Texas Clean Rivers Program

2015 Basin Highlights Report

Boat ramp leading into a dry O.C. Fisher Reservoir

A Characterization of Impaired Water Bodies in the Upper Colorado River Basin

May 29, 2015

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Introduction

About the Clean Rivers Program

The Texas Clean Rivers Program (CRP) provides a foundation for partnerships between the Texas Commission on Environmental Quality (TCEQ), river authorities, local governments, industries and citizens. The program began in 1991 to provide funding for water quality monitoring and comprehensive watershed management on a local level. TCEQ and CRP partners routinely collect water quality data from more than 1,800 sampling locations. TCEQ and others use the data from these sampling locations to establish wastewater permit limits and *Texas Surface Water Quality Standards*, and to evaluate water quality and establish priorities for corrective actions.

In the Colorado River basin, the Lower Colorado River Authority (LCRA) and Upper Colorado River Authority (UCRA) implement the program in their respective areas (Figure 1). Monitoring is performed by LCRA, UCRA, the city of Austin, TCEQ and the U.S. Geological Survey (USGS). Each agency collects and analyzes samples according to a Quality Assurance Protection Plan (QAPP), which ensures comparability.

Fig. 1 – Clean Rivers Program partner regions

Acronyms

ALU – aquatic life use
AU – assessment unit
BMP – best management practices
CAFO – concentrated animal feeding operation
COA – city of Austin
CRMWD – Colorado River Municipal Water District
CRP – Clean Rivers Program
EPA – Environmental Protection Agency
GIS – geographic information system
LCRA – Lower Colorado River Authority
mg/L – milligrams per liter (parts per million)
MGD – million gallons per day
MPN – most probable number
NLCD – National Land Cover Database
NPS – nonpoint-source pollution
QAPP – Quality Assurance Project Plan
RRC – Railroad Commission of Texas
RUAA – Recreational Use Attainability Analysis
SWCD – soil and water conservation district
SWQM – surface water quality monitoring
TCEQ – Texas Commission on Environmental Quality
TDA – Texas Department of Agriculture
TDS – total dissolved solids
TLAP – Texas Land Application Permit
TMDL – Total Maximum Daily Load
UAA – Use Attainability Analysis
UCRA – Upper Colorado River Authority
USDA – United States Department of Agriculture
WPP – watershed protection plan
WWTP – wastewater treatment plant
µg/L – microgram per liter

Rationale for the 2015 Basin Highlights Report

Every two years, TCEQ compares all available quality assured data to the *Texas Surface Water Quality Standards* and publishes the results in the *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*. On December 19, 2014, TCEQ posted the Draft 2014 Integrated Report on its website for public comment. The report identified 25 impaired water bodies in the Colorado River basin (Table 1).

The 2015 Basin Highlights Report characterizes impaired water bodies identified in the 2014 Integrated Report based on data, land use and communication with monitoring personnel and local stakeholders. The watershed characterizations will help prioritize monitoring efforts and restorative measures for impaired water bodies in the basin. The report focuses on impairments upstream of Austin. The 2016 Basin Highlights Report will focus on impaired waters in Austin and the lower river basin.

Water bodies are organized by segment number. The following headings are included for each water body:

- Segment description – Describes the geographic units based on *Texas Surface Water Quality Standards* and the assessment units (AU) and monitoring sites within each segment.
- Land use – A description of the land surrounding the impaired segment based on USGS National Land Cover Database (NLCD) aerial imagery and knowledge of the area.
- Impairment description – Identifies the reason the water body is impaired and when it first appeared on the 303(d) List. It includes number of samples, parameter(s) of concern or impairment, assessment results and the designated state water quality standard for comparison.
- Potential causes of impairment – Identifies possible causes of the impairment based on land use, communication with monitors, agency staff and CRP water quality advisory committee members.
- Potential stakeholders – Lists companies, agencies or organizations that have a vested interest in the impairment and that may serve as stakeholders.
- Actions taken – Identifies actions taken by TCEQ or CRP partners since the water body was first placed on the 303(d) List.
- Recommendations – Proposed next step(s) to help the water body attain *Texas Surface Water Quality Standards*.
- Maps – Maps and aerial imagery that define land uses, segments and other boundaries, monitoring sites, permitted discharges and Texas land application permits (TLAPs).

Table 1 Impaired Water Bodies in the Colorado River Basin (Based on the Draft 2014 Integrated Report)

CRP Agency	Watershed	Segment	Water Body	County	Parameter(s)	Year Listed	Category	Actions Taken
Upper Colorado River Authority	Upper	1411	E.V. Spence Reservoir	Coke	Chloride	2014	5C	None - new listing
					Sulfate	2000	4a	EPA approved a TMDL in 2003. Implementation is ongoing.
					TDS	2000	4a	
		1412	Colorado River below Lake J.B. Thomas	Mitchell and Howard	Bacteria	2008	5c	Maintain monitoring
		1412B	Beals Creek	Howard	Bacteria	2010	5b	High salinity levels prevent proper analysis of bacteria
		1413	Lake J.B. Thomas	Borden and Scurry	Chloride	2008	5b	Standards for chloride, sulfate and TDS were revised during the 2010 Surface Water Quality Standard Revisions. The Revisions are pending approval by EPA.
					Sulfate	2012	5b	
					TDS	2010	5b	
		1426	Colorado River below E.V. Spence Reservoir	Coke	Chlroide	2014	4a	The segment was on the 303(d) List as recently as 2010 but met surface water quality standards in the 2012 assessment. The draft 2014 Integrated Report found it to be impaired again. Because of previous impairments, it was categorized as 4a.
					TDS	2000	4a	EPA approved a TMDL in 2007. Implementation is ongoing.
	Concho River	1421	Concho River	Concho and Tom Green	Dissolved oxygen	2008	5c	A watershed protection plan was completed in 2011 and is pending EPA approval.
					bacteria	2008	5c	
		1425	O.C. Fisher Lake	Tom Green	Chloride	2014	5c	None - new listing
					TDS	2014	5c	None - new listing
	Lake Buchanan	1416A	Brady Creek	McCullough	Dissolved oxygen	2004	5c	A watershed protection plan report was submitted Sept. 2014.
Lower Colorado River Authority		1416	San Saba River	San Saba and Mills	Bacteria	2008	5c	Additional monitoring is being performed to determine spatial distribution of bacteria.
	Pecan Bayou	1432	Upper Pecan Bayou	Brown	Bacteria	2014	5c	None - new listing
		1431	Mid Pecan Bayou	Brown	Bacteria	2006	5b	A recreational use attainability analysis is pending TCEQ approval.
	Lake LBJ	1407A	Clear Creek	Burnet	Zn in water	2014	5c	None - new listing
					Ni in water	2014	5c	None - new listing
					Al in water	2010	5c	On-site remediation and monitoring of source pollutants is ongoing.
					Sulfate	2010	5c	
					TDS	2010	5c	
					pH	2010	5c	

Table 1 Impaired Water Bodies in the Colorado River Basin (Based on the Draft 2014 Integrated Report)

CRP Agency	Watershed	Segment	Water Body	County	Parameter(s)	Year Listed	Category	Actions Taken
Lower Colorado River Authority	Austin	1403	Lake Austin	Travis	Dissolved oxygen	1996	5c	TCEQ adopted a TMDL in 2000. Verification monitoring is ongoing.
		1428C	Gilleland Creek	Travis and Bastrop	Bacteria	2004	4a	EPA approved a TMDL in 2009. Implementation is ongoing.
	Coastal	1501	Tres Palacios Creek (Tidal)	Matagorda	Dissolved oxygen	1999	5b	A use attainability analysis was completed in 2008 and is under review by TCEQ.
					Bacteria	2006	5c	Maintain monitoring
		1402	Colorado River	Wharton	Bacteria	2014	5c	None - new listing
		1402C	Buckners Creek	Fayette	Dissolved oxygen	2010	5c	A special study was discussed at the 2014 coordinated monitoring meeting.
		1402H	Skull Creek	Colorado	Dissolved oxygen	2008	5b	Aquatic life monitoring was completed in 2010. TCEQ proposed changes to the surface water quality standards as part of the 2014 revisions. Monitoring is ongoing.
	Austin	1427	Onion Creek	Hays	Sulfate	2014	5c	None - new listing
City of Austin		1427A	Slaughter Creek	Travis	Impaired benthics	2002	5b	TCEQ plans a use attainability analysis once the drought is over and base flows resume
		1403A	Bull Creek	Travis	Dissolved oxygen	2010	5c	Monitoring frequency increased
		1403J	Spicewood tributary to Shoal Creek	Travis	Bacteria	2002	5a	TMDL development underway
		1403K	Taylor Slough South	Travis	Bacteria	2002	5a	TMDL development underway
		1428B	Walnut Creek	Travis	Bacteria	2006	5a	TMDL development underway
		1429C	Waller Creek	Travis	Impaired benthics	2002	5c	Monitoring postponed until construction of Waller Tunnel is complete
					Bacteria	2004	5a	TMDL development underway

Category 4a - A TMDL has been completed and approved by EPA

Category 5a - A TMDL is underway or being planned.

