A
- **Who uses the data from the station?** Data presently only used by TCEQ personnel
- **How do users obtain the data?** Data was being uploaded to website for access by the public.

Additional comments:

This station was being maintenanced by TCEQ in Harlingen, Texas, Watermaster's Office. Due to personnel changes, the station is now being monitored by TCEQ in Austin. Data is not being uploaded to website as station maintenance is not occurring frequently.

Station C736 – Anzaldua's Dam

Station C736 – Anzaldua's Dam

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: 09-30-2014 10:40 a.m.

Monitoring station number (or identifier): C767

Monitoring station name and description: Rio Grande at Roma

Latitude (decimal degrees): 26.406642 **Longitude (decimal degrees:** -99.020292

Coordinates corrected during site visit

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **[Yes]** or No. If yes, describe: Aluminum Housing
- **Electricity?** **[Yes]** or No. If yes, describe: Solar Power
- **Water supply?** Yes or **[No.]** If yes, describe:
- **Sewer connection/septic?** Yes or **[No.]** If yes, describe:
- **Signs of vandalism?** Yes or **[No.]** If yes, describe:
- **Signs of natural damage?** Yes or **[No.]** If yes, describe:

Photographs taken:

- **All sides** **[Yes]** or No
- **Interior** **[Yes]** or No
- **Location of instruments in the water** **[Yes]** or No
- **View towards the upstream from the station** **[Yes]** or No
- **View towards the downstream from the station** **[Yes]** or No
- **Access to station** **[Yes]** or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? Yes, weather permitting. Dirt road to access station.

Is the station on private or public property? Public US lands

Describe the line of sight for signals: Line of sight is clear, but road ends at station.

Additional comments:
Station is located approximately .20 miles north of the Roma International bridge. Access to station can be made via a dirt road on the river bank. (Take Juarez Ave. SW to end of road and continue on dirt road north to station.) To exit, one must reverse a good 300 yards. Access to station dependent on weather. There is a 30-40 foot bank leading up to the town which shows signs of erosion and small mud slides located at the site.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: TCEQ - Austin

- **Person to contact at monitoring agency:** Charles Dvorsky
- **Phone and email:** (512) 239-5550 charles.dvorsky@tceq.texas.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? Unit equipped with telemetry which transmits data every 15 minutes.

Water quality parameters sampled: temperature, surface specific conductance and total dissolved solids

Date of construction: July 8, 2009

Is the station currently operating? [Yes] or No. **If no, when was the station abandoned?** ____

Is the station regularly maintained? Yes or [No.] **If yes, how frequent is maintenance?** Last maintenance was 5 months ago. Site maintenance done during this visit.

How are data accessed?

- **Sent continuously by wireless signal?** [Yes] or No.
  If yes, describe: telemetry every 15 minutes
- **Sent when queried electronically?** [Yes] or No.
- **Downloaded manually from the station?** Yes or [No.]
- **Other method?** Yes or [No.] **Describe:** ____
- **Who uses the data from the station?** Data presently being used only by TCEQ.
- **How do users obtain the data?** Data was being uploaded to website for access by the public.

Additional comments:

This station was being maintenanced by TCEQ in Harlingen, Texas, Watermaster's Office. Due to personnel changes, the station is now being monitored by TCEQ in Austin. Data is not being uploaded to website as station maintenance is not occurring frequently.

Station C767 – Roma International Bridge

Station C767 – Roma International Bridge

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: 9-29-2014 2:20 p.m.

