Matagorda Bay System: Challenges and Threats

David Bradsby
Water Quantity Program

17 October 2018

TEXAS PARKS & WILDLIFE

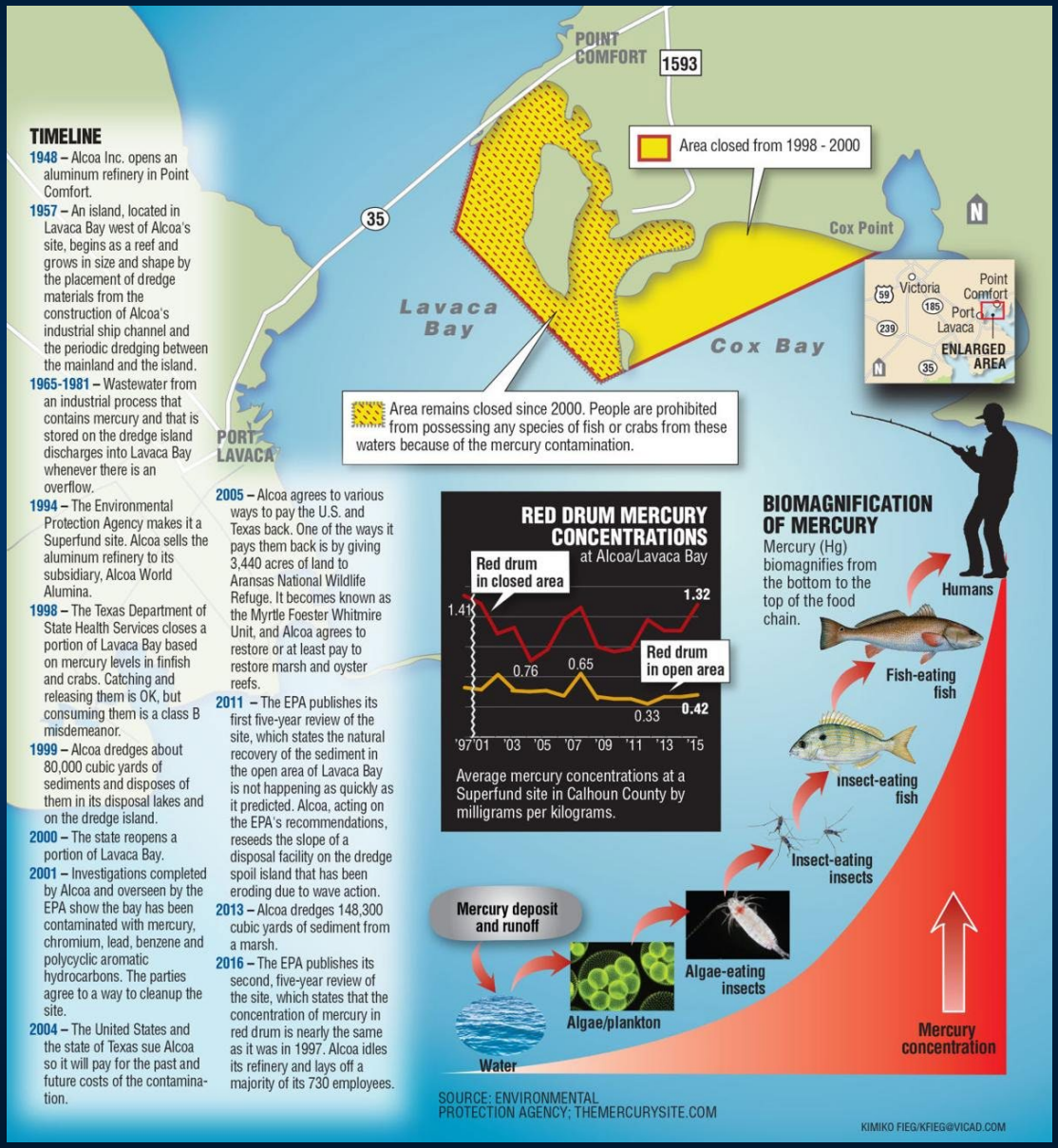
"About your cat, Mr. Schrödinger—I have good news and bad news."

ALCOA (Point Comfort)/Lavaca Bay Superfund Site

Credit: NOAA and USFWS

https://www.cerc.usgs.gov/orda_docs/CaseDetails?ID=932

ALCOA (Point Comfort)/Lavaca Bay Superfund Site



From 2018 Lavaca Basin Highlights Clean Rivers Program Report - LNRA

2017 Basin Highlights

- The Lavaca-Navidad River Basin receives an average annual rainfall of approximately 42 inches per year. During 2017, the Basin received above average rainfall of 45.45 inches, 1.38 inches more than the previous year's total rainfall. A single meteorological event, Hurricane Harvey, was a contributing factor to this year's rainfall total, producing an average of 16 inches across the Basin. Without this major event, the Basin would have received an average of only 29.45 inches which is indicative of the current depressed reservoir levels.

- A rural use attainability analysis (RUAA) was initiated by the Texas Commission on Environmental Quality (TCEQ) and Texas Water Resources Institute (TWRI) on Rocky Creek in Lavaca County due to the stream being placed on the states' 303d list for exceedance of the bacteriological geomean for primary contact recreation.

- A watershed protection plan (WPP) was developed for the Lavaca River Segment 1602_03 to identify best management practices to help reduce bacteria levels found in this segment to current Environmental Protection Agency (EPA) standards. The WPP was approved by TCEQ and is currently under review by the EPA.

- The control of Giant salvinia (*Salvinia molesta*) has been an on-going "battle" in the Lavaca-Navidad River Basin since its discovery in 1999. A biological control method was introduced within LNRA's Texana Park at a designated test site in 2016. As of 2017, measurements of the Salvinia Weevil's productivity have yielded outstanding results.