Category 5b - A review of surface water quality standards will be conducted before a TMDL is scheduled.

Category 5c - Additional data and information will be collected before a TMDL is scheduled.

Restoring Impaired Water Bodies

In 2010, TCEQ developed watershed action planning to help identify and prioritize watershed restoration projects for impaired water bodies. As part of the watershed action planning process, stakeholders and monitoring agencies provide input about local water quality problems. Information about potential sources of pollution, geographic factors in the watershed and community interest is stored in a database and used to implement water quality protection strategies described below.

Total Maximum Daily Load

The first step toward restoration is to determine the source(s) of pollution. One way to determine the source is to develop a scientific model called a total maximum daily load (TMDL). A TMDL study involves a historical water quality data review, targeted monitoring, detailed water quality analysis, and the amount or "load" of a pollutant that a water body can receive and still support its designated uses. Once the load is determined among all potential sources of pollution, an implementation plan outlines strategies to reduce pollutant loads.

Watershed Protection Plan

A watershed protection plan (WPP) is another way to restore impaired water bodies. Unlike the TMDL, a WPP is nonregulatory. Stakeholders drive a WPP to address causes of the identified impairments. Similar to a TMDL, a WPP uses monitoring data and local input to outline strategies that reduce pollutant loads.

Use Attainability Analysis

Another option for addressing impaired water bodies is a use attainability analysis (UAA). While a TMDL and WPP are designed to improve water quality by limiting pollutants, a UAA is designed to evaluate *Texas Surface Water Quality Standards* and, if appropriate, establish new standards. Similarly, a Recreational Use Attainability Analysis (RUAA) is a study that confirms the level of recreation that takes place in a waterway.

Segment 1407A: Clear Creek **Impairment: pH, TDS, sulfate, aluminum, zinc and nickel in water**

Segment Description

The Clear Creek watershed, located on the northeast side of Inks Lake in Burnet County (Figure 2), is approximately 13 square miles. The creek is about 4.5 miles long, beginning at the confluence with Inks Lake upstream to FM 2341. LCRA monitors Clear Creek at Site 18710.

Land Use

The Clear Creek watershed is rural and comprised mostly of undeveloped, forested land and brush (Figure 3 and Figure 4). A tailings pile from an abandoned graphite mine is the source of impairments. Southwestern Graphite began mining operations at the current Greensmiths Inc. site in 1915. The facility produced and refined graphite ore intermittently between 1915 and 1978. Mining stopped in 1978, but Southwestern Graphite continued to process imported ore at the site until the late 1980s. The process required using water from the Colorado River, and later from Inks Lake. After using the water to float graphite from the ore, Southwestern Graphite treated the water and discharged it into Clear Creek where it flowed back into Inks Lake. The parent material from which the graphite was extracted now sits in a 23-acre tailings pile on the bank of Clear Creek. In 2000, Greensmiths Inc. purchased the facility and began using reclaimed tailings materials as a soil amendment to landscape golf courses.

Impairment Description

TCEQ placed Clear Creek on the 2010 303(d) List for not supporting general and aquatic life uses. Data collected from Site 18710, about 1.5 miles downstream of the tailings pile (Figure 5), exceeded criteria for pH, total dissolved solids (TDS), sulfate and aluminum in water. In 2014, data indicated high levels of zinc and nickel in water, and those constituents were added to the Draft 2014 303(d) List (Table 2).

Table 2 – Parameters causing the impairment in Clear Creek

Parameter	Number of samples assessed	Number of times criteria was exceeded	Criteria	Mean results
pH	35	27	6.5	NA
TDS (mg/L)	35	NA*	600 (mg/L)	1,158 (mg/L)
Sulfate (mg/L)	33	NA*	100 (mg/L)	1,132 (mg/L)

Aluminum in water (acute)	15	8	991 (µg/L)	18,951 (µg/L)
Zinc in water (chronic)	15	NA	194 (µg/L)	225 (µg/L)
Nickel in water (chronic)	21	NA	85 (µg/L)	110 (µg/L)

*Averages are assessed. Individual data points are not compared to criteria.

Cause of Impairment

Runoff from the tailings pile creates acidic leachate that drains into the creek. The leachate enhances dissolution of heavy metals.

Actions Taken

- In 2004, LCRA worked with TCEQ and Greensmiths Inc. to help secure a permit that would treat leachate onsite and eliminate discharges to the stream.
- In 2007, LCRA established a water quality monitoring site on Clear Creek. Site 18710 is about 1.5 miles downstream of Greensmiths Inc.
- In 2010, Greensmiths Inc. engineered an industrial disposal plan to allow onsite treatment and eliminate discharges to the stream. LCRA reviewed and commented on the application for an industrial disposal permit from TCEQ.
- TCEQ issued a no-discharge permit in December 2010.
- A TCEQ inspection in July 2012 resulted in an enforcement order for unauthorized discharge. The order remains open and a TCEQ inspection is scheduled for spring 2015.

Potential Stakeholders

- Greensmiths Inc.
- LCRA
- TCEQ

Recommendations

- Continue regular inspections of the Greensmiths Inc. facility.
- Continue monitoring at Site 18710.

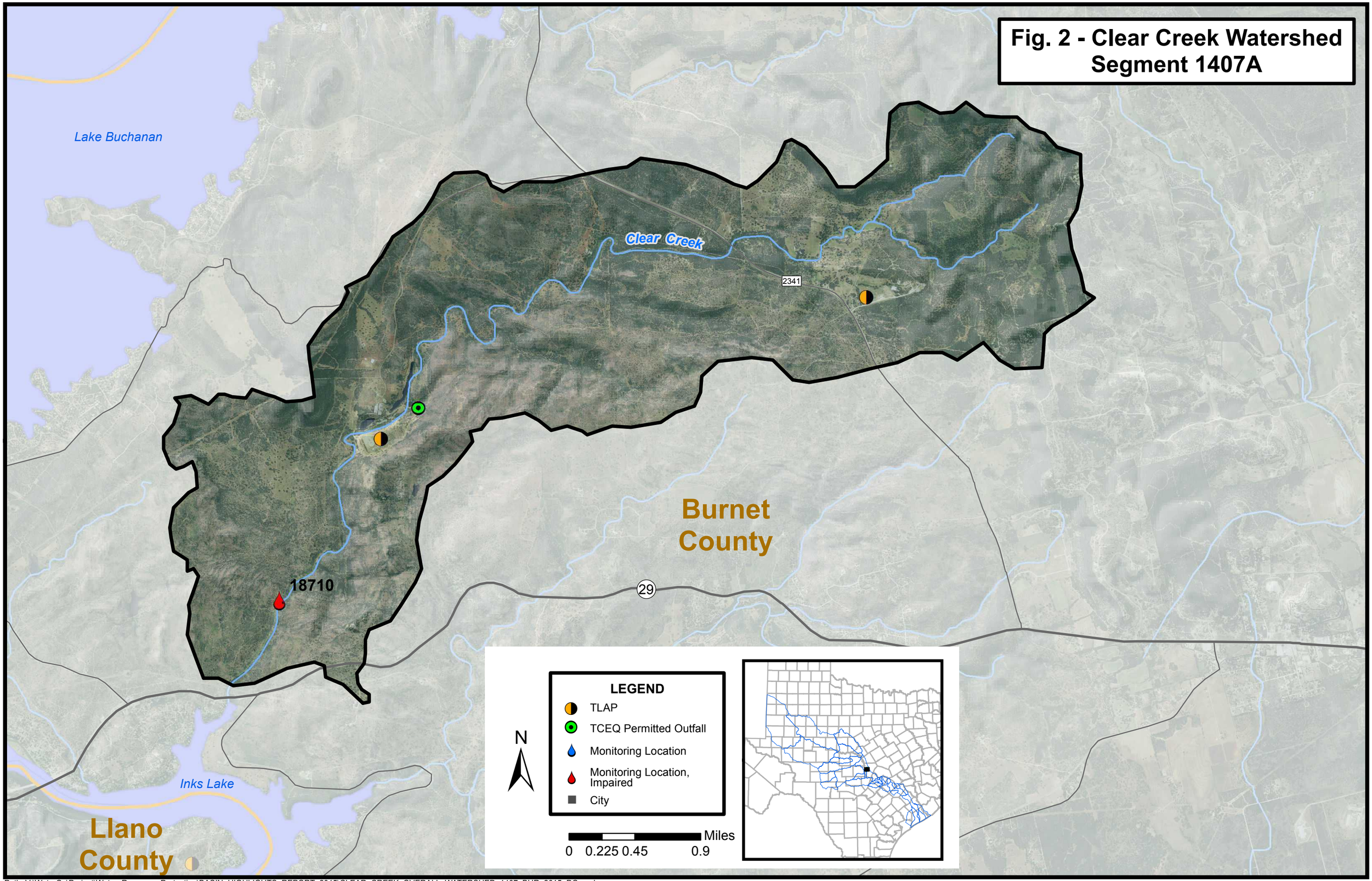

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Fig. 3 - Clear Creek Watershed Segment 1407A Land Use/Cover