Monitoring station number (or identifier): C789

Monitoring station name and description: Rio Grande - Harlingen at Harlingen Irrigation District intake

Latitude (decimal degrees): 26.045278 **Longitude (decimal degrees:** -97.764728

Coordinates corrected during site visit

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** **[Yes]** or No. **If yes, describe:** Aluminum housing
- **Electricity?** **[Yes]** or No. **If yes, describe:** Solar powered
- **Water supply?** Yes or **[No.]** **If yes, describe:**
- **Sewer connection/septic?** Yes or **[No.]** **If yes, describe:**
- **Signs of vandalism?** Yes or **[No.]** **If yes, describe:**
- **Signs of natural damage?** Yes or **[No.]** **If yes, describe:**

Photographs taken:

- **All sides** **[Yes]** or No
- **Interior** **[Yes]** or No
- **Location of instruments in the water** **[Yes]** or No
- **View towards the upstream from the station** **[Yes]** or No
- **View towards the downstream from the station** **[Yes]** or No
- **Access to station** **[Yes]** or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? Weather permitting, yes

Is the station on private or public property? Station located at Rio Grande River bank

Describe the line of sight for signals: Line of sight clear in all directions as area is being maintained by Harlingen Irrigation District.

Additional comments: Location can be accessed through Benson Rd. and then traveling through dirt roads on private property.
Possibly take weed eater to trim around station as needed.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: TCEQ - Austin

- **Person to contact at monitoring agency:** Charles Dvorsky
- **Phone and email:** (512) 239-5550 charlesdvorsky@tceq.texas.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? Unit has telemetry which transmits continuously every 15 minutes.

Water quality parameters sampled: surface water temperature, surface specific conductance, total dissolved solids

Date of construction: June 16, 2010

Is the station currently operating? [Yes] or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or [No.] **If yes, how frequent is maintenance?** Last serviced 5 months ago. Station will be serviced today.

How are data accessed?

- **Sent continuously by wireless signal?** [Yes] or No.
  If yes, describe: telemetry every 15 minutes
- **Sent when queried electronically?** [Yes] or No.
- **Downloaded manually from the station?** Yes or [No.]
- **Other method?** Yes or [No.] **Describe:** ______
- **Who uses the data from the station?** Data is presently being used by TCEQ only.
- **How do users obtain the data?** Data was being uploaded to website for access by the public.

Additional comments:

This station was being maintenanced by TCEQ in Harlingen, Texas, Watermaster's Office. Due to personnel changes, the station is now being monitored by TCEQ in Austin. Data is not being uploaded to website as station maintenance is not occurring frequently.

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: 9-30-14 9:38 a.m.

Monitoring station number (or identifier): C791

Monitoring station name and description: Rio Grande Near United Irrigation District Intake

**Coordinates corrected during site visit. Coordinates show location of transmitting unit. Probe located at 26.183086 -98.404953

Latitude (decimal degrees): 26.183281 **Longitude (decimal degrees:** -98.404719

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** [Yes] or No. **If yes, describe:** Aluminum Housing
- **Electricity?** [Yes] or No. **If yes, describe:** Solar powered
- **Water supply?** Yes or [No.] **If yes, describe:**
- **Sewer connection/septic?** Yes or [No.] **If yes, describe:**
- **Signs of vandalism?** Yes or [No.] **If yes, describe:**
- **Signs of natural damage?** Yes or [No.] **If yes, describe:**

Photographs taken:

- **All sides** [Yes] or No
- **Interior** [Yes] or No
- **Location of instruments in the water** [Yes] or No
- **View towards the upstream from the station** Yes or [No]
- **View towards the downstream from the station** Yes or [No]
- **Access to station** [Yes] or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? Yes

Is the station on private or public property? Station located at Rio Grande River bank

Describe the line of sight for signals: Probe location line of sight is hindered by dense growth. Station location is clear to all sides as site is maintained by United Irrigation District.

Additional comments: Location can be accessed through Levy Rd. (CR-12450) to the United Irrigation District canal intake structure on the river.
Probe location needs to be reinforced with concrete as there are signs of bank disturbance due to rain.
It is also suggested that precautions be taken due to United Irrigation guard dogs.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: TCEQ - Austin

- **Person to contact at monitoring agency:** Charles Dvorsky
- **Phone and email:** (512) 239-5550 charlesdvorsky@tceq.texas.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? Unit has telemetry which transmits continuously every 15 minutes.