From 2018 Lavaca Basin Highlights Clean Rivers Program Report - LNRA

Label	AU	Segment Name	Impairments
A	1601_01	Lavaca River Tidal	None
B	1601_02	Lavaca River Tidal	None
C	1601_03	Lavaca River Tidal	None
D	1601A_01	Catfish Bayou	None
E	1601B_01	Redfish Bayou	None
F	1601C_01	Dry Creek	None
G	1602_02	Lavaca River Above Tidal	None
H	1602_03	Lavaca River Above Tidal	Primary Contact Recreation (Elevated Bacteria)
I	1602A_01	Big Brushy Creek	None
J	1602B_01	Rocky Creek	Primary Contact Recreation (Elevated Bacteria)
K	1602B_02	Rocky Creek	None
L	1602C_01	Lavaca River Above Campbell Branch	Aquatic Life (Depressed Dissolved Oxygen)
M	1602C_02	Lavaca River Above Campbell Branch	Aquatic Life (Depressed Dissolved Oxygen)

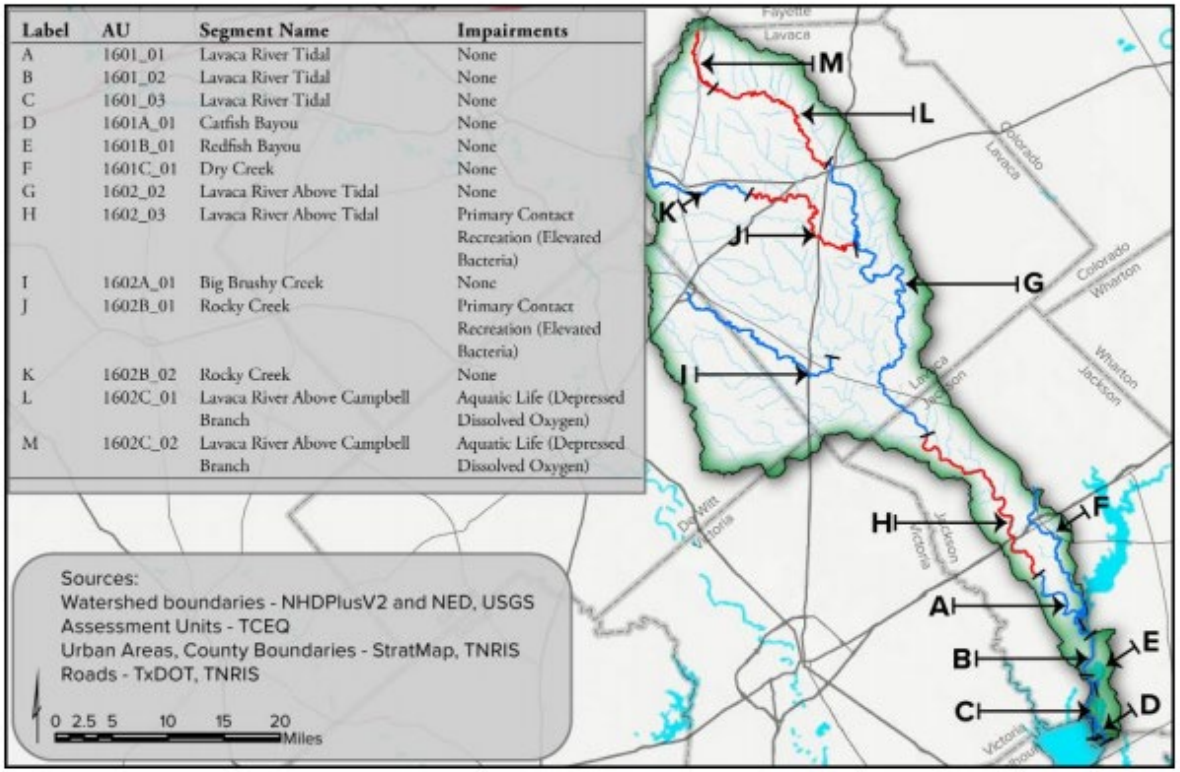


Figure 8- Map of Impaired Streams(Red) in the Lavaca River
Map Credit: Texas Water Resources Institute

Tres Palacios Creek Watershed Protection Plan

Developed by the stakeholders in the Tres Palacios Creek watershed

Authored and prepared by:
Michael Schramm, Allen Berthold and Clare Entwistle
Texas Water Resources Institute

Texas Water Resources Institute Technical Report – 500
2017

College Station, Texas

Funding was provided through a federal Clean Water Act §106 grant to the Texas Water Resources Institute, from the U.S. Environmental Protection Agency, administered by the Texas Commission on Environmental Quality.

Cover photo: Unnamed tributary to Tres Palacios Bay, by Michael Schramm, TWRI

Texas Water Resources Institute
make every drop count

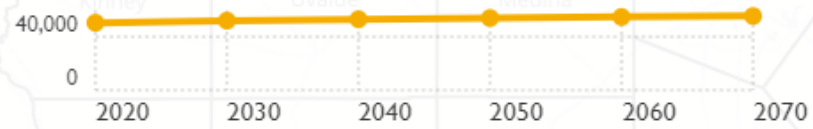
TCEQ

Texas A&M AgriLife Research | Extension

Planning Region P

Regional Water Planning Area in Texas

Population

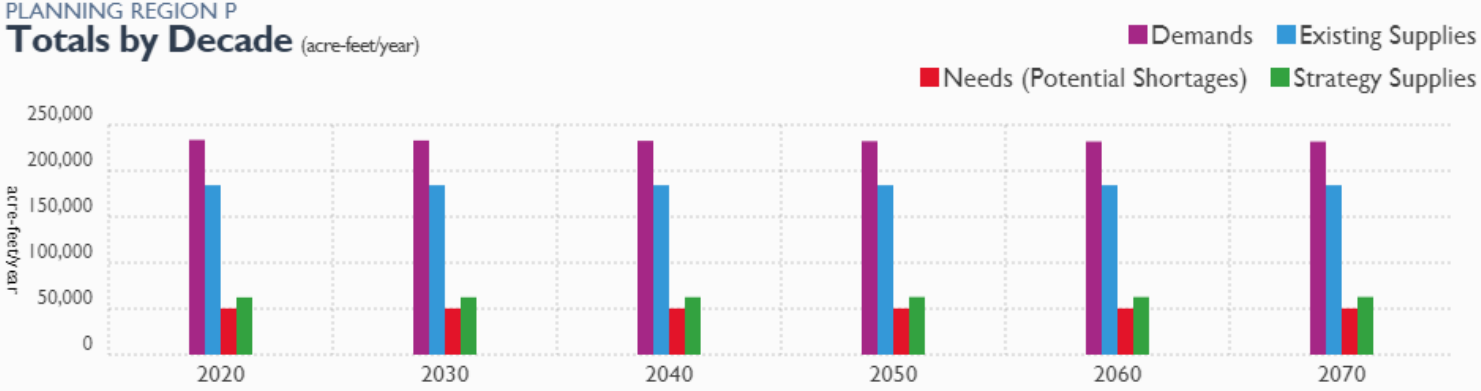


HIDE DATA TABLE

2020	2030	2040	2050	2060	2070
50,489	52,068	53,137	54,053	54,846	55,522

PLANNING REGION P

Totals by Decade (acre-feet/year)