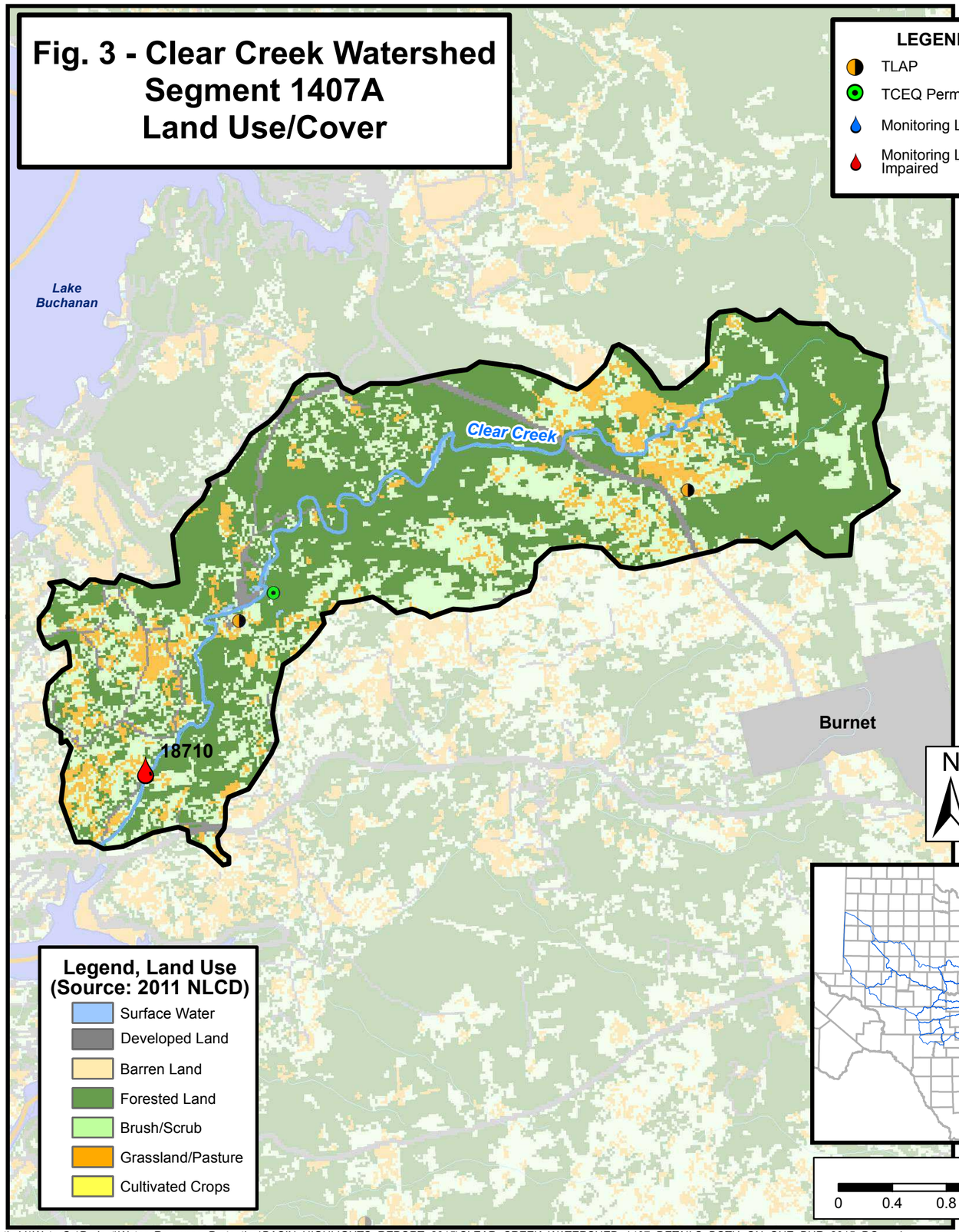
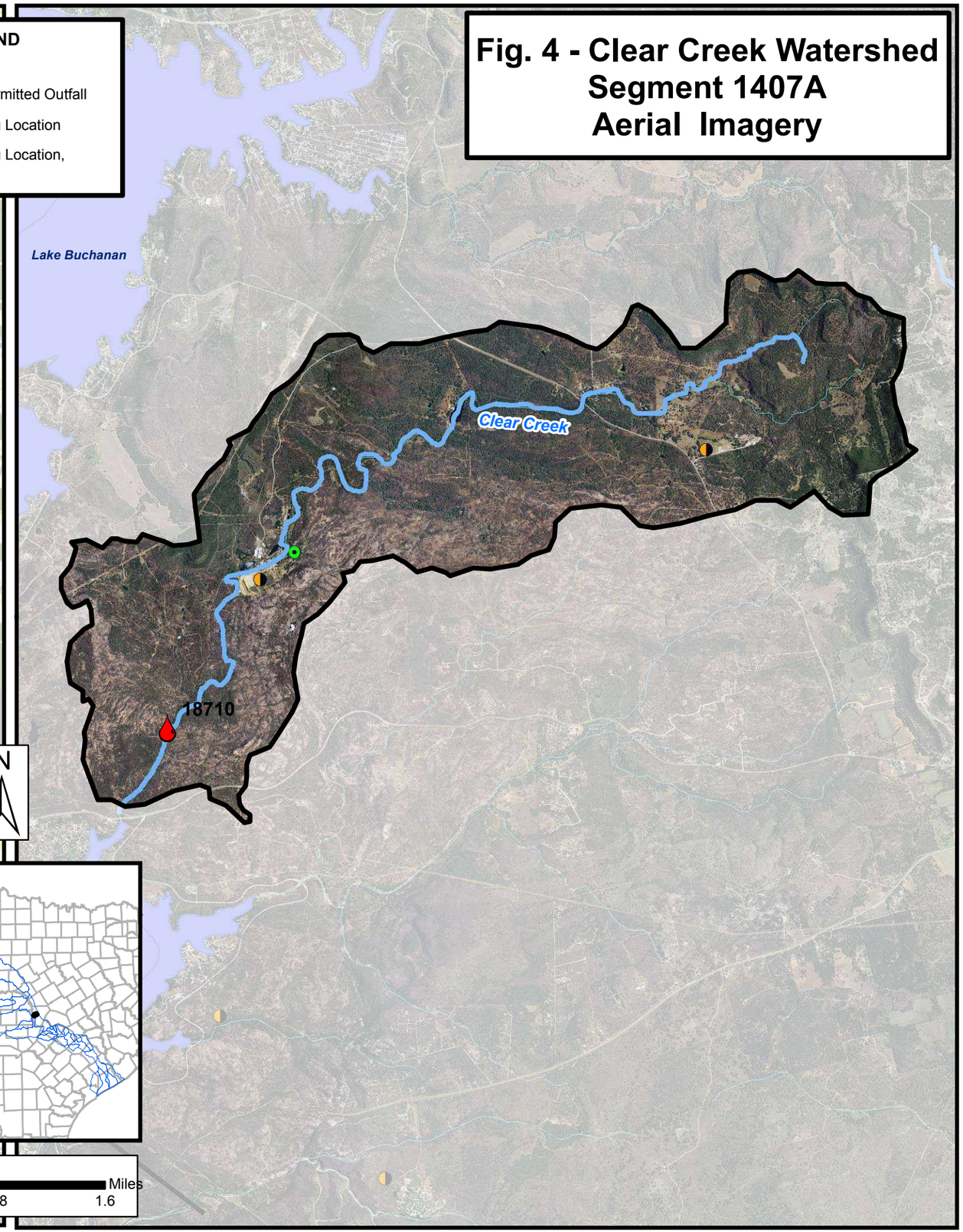