Water quality parameters sampled: surface water temperature, surface specific conductance, total dissolved solids

Date of construction: December 2, 2010

Is the station currently operating? [Yes] or No. **If no, when was the station abandoned?** ______

Is the station regularly maintained? Yes or [No.] **If yes, how frequent is maintenance?** 5 months ago. Site will be maintenanced today.

How are data accessed?

- **Sent continuously by wireless signal?** [Yes] or No.
  If yes, describe: telemetry every 15 minutes
- **Sent when queried electronically?** [Yes] or No.
- **Downloaded manually from the station?** Yes or [No.]
- **Other method?** Yes or [No.] **Describe:** ______
- **Who uses the data from the station?** Data is presently being used by TCEQ only.
- **How do users obtain the data?** Data was being uploaded to website for access by the public.

Additional comments:

This station was being maintenanced by TCEQ in Harlingen, Texas, Watermaster's Office. Due to personnel changes, the station is now being monitored by TCEQ in Austin. Data is not being uploaded to website as station maintenance is not occurring regularly.

Station C791 – United Irrigation Intake

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: Pilar Corpus

Date and time of visit to monitoring location: 9-29-14 3:25 p.m.

Monitoring station number (or identifier): C793

Monitoring station name and description: Rio Grande Near Hidalgo County & Cameron County ID #9 intake structure

Latitude (decimal degrees): 26.061625 **Longitude (decimal degrees:** -97.899847

Coordinates corrected during site visit

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** [Yes] or No. **If yes, describe:** Aluminum Housing
- **Electricity?** [Yes] or No. **If yes, describe:** Solar power
- **Water supply?** Yes or [No.] **If yes, describe:**
- **Sewer connection/septic?** Yes or [No.] **If yes, describe:**
- **Signs of vandalism?** Yes or [No.] **If yes, describe:**
- **Signs of natural damage?** Yes or [No.] **If yes, describe:**

Photographs taken:

- **All sides** [Yes] or No
- **Interior** [Yes] or No
- **Location of instruments in the water** [Yes] or No
- **View towards the upstream from the station** [Yes] or No
- **View towards the downstream from the station** [Yes] or No
- **Access to station** [Yes] or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? Yes

Is the station on private or public property? Station located on HC & CC ID #9 property structure.

Describe the line of sight for signals: Line of sight clear on all sides.

Additional comments: Location can be accessed through Old Rio Rico Rd. and then through a private dirt road owned by HD&CC #9.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: TCEQ - Austin

- **Person to contact at monitoring agency:** Charles Dvorsky
- **Phone and email:** (512) 239-5550 charlesdvorsky@tceq.texas.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? Unit has telemetry which transmits continuously every 15 minutes.

Water quality parameters sampled: surface water temperature, surface specific conductance, total dissolved solids

Date of construction: June 15, 2010

Is the station currently operating? **[Yes]** or **No.** **If no, when was the station abandoned?** ______

Is the station regularly maintained? **Yes** or **[No.]** **If yes, how frequent is maintenance?** ~~last maintenance~~ 5 months ago Station maintained today.

How are data accessed?

- **Sent continuously by wireless signal?** **[Yes]** or **No.**
  If yes, describe: telemetry every 15 minutes
- **Sent when queried electronically?** **[Yes]** or **No.**
- **Downloaded manually from the station?** **Yes** or **[No.]**
- **Other method?** **Yes** or **[No.]** **Describe:** ______
- **Who uses the data from the station?** Data is presently being used by TCEQ only.
- **How do users obtain the data?** Data was being uploaded to website for access by the public.

Additional comments:

This station was being maintenanced by TCEQ in Harlingen, Texas, Watermaster's Office. Due to personnel changes, the station is now being monitored by TCEQ in Austin. Data is not being uploaded to website as station maintenance is not occurring frequently.