	2020	2030	2040	2050	2060	2070
Demands	233,596	232,971	232,531	232,167	231,820	231,778
Existing Supplies	184,331	184,331	184,331	184,331	184,331	184,331
Needs (Potential Shortages)	50,285	50,285	50,285	50,285	50,285	50,285
Strategy Supplies	62,300	62,411	62,530	62,694	62,675	62,762

Lake Texana

About Lake Texana

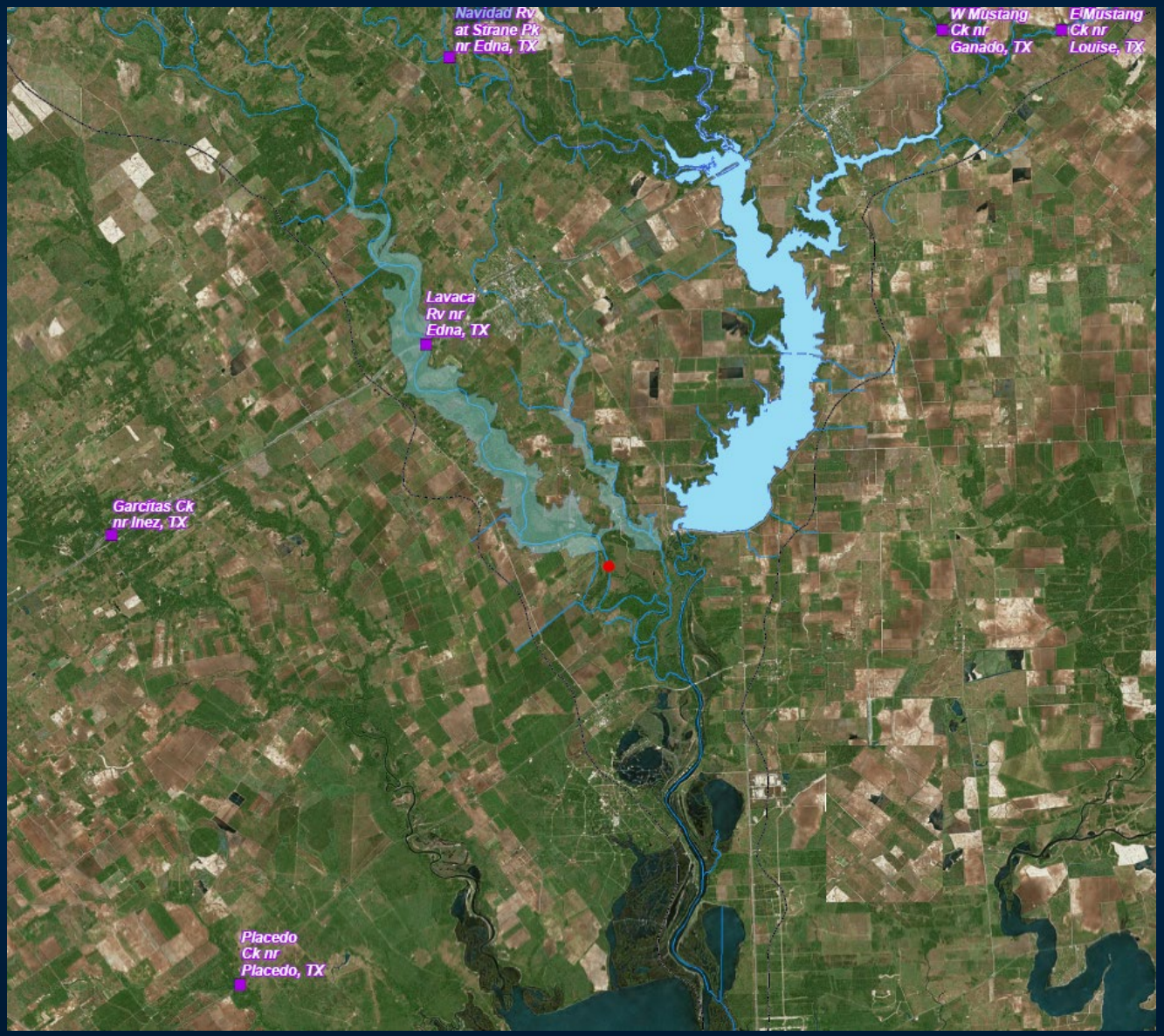
Construction of the Palmetto Bend Project was approved by congress in 1968. It was a cooperative water resource project between LNRA, the Texas Water Development Board and the United States Bureau of Reclamation. Construction began shortly after contract execution. Lake Texana began impounding water in May 1980. The Lake was filled over a 2 year period in stages of elevation. The conservation elevation of Lake Texana at 44.00 ft. was reached on May 6, 1982.

Palmetto Bend Dam impounds the waters of the Navidad River, Sandy Creek and Mustang Creek. The dam is located 4 miles upstream of the confluence of the Navidad and Lavaca Rivers. The River Outlet Works is located within the original Navidad River channel.

The reservoir's name was derived from the old town of Texana. The Lake now covers the original site of Texana. The lake reaches approximately 18 miles into the Navidad River Basin and covers the lower portions of Mustang Creek and Sandy creek sub areas.