Fig. 4 - Clear Creek Watershed Segment 1407A Aerial Imagery



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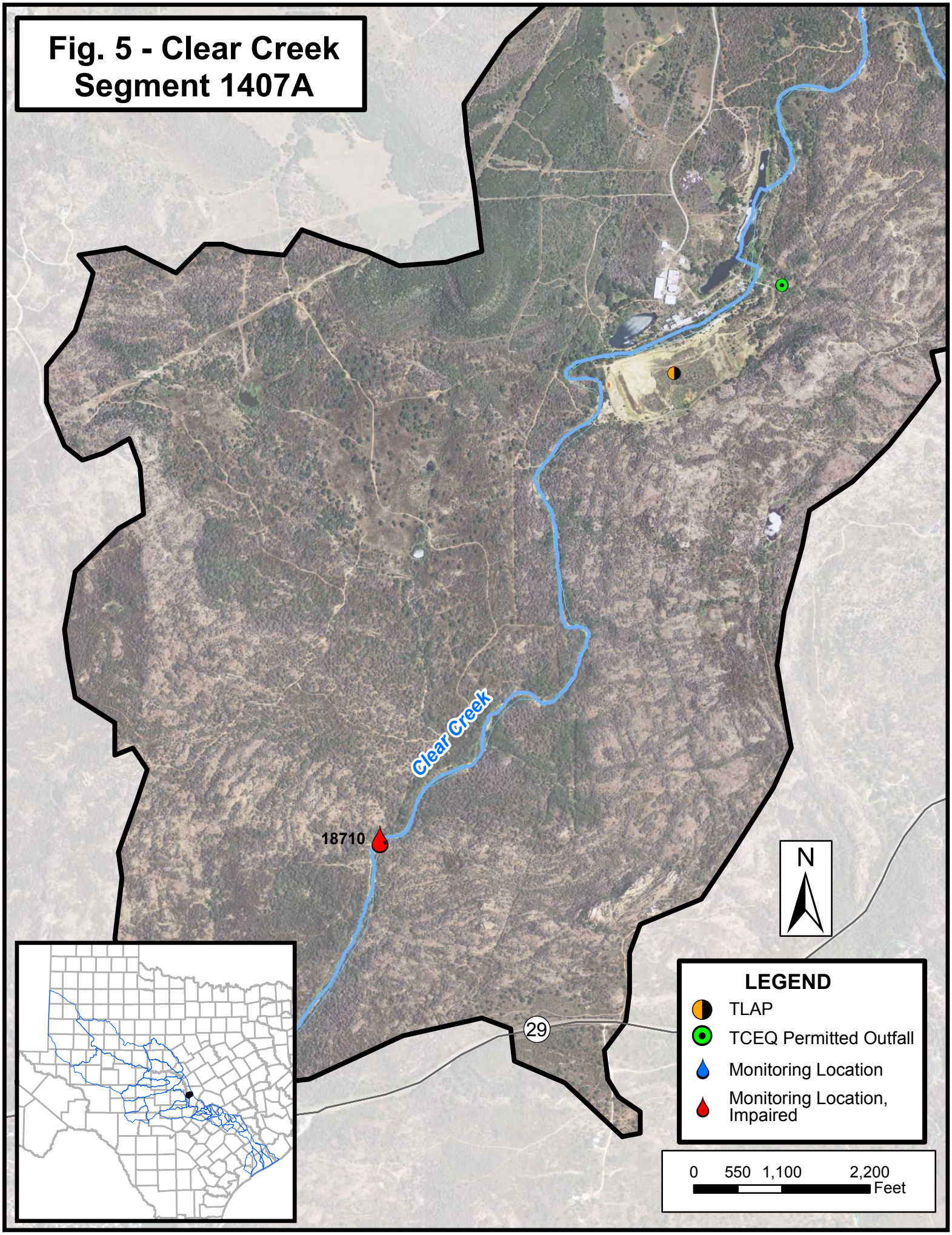

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Segment 1411: E.V. Spence Reservoir Impairment: Chloride, sulfate and TDS

Segment Description

Segment 1411 is located in the upper Colorado River watershed immediately west of the city of Robert Lee (Figure 6). The watershed begins at Robert Lee Dam on the Colorado River and continues upstream to the confluence of Little Silver Creek in Coke County. The reservoir encompasses approximately 14,640 acres and has a conservation storage capacity of 512,272 acre-feet. During the reporting period, the reservoir contained less than 10 percent of capacity (Figure 9). TCEQ monitored the reservoir at the following sites during the reporting period:

13863 – E.V. Spence Reservoir at dam.
12359 – E.V. Spence Reservoir approximately 5.3 kilometers west of State Highway 208.
12360 – E.V. Spence Reservoir at the FM 2059 bridge near Silver, Texas.

Land Use

The majority of land in the contributing drainage area is characterized by pasture land and scrub vegetation (Figure 7). Oil and gas production is prevalent in the watershed.

Impairment Description

E.V. Spence Reservoir was first placed on the 303(d) List in 2000 due to elevated sulfate and TDS levels. The TCEQ predecessor agency, Texas Natural Resource Conservation Commission adopted a TMDL in 2001, and the Environmental Protection Agency (EPA) approved it in 2003. Sulfate and TDS remained high in subsequent assessments. According to the 2014 Integrated Report, sulfate averaged 793 mg/L and TDS averaged 3,054 mg/L for criteria that are 450 and 1,500 mg/L, respectively. Chloride was listed for the first time in 2014 with a mean of 1,153 mg/L, surpassing the criterion of 950 mg/L.

The reservoir is divided into two assessment units: AU 01 extends from the dam upstream to the Rough Creek arm, and AU 02 extends from the Rough Creek arm of the reservoir upstream to the confluence of Little Silver Creek. The entire segment is impaired because general use constituents are averaged for all assessment units during assessment.

Potential Causes of Impairments

<u>Point Sources</u>

- The cities of Big Spring and Snyder discharge treated wastewater effluent into tributaries far upstream of E.V. Spence Reservoir. They are not a likely major source of salt constituents into the reservoir.

Nonpoint Pollution Sources

- Leaking oil wells.
- Former brine disposal pits.
- Produced brine injection wells.
- Brine leached in the groundwater from an abandoned magnesium plant.
- Mineral dissolution of naturally occurring shallow geological formations.
- Saltcedar transports salts from groundwater to leaves, which then concentrate salts at the surface of the soil when leaves drop each year.

Action Taken

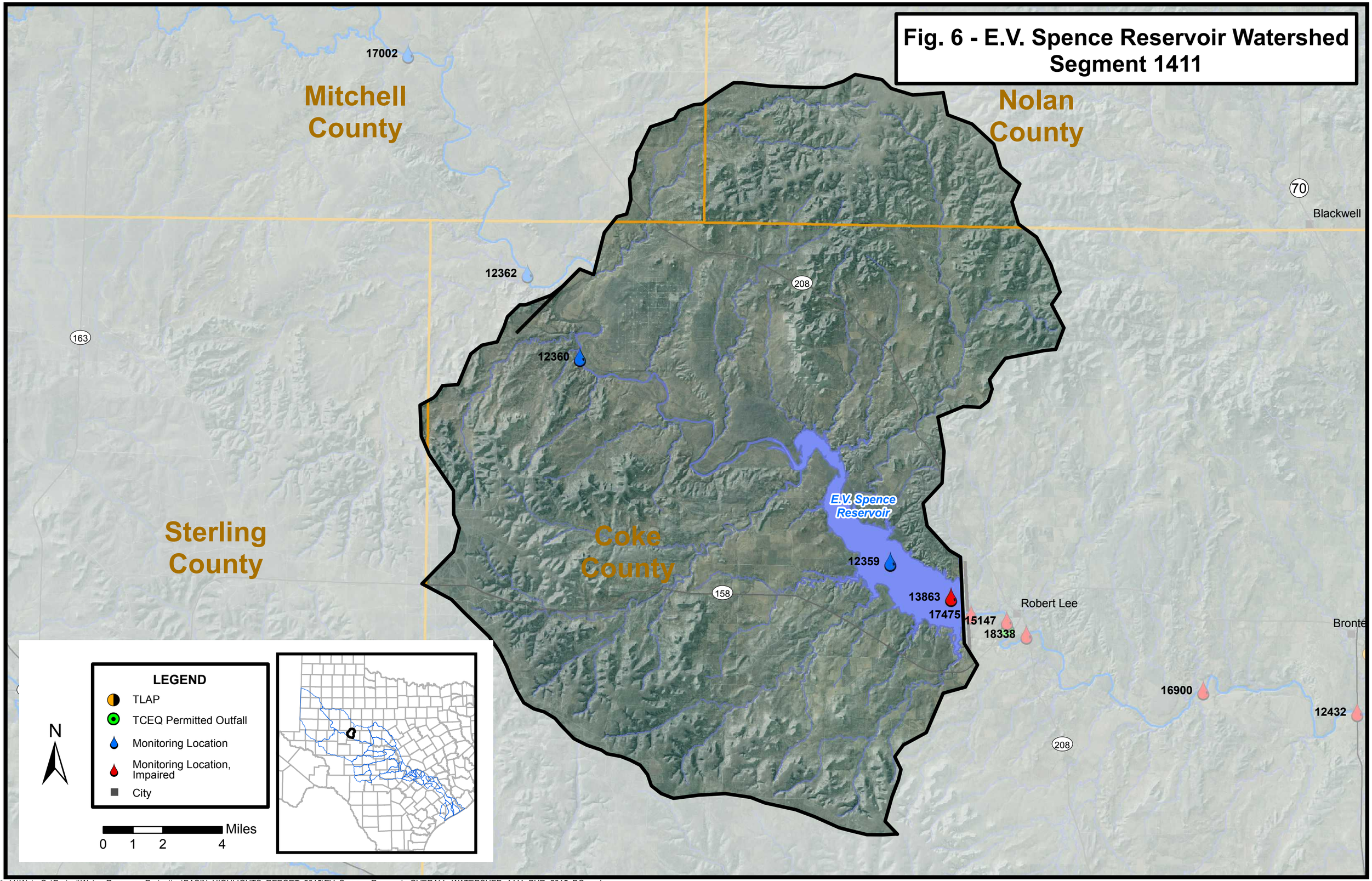
- The Texas Railroad Commission (RRC) drilled monitoring wells up-gradient and down-gradient of known seeps in the watershed to investigate the impact on surface water. They have plugged over 180 wells in Runnels and Coke counties, many upstream of E.V Spence Reservoir.
- Since EPA approval in 2003, TCEQ has been carrying out the TMDL Implementation Plan, including water quality modeling.
- Saltcedar eradication programs in the watershed include aerial application of herbicide and biological treatment through the introduction of saltcedar leaf beetles.