Station C793 – HC & CC #9 Intake

Station C793 – HC & CC #9 Intake

Lower Rio Grande Water Quality Monitoring Stations – Field Assessment

Name of person collecting information for this form: ______________________

Date and time of visit to monitoring location: ______________________

Monitoring station number (or identifier): C796

Monitoring station name and description: Rio Grande DS of Arroyou Los Olmos

____

Latitude (decimal degrees): 26.349503 **Longitude (decimal degrees:** -98.796053

Provide the following information for continuous monitoring stations:

Does the station have?

- **Cover or housing?** Yes or No. If yes, describe: ______________________
- **Electricity?** Yes or No. If yes, describe: ______________________
- **Water supply?** Yes or No. If yes, describe: ______________________
- **Sewer connection/septic?** Yes or No. If yes, describe: ______________________
- **Signs of vandalism?** Yes or No. If yes, describe: ______________________
- **Signs of natural damage?** Yes or No. If yes, describe: ______________________

Photographs taken:

- **All sides** Yes or No
- **Interior** Yes or No
- **Location of instruments in the water** Yes or No
- **View towards the upstream from the station** Yes or No
- **View towards the downstream from the station** Yes or No
- **Access to station** Yes or No

Overall station assessment:

Can the station be safely accessed for equipment maintenance and repair? ______________________

Is the station on private or public property? Station located at Rio Grande River bank

Describe the line of sight for signals: ______________________

Additional comments: Location via Google Earth seems remote and located in brush land. Access to the station to be determined at time of visit. Access may have to be made through private farm land to the East. We need to verify coordinates as the station may be located further south as a clear patch of land can be seen to the south of the coordinates listed.

Lower Rio Grande Water Quality Monitoring Stations – Office Assessment

Monitoring agency: TCEQ - Austin

- **Person to contact at monitoring agency:** Charles Dvorsky
- **Phone and email:** (512) 239-5550 charlesdvorsky@tceq.texas.gov

How frequently are data collected (monthly, quarterly, annually, and continually)? Unit has telemetry which transmits continuously every 15 minutes.

Water quality parameters sampled: temperature, surface specific conductance, total dissolved solids

Date of construction: July 6, 2011

Is the station currently operating? **Yes** **or** **No.** **If no, when was the station abandoned?** ____

Is the station regularly maintained? **Yes** **or** **No.** **If yes, how frequent is maintenance?** ____

How are data accessed?

- **Sent continuously by wireless signal?** **Yes or No.**
  If yes, describe: telemetry every 15 minutes
- **Sent when queried electronically?** **Yes or No.**
- **Downloaded manually from the station?** **Yes or No.**
- **Other method?** **Yes or No. Describe:** ____
- **Who uses the data from the station?** Data is presently not being used.
- **How do users obtain the data?** Data was being uploaded to website for access by the public.

Additional comments:

This station was being maintenanced by TCEQ in Harlingen, Texas, Watermaster's Office. Due to personnel changes, the station is now being monitored by TCEQ in Austin. Data is not being uploaded to website as station maintenance is not occurring as frequently as TCEQ would like.

Appendix D

Texas Water Development Board Draft Report Review Comments

Attachment I

Lower Rio Grande Water Quality Monitoring Feasibility Assessment

TWDB Contract No. 1448321705

Draft Report Review Comments

Comments:

1) Scope of work item D.2.iii (report section 3.1): The report also mentions that "IBWC and TCEQ do not have time-of-travel data which could be used to estimate how long it may take taste and odor-causing compounds or potentially hazardous materials to travel down the Rio Grande." and, accordingly, relied on HEC-RAS modeling to estimate time-of-travel, at least for the lower portion of the study area. Please explain why time-of-travel wasn't estimated using data from IBWC stream gages (Table 1) that collect stage and discharge values at 15 minute increments. Gages of particular interest are listed in the Table 1 below.

   Table 1: IBWC stream gages on the main stem lower Rio Grande.