The purpose of the project is to provide a dependable municipal and industrial water supply. The current firm yield of the Lake's capacity of 161,085 acre-feet is 74,500 acre-feet annual. The project was also intended to provide associated recreational, fish, and wildlife benefits to surrounding counties.

Lavaca Navidad River Authority Off-Channel Reservoir



Lavaca Navidad River Authority Off-Channel Reservoir

Issues and Considerations

The off-channel reservoir alternatives minimize challenges to implementation as compared to the on-channel scenario. Water rights, land acquisition, and relocation of infrastructure are considerations in the feasibility of this strategy. The evaluation of this strategy assumes that a new water right permit would be obtained for the project. As such, the TCEQ-adopted, Senate Bill 3-developed environmental flow standards, effective August 30, 2012, would need to be met in order for TCEQ to approve the permit.

Environmental Impacts

The proposed off-channel reservoir scenarios would have substantially less impacts on valuable habitat than the considered on-channel reservoir option. In the off-channel scenarios, some habitat would be altered or lost as a result of temporary flooding and the area impacted would be smaller than that of the on-channel reservoir. The impact of the proposed off-channel reservoir scenarios appears to have minimal or no impact on threatened and endangered species.

Since the *Lavaca River Water Supply Project Feasibility Study (Study),* completed in 2011, the TCEQ has adopted new environmental flow standards that apply to new or amended water rights permits.

These standards were not included as part of the 2011 *Study* analysis, so a re-evaluation of the potential firm yield was completed using the new standards for the 2016 Lavaca Regional Water Plan.

The proposed location of the off-channel reservoir is such that it is downstream of all TCEQ adopted environmental flow standard instream flow measurement points along the Lavaca River. The only TCEQ standard that needs to be met is the Bay and Estuary Freshwater Inflow standards for the Lavaca Bay System. The Standards are identified in the table below. Projects requiring new water rights permits shall not cause or contribute to an impairment of the inflow regimes described below.

Lavaca Navidad River Authority Off-Channel Reservoir

Table 5-1 Bay and Estuary Freshwater Inflow Standards for the Lavaca Bay System

Inflow Regime	Spring Inflow Quantity (af)	Fall Inflow Quantity (af)	Intervening Inflow Quantity (af)	Annual Strategy Frequency
Subsistence	13,500	9,600	6,900	96%
Base Dry	55,080	39,168	28,152	82%
Base Average	127,980	91,080	65,412	46%
Base Wet	223,650	158,976	114,264	28%

af=acre feet

The Lavaca off-channel reservoir project was modeled so that the model incorporating the strategy either met or exceeded the required annual strategy frequency for each seasonal period; or if the Base Lavaca WAM did not meet the required annual strategy frequency, then the strategy model did not decrease it further. The frequency attainment results are shown below for the Base WAM and the Strategy WAM, respectively.

Table 5-2 Comparison of WAM Results for the Lavaca Off-Channel Reservoir

Base WAM Results

	Subsistence		Base Dry		Base Avg		Base Wet	
Onset Period	Count	%	Count	%	Count	%	Count	%
Springtime	51	89%	45	79%	38	67%	25	44%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	39	68%

Lavaca OCR Results

	Subsistence		Base Dry		Base Avg		Base Wet	
Onset Period	Count	%	Count	%	Count	%	Count	%
Springtime	51	89%	45	79%	37	65%	24	42%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	38	67%

As a result of developing a reservoir to capture and store flow from the river, up to 25,000 ac-ft/yr would be diverted to storage in any given year. Additionally, the new reservoir could provide up to 1,200 acres of new waterfowl habitat.

Impacts to Agriculture

The proposed off-channel reservoir scenarios would have a marginal impact on local agricultural activities. Siting of the project and inundation of the off-channel reservoir would remove approximately 1,200 acres of agricultural land from production but would have minimal influence given the large quantity of agricultural land in the area.

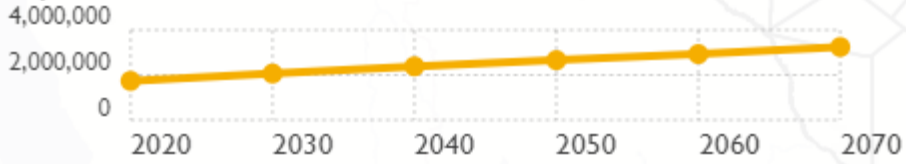
Impacts to Navigation

The proposed off-channel reservoir scenarios would have no impact on navigation. Any diversion dam structure would need to consider navigation impacts.

Planning Region K

Regional Water Planning Area in Texas

Population

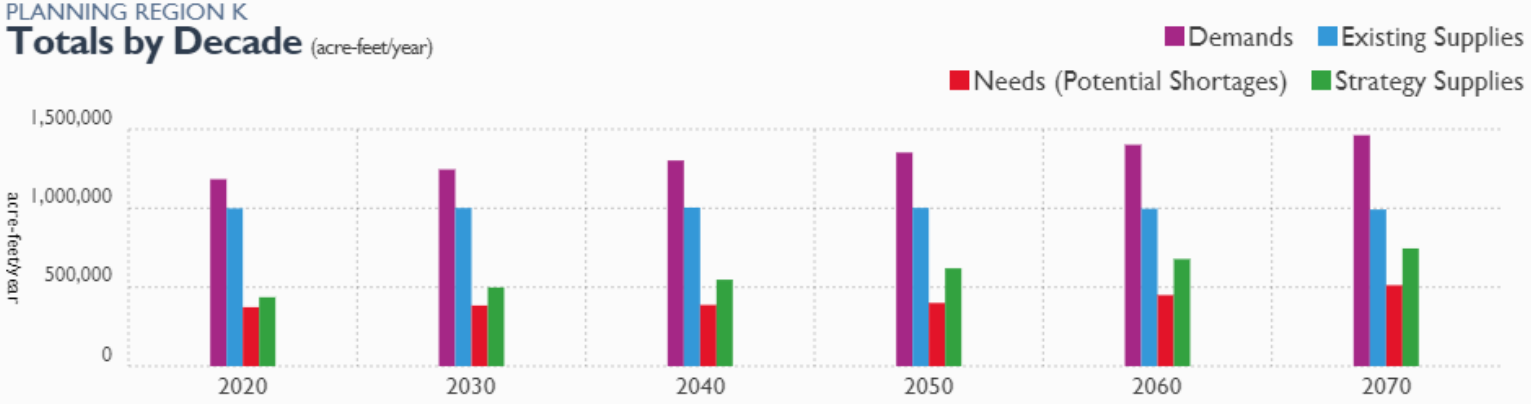


HIDE DATA TABLE

2020	2030	2040	2050	2060	2070
1,737,227	2,064,522	2,381,949	2,658,492	2,928,400	3,243,127