Potential Stakeholders

- TCEQ
- RRC
- Colorado River Municipal Water District (CRMWD)
- Texas State Soil and Water Conservation Board
- UCRA
- Oil and Gas Operators
- Agricultural Interests

Recommendations

- Continue to identify and plug abandoned or leaking oil and gas wells.
- Continue the introduction of saltcedar leaf beetles.
- Seek funding mechanisms for further implementation of best management practices (BMPs) identified by the RRC.
- Continue routine surface water quality monitoring.



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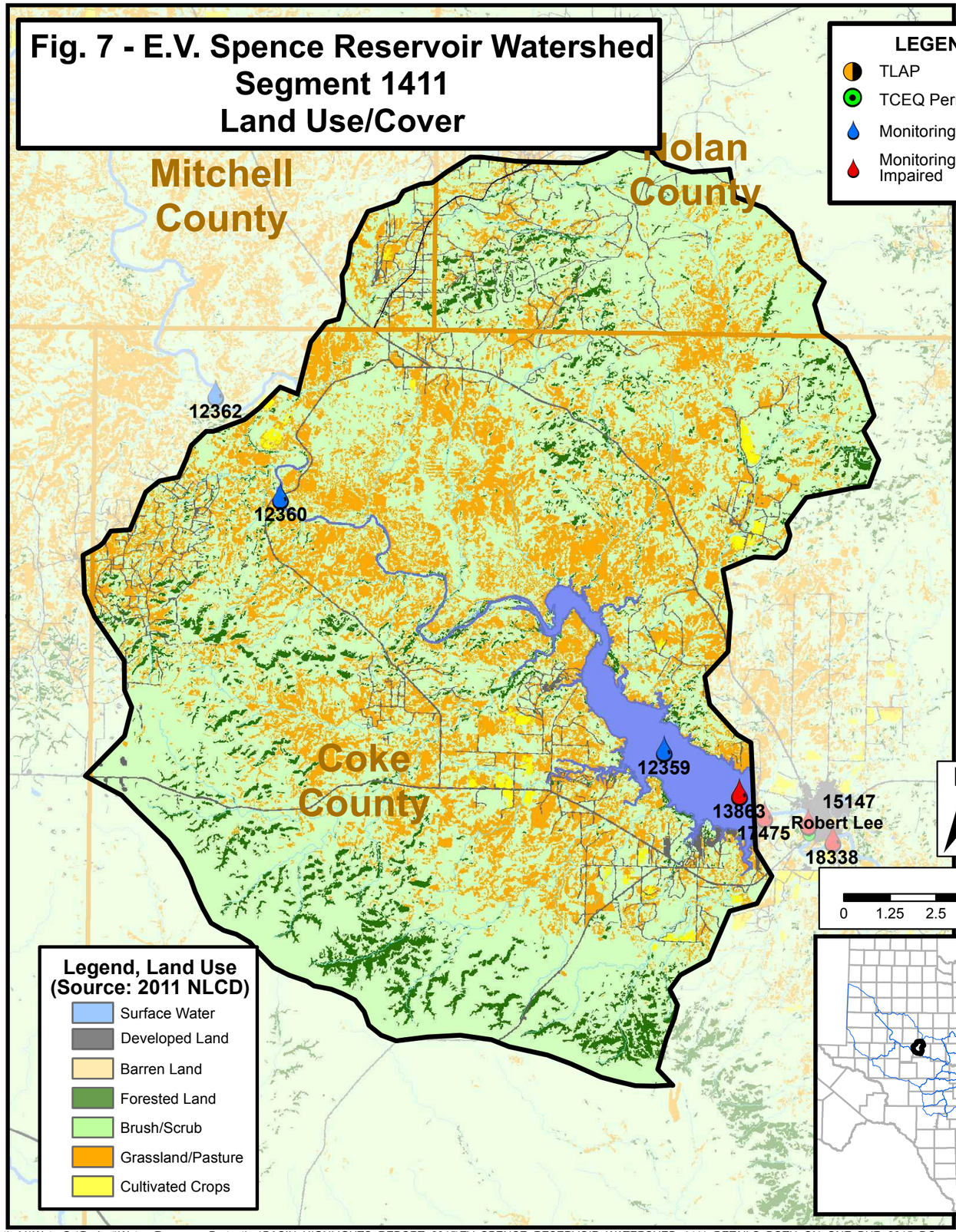