Station	Number	River Kilometer	River Mile	River Miles below Falcon Dam
Below Falcon Dam	08-4613.00	442	275	-
At Rio Grande City	08-4647.00	378	235	40
Near Los Ebanos	08-4663.00	329	204	71
At Progreso Bridge	08-4725.30	199	124	151
Near San Benito	08-4737.00	156	97.0	178
Near Brownsville	08-4750.00	78.3	48.7	226

   The most recent 15 minute data for these sites is available on-line from the following link: http://www.ibwc.gov/Water_Data/rtdata.htm.

2) Section II, Article III, Paragraph 5 requires that a copy of the TWDB's comments be included in the final report. Please review the requirements of this paragraph and include the comments in the final report.

Optional Comments for Consideration

(not required to be included in the final report document)

Suggested Changes that may improve the readability of the final report:

There are some inconsistences in referencing tables within the document. For example, on page 14, in the text, Table 1 and Table 2 are mentioned. The titles for the actual tables refer to them as Table 6-1 and Table 6-2. Either convention for referencing tables is acceptable, but only one, consistent convention should be used in the document. There are also some inconsistencies referencing costs between the text and tables.

- Section 1, page E-1, 3rd paragraph: reference to Table 3 on page 9 should be Table 3-1.
- Section 1, page E-1, last paragraph: reference to cost of $225,000 does not match total cost listed in Table 7-2 on page 33.
- Section 3.1, page 8, 3rd paragraph: reference to Table 3 should be Table 3-1.
- Section 3.1, page 9, 1st paragraph: reference to Table 4 should be Table 3-2.
- Section 5, page 13, 2nd paragraph: reference to Table 6-2 should be Table 5-1.
- Section 6.1, page 14, 1st paragraph: reference to Table 1 should be Table 6-1. Reference to Table 2 should be Table 6-2. Reference to Figure 1 appears misplaced.
- Section 6.1, page 15, 1st paragraph continued from page 14: reference to Table 2 should be Table 6-2.
- Section 6.1, page 15, 2nd paragraph: "Figure 5-11" should be "Figures 5-11".
- Section 6.2, page 21, last sentence: reference to Table 5 should be Table 6-3.
- Section 6.3.1 A, page 23, last paragraph: reference to cost of $2,000-$3,000 does not match costs listed in Table 6-4 on page 27.
- Section 6.3.1 D, page 24, 1st paragraph: reference to cost of $1,000-$2,000 does not match cost listed in Table 6-4 on page 27.
- Section 6.6, page 27, 1st paragraph: reference to Table 5 should be Table 6-4.
- Section 7.3, page 31, 1st paragraph: reference to Table 6 should be Table 7-1.
- Section 7.6, page 32, 1st paragraph: reference to Table 7 should be Table 7-2.
- Section 7.6, page 32, 1st paragraph: reference to cost of $70,000 does not match cost listed in Table 7-2.
- Appendix B/Guidance Document: consider renaming Table 3 as Table 1. Consider renumbering Table 4 as Table 2. Also update text under section 3.0 if table numbers are revised.
- The Appendices at the end of the report (A through C) are out of order.
- Reviewers also noted several spelling and grammatical errors including examples below.
  - Section 6.3.1 A, page 23, 1st paragraph: "Algae may cause **of** taste and odor problems…"

- Section 6.3.1 B, page 24, 1st paragraph: "If oxygen levels are low…bacterial respiration may **using** oxygen faster…"
- Section 6.3.1 E, page 25, 1st paragraph: "In at least **on** case, use…"
- Section 7.6, page 32, 1st paragraph: "Actual costs…the monitoring effort **could can** become…"

Additional information regarding time-of-travel methodology:

TWDB staff had concern related to one technical aspect of the report, specifically the time-of-travel values estimated using the HEC-RAS model described in the report (related to Scope of Work Item 2C and report section 3.1). As mentioned in the report, "A major consideration in placing monitoring locations for taste and odor-causing substances and potentially hazardous materials is how long it may take those substances to travel down river to irrigation diversions." The report also mentions that "IBWC and TCEQ do not have time-of-travel data which could be used to estimate how long it may take taste and odor-causing compounds or potentially hazardous materials to travel down the Rio Grande." In light of this situation, the project relied on HEC-RAS modeling to estimate time-of-travel, at least for the lower portion of the study area. Results are presented in the report to indicate that a time-of-travel of from three to six days could be expected for the reach from Peñitas to Brownsville (depending on flow conditions).