PLANNING REGION K

Totals by Decade (acre-feet/year)



	2020	2030	2040	2050	2060	2070
Demands	1,183,325	1,245,335	1,301,963	1,352,231	1,401,321	1,461,807
Existing Supplies	998,867	1,000,960	1,003,758	1,001,689	996,571	991,929
Needs (Potential Shortages)	373,563	383,821	387,321	400,009	449,699	512,304
Strategy Supplies	436,423	498,166	547,422	619,498	678,062	745,317

Table 5-16: Summary of LCRA Water Management Strategies (ac-ft/yr)

Recommended Strategy	2020	2030	2040	2050	2060	2070
Lane City Off-Channel Reservoir	90,000	90,000	90,000	90,000	90,000	90,000
Prairie Site Off-Channel Reservoir	0	18,000	18,000	18,000	18,000	18,000
Mid-Basin Off-Channel Reservoir	18,000	18,000	18,000	18,000	18,000	18,000
Excess Flows Permit (5731) Off-Channel Reservoir	15,257	15,543	15,830	16,117	16,404	16,691
Enhanced Municipal and Industrial Conservation	4,500	10,000	15,000	20,000	20,000	20,000
Development of New Groundwater - Onsite FPP	700	700	700	700	700	700
Development of New Groundwater - Offsite FPP	2,500	2,500	2,500	2,500	2,500	2,500
Expand Use of Groundwater - Carrizo-Wilcox aquifer	300	300	300	300	300	300
Downstream Return Flows	5,086	5,834	6,784	8,636	8,997	10,453
Acquire New Water Rights	250	250	250	250	250	250
Amendment of ROR Water Rights, including Garwood	N/A	N/A	N/A	N/A	N/A	N/A
New Firm Contracts	(2,877)	(14,154)	(19,154)	(22,154)	(28,654)	(33,654)
Firm Contract Amendments	(32,963)	(40,487)	(45,037)	(54,323)	(65,634)	(77,263)

5.3.1.3 Supplement Bay and Estuary Inflows with Brackish Groundwater

Brackish groundwater delivery to the Matagorda Bay Delta is considered as a potential water management strategy for the LCRA (wholesale water provider) to offset required releases from the Highland Lakes. By developing a new source to meet environmental needs, the firm supply normally released from the Highland Lakes to meet bay and estuary inflow requirements can remain in the Highland Lakes and become a firm supply for LCRA's existing and future customers. Equivalence of brackish groundwater to achieve the same effect as a volume of water released from the Highland Lakes would be a function of the brackish and groundwater total dissolved solids (TDS) values, the effectiveness of delivery directly to the lower marsh versus through the channel, and the amount of released water that reaches the Bay.

As part of its plan for growth, LCRA is considering brackish groundwater delivery for Bay & Estuary needs as a potential water source strategy in the 2016 Regional Water Plan. The strategy would consist of:

- Obtaining a permit from Coastal Plains GCD
- Developing a well field in the Matagorda Bay Delta with associated piping for discharge into the lower marsh.

A preliminary project concept sizes the well field supply with a capacity of 12,000 ac-ft/yr and a peak pumping capacity of 3,150 ac-ft per month could be potentially feasible, depending on results of future studies.

The infrastructure required for this strategy consists of:

- Twelve (12) brackish groundwater wells, depths up to 1,200 ft
- Simple Outfall Structure

Climate change in TEXAS

While climate change is often talked about in the future tense, our climate is already changing in both averages and the number and intensity of extremes. Texas has already experienced record-breaking temperatures, increased drought and flash flooding, and rapid sea level rise in recent years. As global temperatures continue to rise, Texas is expected to experience more heat waves, droughts, floods, sea level rise and intensified hurricanes. The Southern Climate Impacts Planning Program (SCIPP) is a climate hazards research program whose mission is to help Texas residents increase their resiliency and level of preparedness for weather extremes now and in the future.

Climate Change: Observations

Temperature

While "global warming" implies rising temperatures, climate change isn't quite that simple. In Texas, temperatures have increased in recent decades, but not as steadily as in the rest of the country.

In the last 20 years, temperature increases across Texas have ranged from 0.5° Fahrenheit in the northeast and 1.5 degrees in the southwest. Temperatures throughout the Great Plains have increased by 1.5 degrees since the 1960s (NCA).

Mosquito-borne illnesses, like Malaria and Dengue fever, spread in the southeast during the last decade as freezing days and annual frosts gradually decreased (CDC). Since 1990, Texas and the Great Plains have had only a few periods cold enough to kill large numbers of pests (NCA).

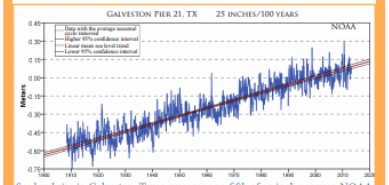
Exposure to excessive heat (temperatures 90 degrees or above) killed 150 people in Texas in 2011. In west Texas, there are now between 70-100 days over 90 degrees (NCA). Each year, heat waves kill more people than hurricanes, floods, tornadoes, blizzards, and lightning combined (CDC).

All of the environmental changes observed in the last 150 years resulted from a 2 degree global temperature rise. Temperatures in the southern Great Plains are projected to increase another 3-9 degrees by 2100 (NCA).

Sea Level Rise

Sea level rose 8 inches during the last century, inundating the Texas coastline, as a result of both sea level rise and subsidence. The current rate of erosion in Texas is now five times faster than the average rate of the last 4,000 years (Texas Sea Grant).