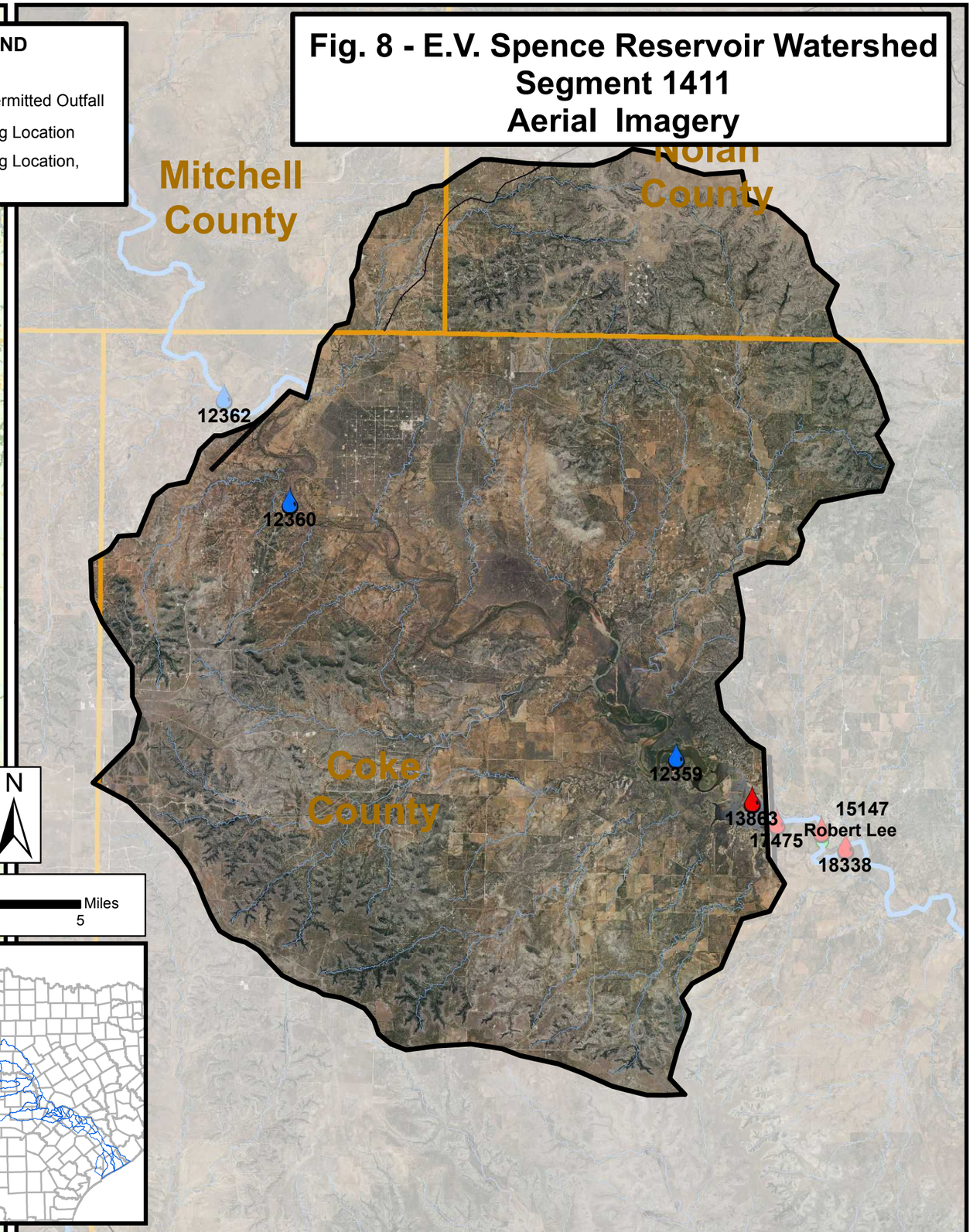

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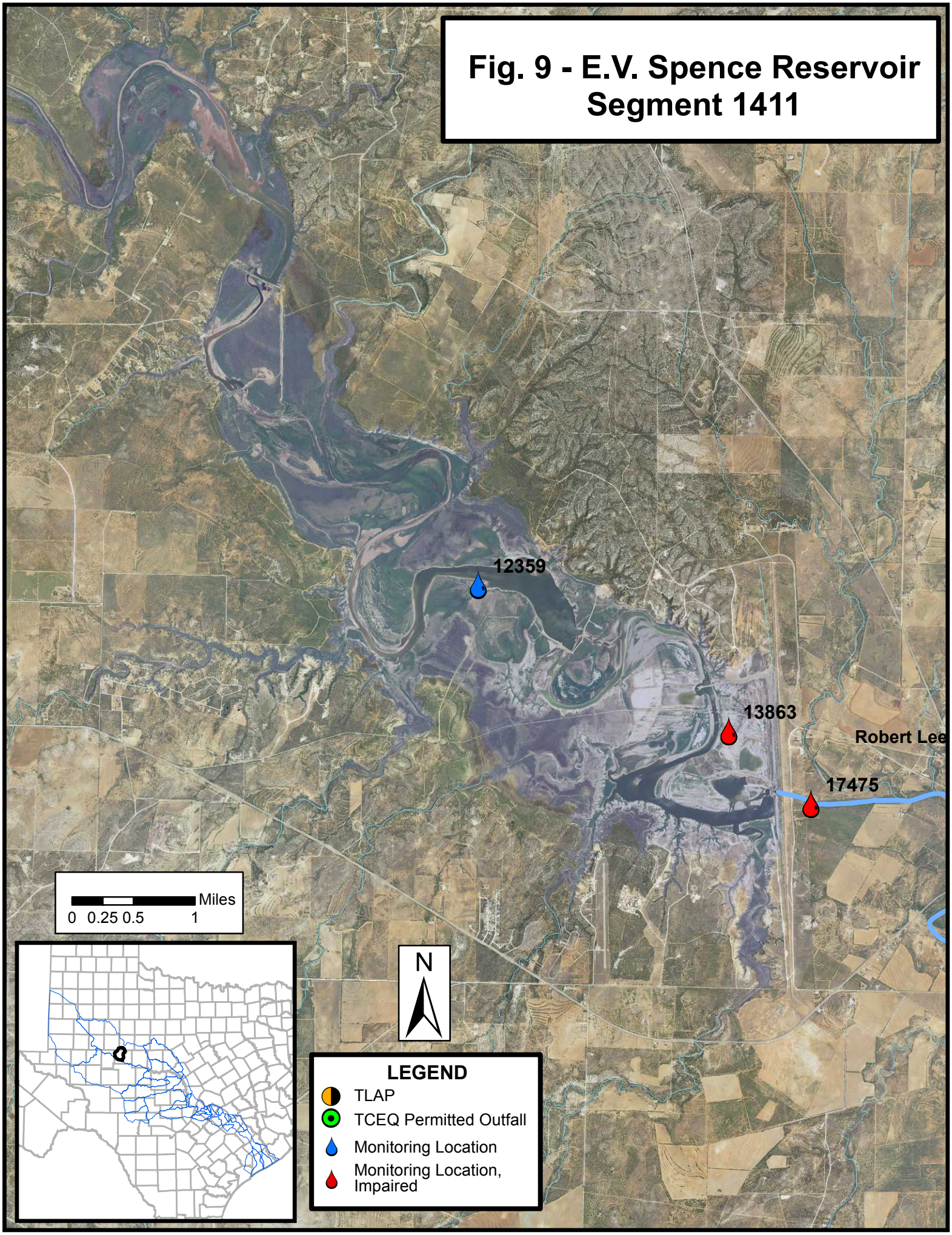

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Segment 1412: Colorado River below Lake J.B. Thomas **Impairment: Bacteria**

Segment Description

Segment 1412 is located in the upper Colorado River watershed (Figure 10). It begins from a point immediately upstream of the confluence with Little Silver Creek in Coke County and continues upstream to J. B. Thomas Dam. It is about 99 miles long. TCEQ monitored the river at the following sites during the period of record:

12362 – Colorado River 4.7 miles west of Silverado.
17002 – Colorado River at Mitchell CR 343.
12363 – Colorado River at State Highway 163.
12364 – Colorado River upstream of Interstate Highway 20.
12365 – Colorado River at FM 1808.
17003 – Colorado River at FM 2835.
12366 – Colorado at State Highway 350.

Land Use

The watershed consists mainly of pastures, brush and cultivated land (Figure 11). Colorado City has a population of 4,000 and is located just upstream of monitoring site 12363, but there are no direct discharges or land application permits immediately upstream of the site.

Impairment Description

The impaired AU, 1412_02 begins at the Colorado River's confluence with Beals Creek and continues upstream to a point above Colorado City (Figure 12). Data responsible for the listing are from Site 12363.

TCEQ placed Segment 1412 on the 2008 303(d) List for not supporting contact recreation due to elevated *E. coli* bacteria levels. As part of the 2010 *Texas Surface Water Quality Standards* revisions, TCEQ identified *Enterococcus* as more appropriate indicator bacteria for Segment 1412 and other inland saline waters.

In 2014, TCEQ began assessing *Enterococcus* data and assessed three samples. The geometric mean was 114 MPN, exceeding the criteria of 33 MPN. It is unusual to list a water body with only three samples, but the *E. coli*-based impairment from previous assessments justified continuing the listing.

In addition to the bacteria impairment, TCEQ identified low dissolved oxygen levels and high chlorophyll-*a* levels as a concern in the Draft 2014 Integrated Report. Depressed dissolved oxygen concentrations likely are associated with low-flow conditions.

Potential Causes of Impairment

Point Sources

There are no permitted discharges. Colorado City, which is located near the monitoring site, land-applies wastewater effluent downstream of site 12363.

Nonpoint Sources

- Much of the contributing watershed for this segment consists of rangeland used for cattle grazing and may be a source of bacteria.
- In Colorado City, homes and businesses are located along the Colorado River. Failing wastewater lines or inadequate septic systems may be sources of bacteria.
- The western portion of Colorado City drains toward Site 12363. Runoff from precipitation events may be sources of bacteria. However, consistently high *E. coli* levels collected at the site indicate something more than stormwater.
- A superfund site, the former Col-Tex Refinery, is located about 1 mile upstream of the monitoring site. Remediation of organic chemicals at the refinery is ongoing, but it is not a likely source of bacteria.

About 4 miles upstream of the site, CRMWD operates a pump station that diverts water from the river. The diversion into an off-channel reservoir helps maintain downstream water quality. It is located upstream of the superfund site and Colorado City, indicating the bacteria is from local sources.

Actions Taken

Sampling and analysis of *Enterococcus* is problematic in remote areas. Bacteria samples are no longer collected as part of routine monitoring in segment 1412 because there are no certified laboratories close to the monitoring site and holding time limitations prevent timely analysis of bacteriological samples. The segment will remain on the 303(d) List for the foreseeable future.

Potential Stakeholders

- City of Colorado City
- CRMWD
- TCEQ
- Texas State Soil and Water Conservation Board
- Texas AgriLife Extension
- UCRA

Recommendations

- Communicate with TCEQ or Texas State Soil and Water Conservation Board to determine if the stream is a candidate for an RUAA.
- Find an accredited lab close enough to receive samples within holding time so bacteria sampling can resume.