Staff had concern that the time-of-travel estimates provided in the report are too long and provide an overly optimistic assessment of how much time would be available for operators to react when odor-causing substances or potentially hazardous materials are detected in the river. While it is true that no reports documenting time-of-travel values for the lower Rio Grande are readily available, there is some data available for estimating these values. The IBWC operates a series of stream gages on the lower Rio Grande that collect stage and discharge values at 15 minute increments. Data from these gages can be used to make reasonable estimates of travel times for the lower Rio Grande. Gages of particular interest are listed in the table below.

Table 1. IBWC stream gages on the main stem lower Rio Grande.

Station	Number	River Kilometer	River Mile	River Miles below Falcon Dam
Below Falcon Dam	08-4613.00	442	275	-
At Rio Grande City	08-4647.00	378	235	40
Near Los Ebanos	08-4663.00	329	204	71
At Progreso Bridge	08-4725.30	199	124	151
Near San Benito	08-4737.00	156	97.0	178
Near Brownsville	08-4750.00	78.3	48.7	226

The most recent 15 minute data for these sites is available on-line from the following link: http://www.ibwc.gov/Water_Data/rtdata.htm. It is also possible to obtain older 15-minute data from these gages from the IBWC. Precipitation data is also collected at these gages, making it possible to identify times when moving storms may be impacting the shape of hydrographs at each of the gages. By eliminating those periods from consideration, it is possible to find time periods when peaks (or troughs) in an upstream hydrograph can be followed at downstream hydrographs, providing an estimate of time-of-travel between the stations. Although a detailed analysis of this gage data was not included in the scope of work of this project, a quick review of this data would provide an estimate of time-of-travel values in the upper reach (which could not be estimated with the HEC-RAS model) and a check of the values in the lower reach (which were estimated with the HEC-RAS model).

As an example, the data for the three lowest gages for early March of this year is plotted in the figure below. Discharge in cubic meters per second is plotted on the left y-axis; cumulative precipitation at the gage locations in millimeters is plotted on the right y-axis. Because of the influence of local precipitation after March 9th, data after that date is not suitable for estimating time-of-travel. Prior to that rainfall event, there are several opportunities to estimate time-of-travel between the gage locations based on features of the hydrographs. Those features are highlighted with a circle, square, or triangle in the figure. Flow conditions at this time are low (between 3 and 20 cms or about 100 to 700 cfs), well below the 1,130 cfs listed as the 25th percentile flow on page 9 of the report. For these conditions, the time-of-travel between the Progreso and San Benito gages ranges from 1.5 to 4.75 hours. From the Progreso to Brownsville gage, the values range from 22 to 30.5 hours. Keep in mind that these travel times are for very low flow conditions. At higher flow rates, travel times would be reduced from these values.