The Texas coastline is now eroding at an average rate of 2-10 feet per year, depending on local subsidence (CSC). Freeport is experiencing a sea level rise rate of 17 inches per 100 years, Rockport at 22 inches per 100 years, and Galveston (below) at 25 inches per 100 years, one of the highest sea level rise rates in the country (NOAA).



Sea level rise in Galveston, Texas averages one-fifth of an inch per year. NOAA

Quick Fact: Subsidence is a term used to describe what happens when land begins to sink or lose elevation as the result of natural and human processes (USGS).

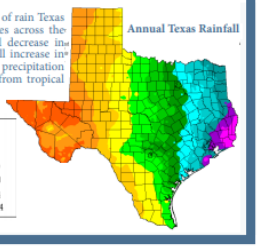
Precipitation

Precipitation across Texas varies each year but shows an overall rising trend. Summer and winter rainfall has increased and extreme precipitation events are becoming more frequent (NCA). Overall, precipitation totals have increased 10 percent in the last century.

Even though overall rainfall has increased across the state, mostly in eastern Texas, drought in west Texas is becoming more frequent, more severe, and lasting longer (NCA).

The most severe drought on record occurred in 2011. Texas received only 14.98 inches of rain across the state for the entire year, and 4,809 temperature records were broken. The drought resulted in $7.62 billion losses in agriculture (NOAA, FEMA).

Changes in the amount of rain Texas receives each year varies across the state - from an overall decrease in west Texas to an overall increase in east Texas. Much of the precipitation east Texas gets comes from tropical storms (NOAA).



To learn more, visit www.southernclimate.org

SCIPP

Overview

The models scientists use to project future climate change are extremely thorough, consider the unique geography and climate of every region, and look forward 25 and 100 years (NOAA).

In Texas, models project increased hurricane intensity and storm surge, continued sea level rise, and changes in rainfall that will likely create more periods of heavy precipitation between long dry spells.

Climate change acts as a threat-multiplier, loading the dice for more intense hurricanes, heat waves, floods, droughts, and extreme weather.

Droughts will likely become more frequent, last longer and be more intense. Rains following droughts will often be quick and heavy, causing flash-flooding and destroying aging and vulnerable infrastructure (NCA).

With more dry periods, higher temperatures and more lightning, large wildfires are expected to become more common (Price 2012, NCA).

Warmer ocean temperatures mean stronger hurricanes (NASA). A recent study suggests that hurricanes may become more frequent and more intense - meaning more category 4 and 5 hurricanes forming each year (Emanuel 2013, NCA). Storm surge is also expected to become more severe as sea level rises and hurricanes become more intense (NOAA).

Sea levels are expected to rise between 1 and 6 feet in the next century (NOAA).

Growing seasons will likely become longer, the types of plants that can survive in Texas will begin to change and precipitation events will become more intense causing more flooding of agricultural areas (USDA).

Q: How will climate change affect drought and water resources in Texas?

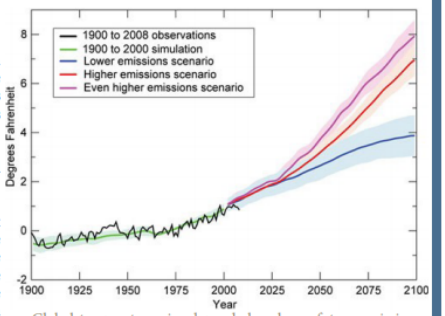
A: Rising temperatures and changing precipitation patterns are expected to cause more frequent and intense drought events, stressing water resources like the Ogallala aquifer. Extremes in precipitation will become more frequent and intense (USGS).

Temperature

Future temperature rise depends partly on the amount of greenhouse gasses added to the atmosphere in coming decades. Global temperatures are expected to increase another 3-12 degrees Fahrenheit by 2100 (IPCC).

Temperatures in the southern Great Plains are projected to increase another 3-9 degrees by 2100 (NCA).

The southern Great Plains experience about seven days per year above 100 degrees. These high temperatures are likely to occur much more frequently in the future – as much as four times more frequently. The impacts of such increases in extreme heat could include: increased evaporation from reservoirs, greater demand for air conditioning, and increases in the number of heat stress days (NCA).



Global temperature rise depends largely on future emissions scenarios, which range from low, 3°F increase, to high, 12°F or higher (IPCC).

Houston

Houston is the #1 municipal purchaser of green power in the United States (EPA). Houston has created a website (www.greenhoustontx.gov) to educate and help the public make Houston a "greener" city.

Austin

The EPA named Austin as a top 20 city for green power usage in the U.S. All power for city facilities comes from renewable energy, such as solar, hydro and wind power, and methane gas from landfills.

San Antonio

San Antonio is trying to promote sustainability and reduce the city's carbon footprint through solar arrays, recycling, efficient vehicles, bike and car sharing programs, and by declaring September as "Climate Change Awareness Month."

Dallas

Dallas is a leader in clean energy and climate change. A website (www.greendallas.net) helps educate the public on how to go green including the policies that have passed encouraging a greener Dallas.

Lubbock

A local news station in Lubbock has created a website to explain climate change, with suggestions and methods for becoming greener (KCBD 2013).

El Paso

El Paso has signed an agreement that urges federal and state government to reduce pollution 7% by 2012. It also states that the city will try to meet or exceed the goals of the Kyoto Protocol (City of El Paso Sustainability Program).