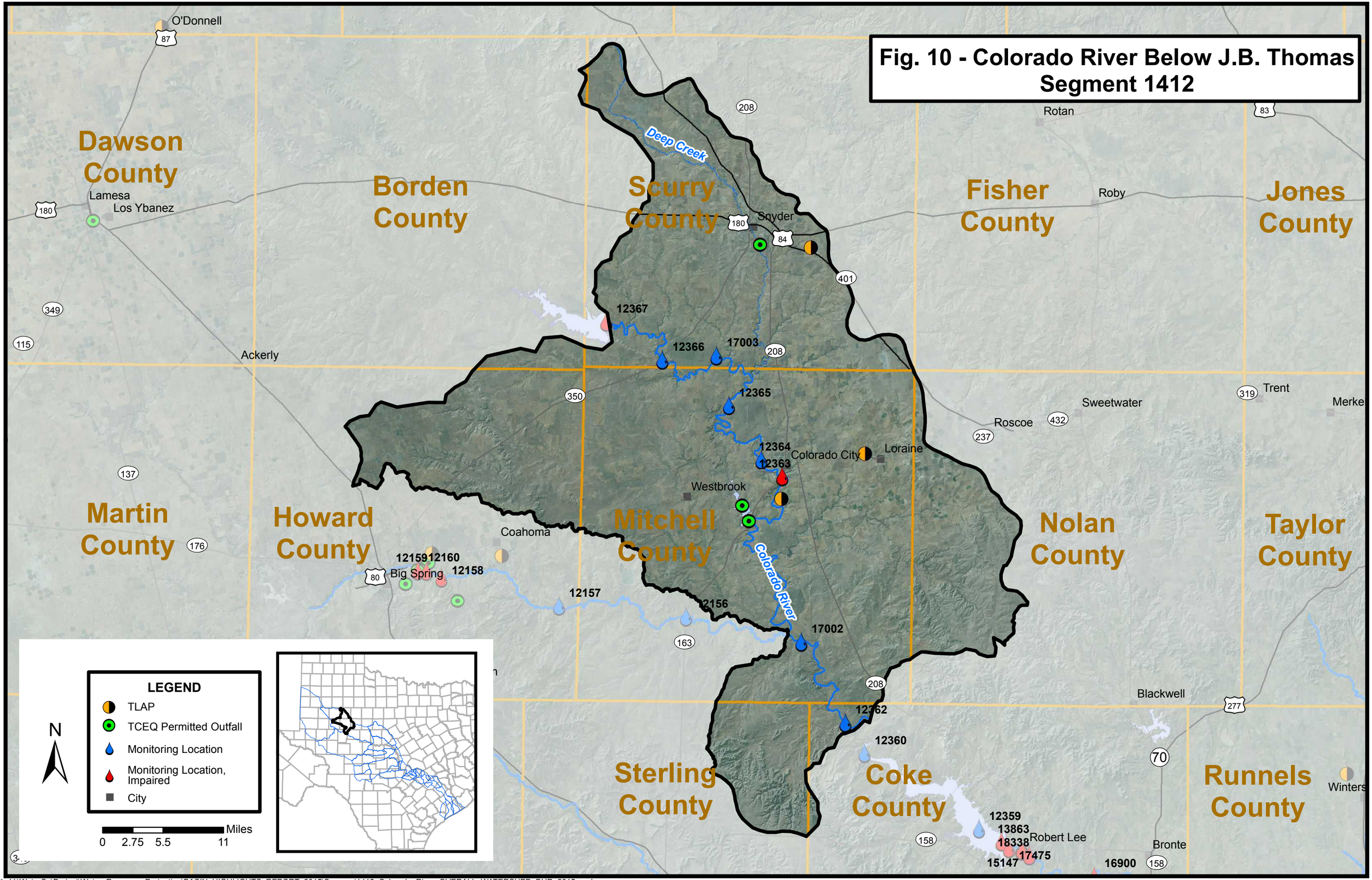

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Fig. 11 - Colorado River Below J.B. Thomas Segment 1412 Land Use/Cover