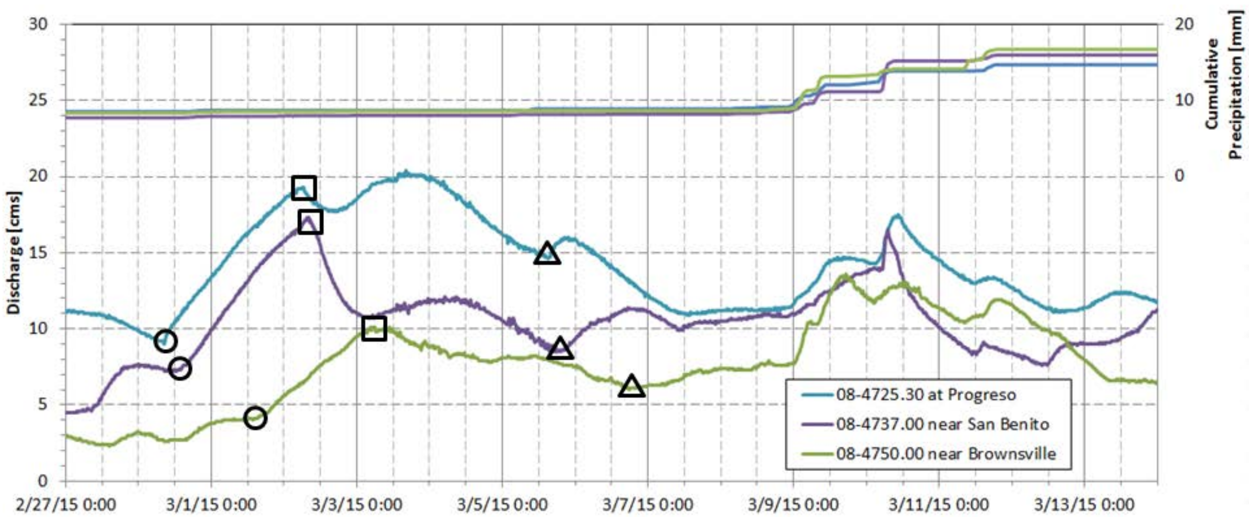


Figure 1. Hydrograph and cumulative precipitation for three IBWC gaging stations on the lower Rio Grande.

This data and comparable data from Table 3-1 of the report (page 9) are shown in Table 2.

Table 2. Time-of-travel for select reaches of the lower Rio Grande as estimated from gage data or HEC-RAS modeling.

Method	Reach	River miles below Falcon Dam	Flow Conditions	Time-of-Travel
Gage Data	Progreso – San Benito gages	151-178	< 700 cfs	1.5-4.75 hrs
HEC-RAS	Hidalgo and Cameron Co. ID #9 – Cameron Co. ID #2 diversions	158-174.5	1,130 cfs	16 hrs
HEC-RAS	Hidalgo and Cameron Co. ID #9 – Cameron Co. ID #2 diversions	158-174.5	4,273 cfs	10 hours
Gage Data	Progreso – Brownsville gages	151-226	< 700 cfs	22-30.5 hrs
HEC-RAS	Hidalgo and Cameron Co. ID #9 – Brownsville PUB diversions	158-218	1,130 cfs	65 hours
HEC-RAS	Hidalgo and Cameron Co. ID #9 – Brownsville PUB diversions	158-218	4,273 cfs	40 hours

As can be seen from the table, even at high flow rates the HEC-RAS model predicts relatively long travel times. For example, at a flow rate of 4,273 cfs, the HEC-RAS model predicts the time-of-travel from the Hidalgo and Cameron County Irrigation District #9 to the Cameron County Irrigation District #2 diversions to be 10 hours. The gage data shows the time-of-travel of a slightly longer reach (Progresso to San Benito gages) to be less than 5 hours for significantly lower flow conditions. It appears the HEC-RAS model has exaggerated the time-of-travel values. This in turn exaggerates the estimate of the amount of time that would be available to warn operators regarding odor-causing substances or potentially hazardous materials in the river.

Over estimation of time-of-travel based on average cross section velocity as computed with a HEC-RAS model has been reported by other researchers (Gogase-Nistorian, et al. 2008).

Gogoase-Nistoran, D.E., D. Popescu, and V. Panaitescu. 2008. Use of hydraulic modeling for river oil spills: travel time computation for quick response. U.P.B. Sci. Bull., Series D, Vol. 70, No. 4. https://www.academia.edu/216716/Use_of_Hydraulic_Modeling_for_river_Oil_Spills._1.Travel_time_computation_for_quick_response