Sources: National Climate Assessment II and/or III (NCA)
United States Department of Agriculture (USDA)
National Oceanic and Atmospheric Administration (NOAA)
Federal Emergency Management Agency (FEMA)
U.S. Geological Survey (USGS)
Intergovernmental Panel on Climate Change (IPCC)

SCIPP

FOOD

Climate Change Could Make Beer Prices Double, Study Says

October 16, 2018 · 12:17 PM ET

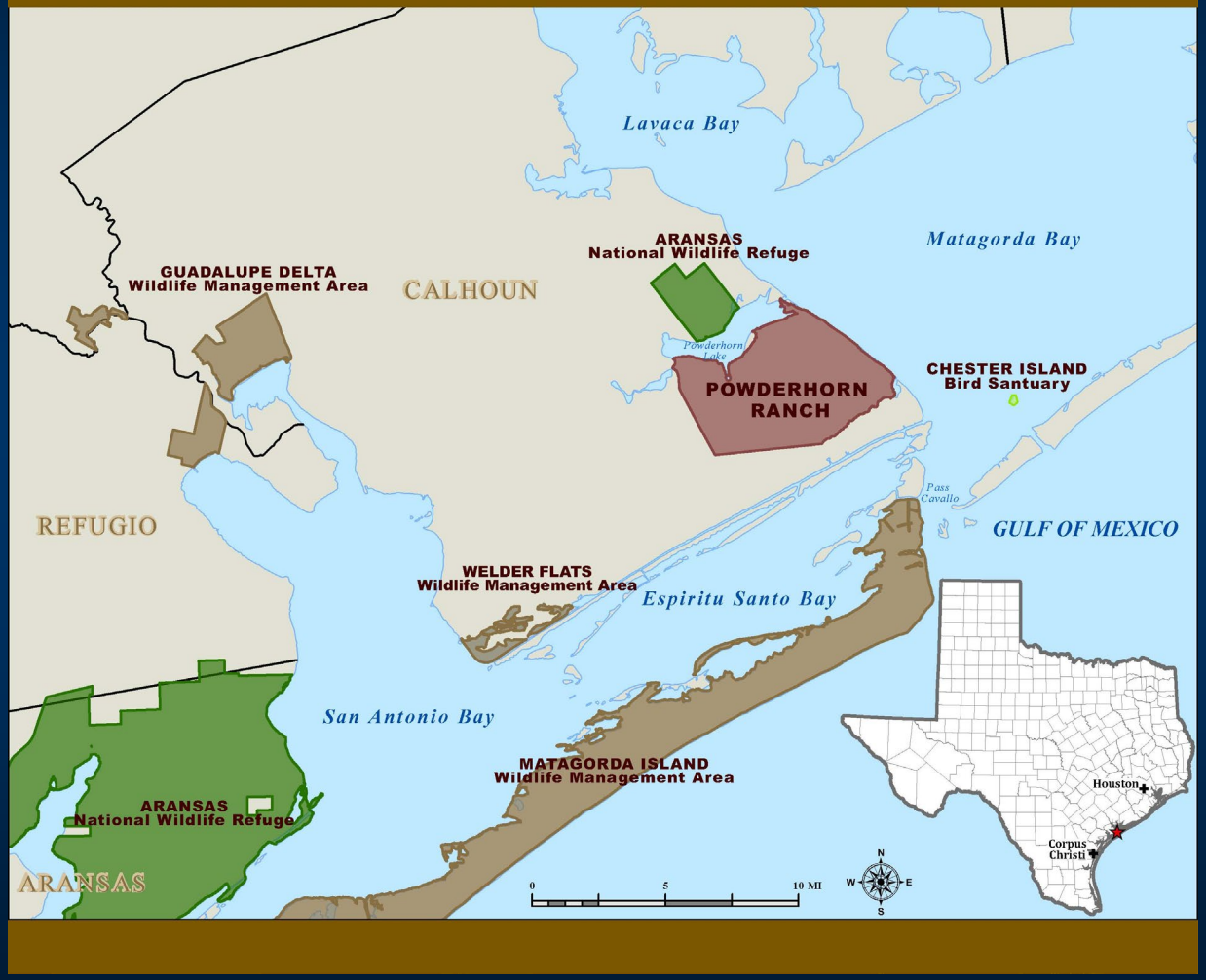
BILL CHAPPELL

The cost of a pint of beer could rise sharply in the U.S. and other countries because of increased risks from heat and drought, according to a new study that looks at climate change's possible effects on barley crops.

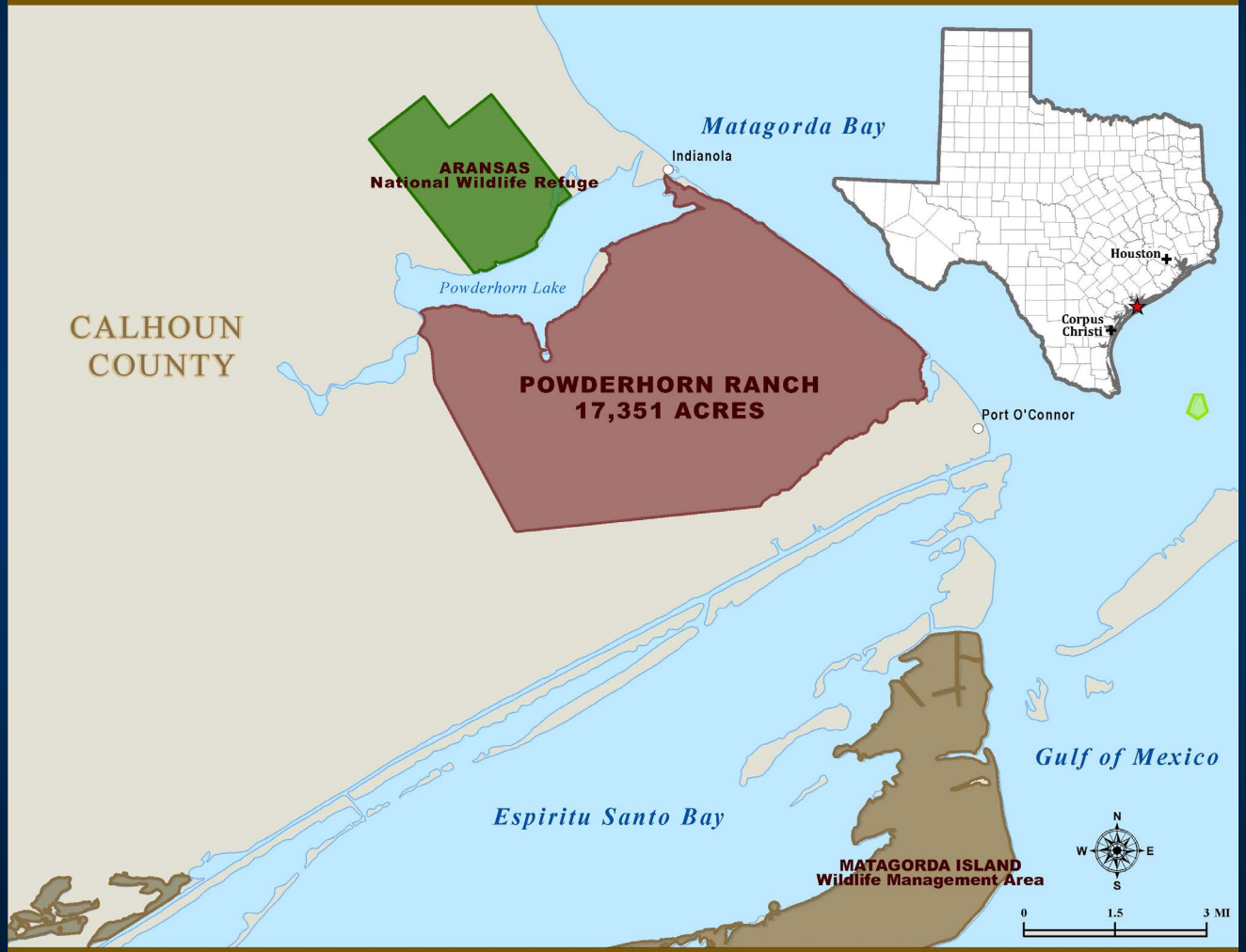
Peter Nicholls/Reuters

Powderhorn Ranch Acquisition

With Existing Texas Mid-Coast Conservation Areas



Powderhorn Ranch Acquisition



HB 51 Oyster Shell Planting

Noble Point Reef, Lavaca Bay

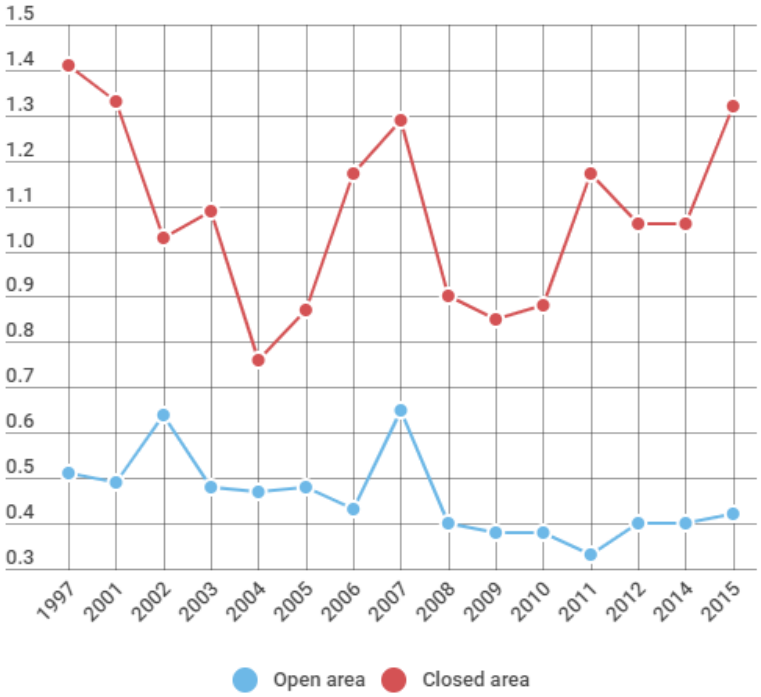
- Cumulative oyster shell planting has reached 3,323 cubic yards.

Galveston Bay
From Texas Living Waters Project

The EFIT Objective:

Develop an easy to use publicly available geospatial web application that identifies priority streamflow protection and restoration opportunity areas

Red drum mercury concentrations



The graph above shows average mercury concentrations at a Superfund Site in Calhoun County by milligrams per kilograms.

SOURCE: Environmental Protection Agency

Water Quality

SegID: 1501 **Tres Palacios Creek Tidal**
From the confluence with Tres Palacios Bay in Matagorda County to a point 1.6 km (1.0 mi) upstream of the confluence of Wilson Creek in Matagorda County

Impairment Description(s)	*Category*	*Year Segment First Listed*
bacteria (Recreation Use)	**5a**	**2006**
1501_01 From the confluence with Willow Dam Creek at Tres Palacios Bay/Turtle Bay upstream to a point 1.6 km (1.0 mile) upstream of the confluence of Wilson Creek in Matagorda County		

Impairment Description(s)	*Category*	*Year Segment First Listed*
depressed dissolved oxygen	**5b**	**1999**
1501_01 From the confluence with Willow Dam Creek at Tres Palacios Bay/Turtle Bay upstream to a point 1.6 km (1.0 mile) upstream of the confluence of Wilson Creek in Matagorda County		

SegID: 1602 **Lavaca River Above Tidal**
From a point 8.6 km (5.3 mi) downstream of US 59 in Jackson County to the confluence of Campbell Branch west of Hallettsville in Lavaca County

Impairment Description(s)	*Category*	*Year Segment First Listed*
bacteria (Recreation Use)	**5a**	**2008**
1602_03 Lower portion of segment from confluence with NHD RC 12100101002463 south of Edna in Jackson County upstream to confluence with Beard Branch		

SegID: 1602B **Rocky Creek**
Perennial stream from the confluence with the Lavaca River upstream to 2.9 km upstream of County Rd 364 north west of the City of Shiner

Impairment Description(s)	*Category*	*Year Segment First Listed*
bacteria (Recreation Use)	**5a**	**2014**
1602B_01 From the confluence of Lavaca River upstream to confluence of Ponton Creek		

SegID: 1602C **Lavaca River Above Campbell Branch**
From the confluence of Campbell Branch in Hallettsville to approximately 3.4 mi upstream of SH 95 in Lavaca Co.

Impairment Description(s)	*Category*	*Year Segment First Listed*
depressed dissolved oxygen	**5b**	**2014**
1602C_01 From confluence of Campbell Branch in Hallettsville upstream to the confluence of West Prong Lavaca River		
1602C_02 From confluence of West Prong Lavaca River to the headwaters approximately 6.5 km upstream of TX Hwy 95 in the City of Moulton		