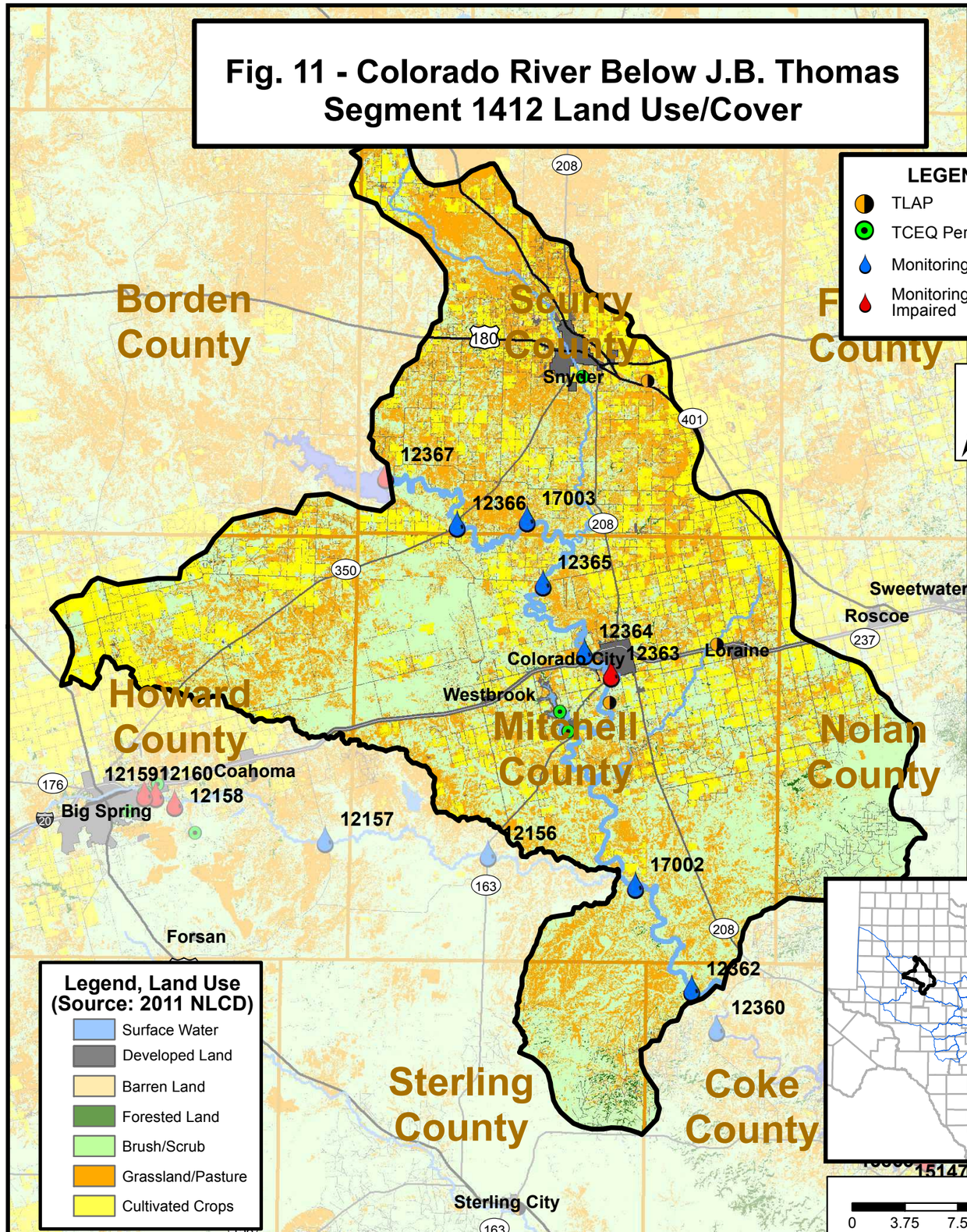

Fig. 12 - Colorado River Below J.B. Thomas Segment 1412 Aerial Imagery

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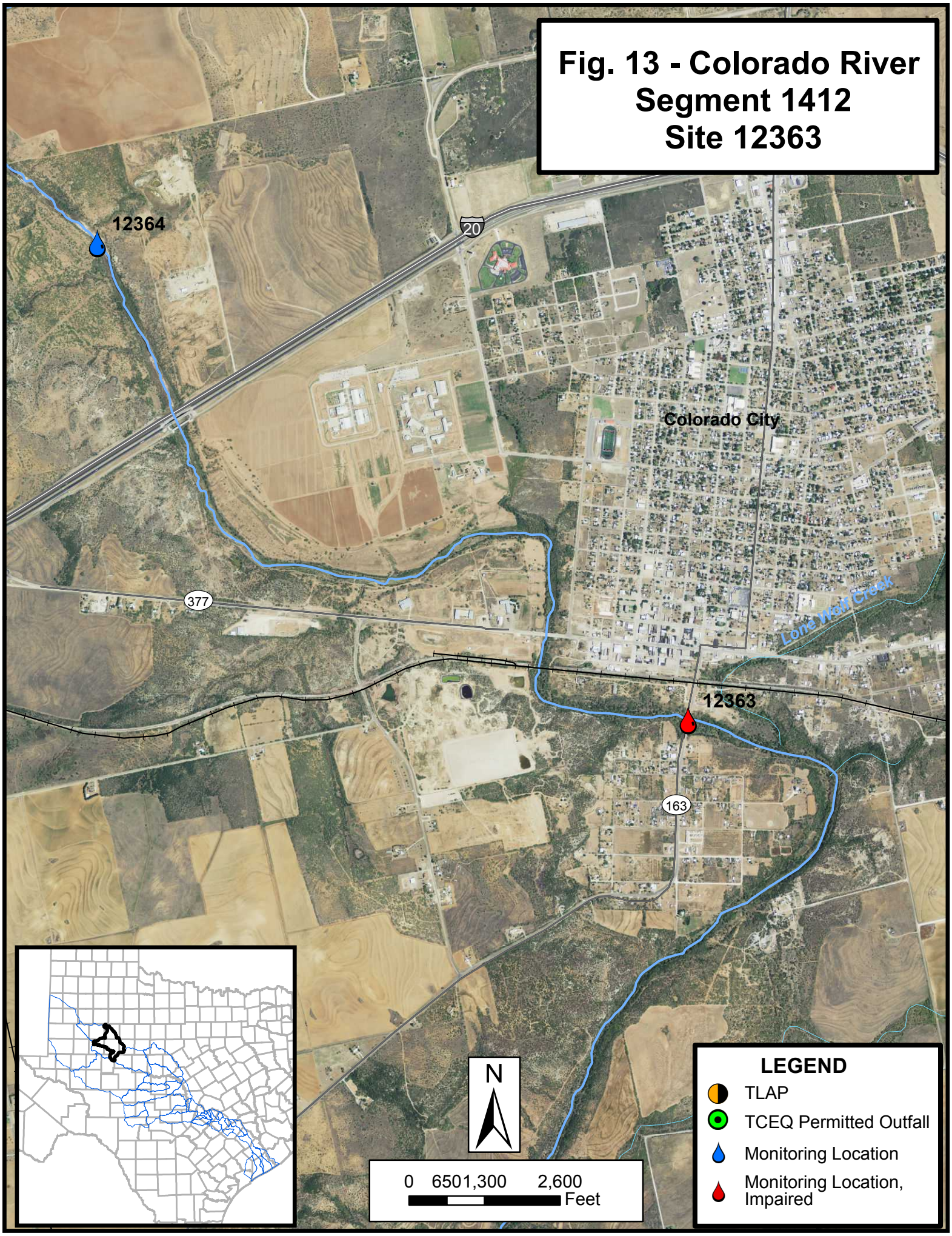

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Segment 1412B: Beals Creek **Impairment: Bacteria**

Segment Description

Segment 1412B begins from the confluence with the Colorado River in Mitchell County and continues upstream to the confluence of Mustang Draw and Sulphur Springs Draw in Howard County (Figure 14). The following sites were monitored during the period of record:

12156 – Beals Creek at SH 163.
12157 – Beals Creek at FM 821.
12158 – Beals Creek at Val Verde Road.
12159 – Beals Creek at East Midway Road in Big Spring.
12160 – Beals Creek at FM 700.

Land Use

Cultivated crops dominate the upper portion of the watershed, while most of the lower two-thirds of the watershed are composed of brush and grassland (Figure 15). The city of Big Spring is located near the headwaters of the stream. Treated effluent from a desalination plant and the city's wastewater plant provide perennial flow downstream of the city. Oil and gas production also occur in the watershed.

Impairment Description

The impaired AU, 1412B_03, begins at the confluence with Guthrie Draw and continues upstream to the confluence of Mustang Draw and Sulphur Springs Draw (Figure 16). TCEQ first placed Segment 1412B on the 2010 303(d) List for not supporting contact recreation because of elevated levels of *E. coli* bacteria.

Similar to Segment 1412, the bacteria standard for Beals Creek is based on *Enterococcus*. In the absence of *Enterococcus* data, the impairment carried forward in the Draft 2014 303(d) List based on *E. coli* values. Seventeen *E. coli* samples were assessed from sites 12158, 12159 and 12160. The geometric mean of the samples was 173 most probable number (MPN), exceeding the criteria of 126.

The Draft 2014 Integrated Report identified concerns for elevated levels of chlorophyll-*a* ammonia, nitrate and total phosphorous in the segment.

Potential Causes of Impairment

Point Sources

The city of Big Spring and CRMWD are permitted to discharge treated effluent into Beals Creek (1412B_03) just upstream of sites 12158 and 12159. The CRMWD discharge is wastewater from a desalination plant and not likely to be a source of bacteria.

Nonpoint Sources

Big Spring is upstream of the monitoring sites (Figure 17) and drains into Beals Creek. Runoff from storm events may be sources of bacteria and nutrients. Failing wastewater lines or inadequate septic systems also may be sources.

Action Taken

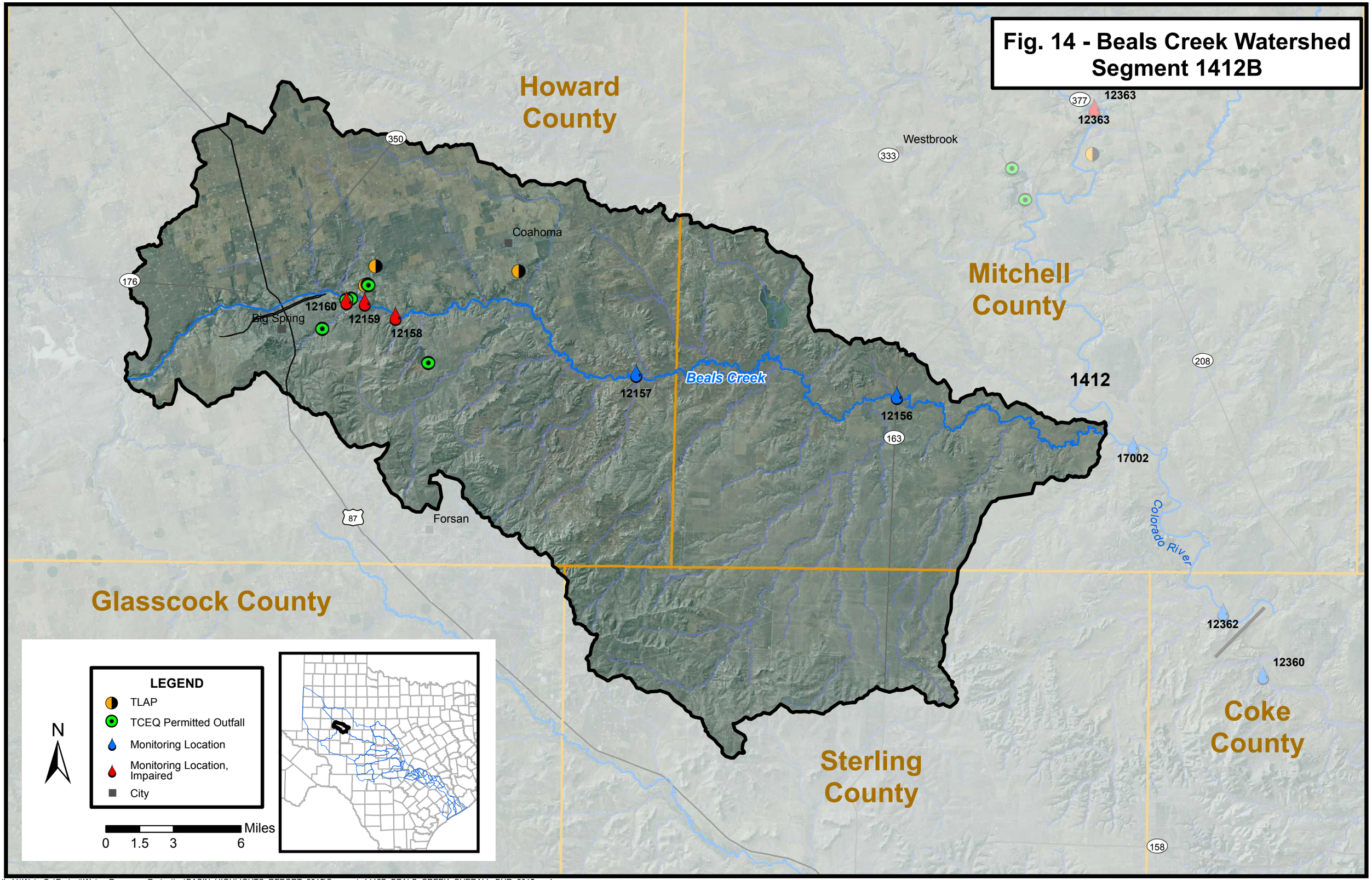
- The 2010 Integrated Report identified Beals Creek as impaired for total selenium levels in water. CRMWD and TCEQ Region 7 monitored extensively at several sites between 2011 and 2013. Samples contained selenium levels within *Texas Surface Water Quality Standards* and Beals Creek was removed from the 303(d) List in 2014.
- Holding time limitations prevent further collection of bacteriological data until a resolution can be found.

Potential Stakeholders

- TCEQ
- CRMWD
- UCRA
- City of Big Spring
- Agriculture interests

Recommendations

- Communicate with TCEQ or Texas State Soil and Water Conservation Board to determine if the stream is a candidate for an RUAA.
- Find an accredited lab close enough to receive samples within holding time so bacteria sampling can resume.



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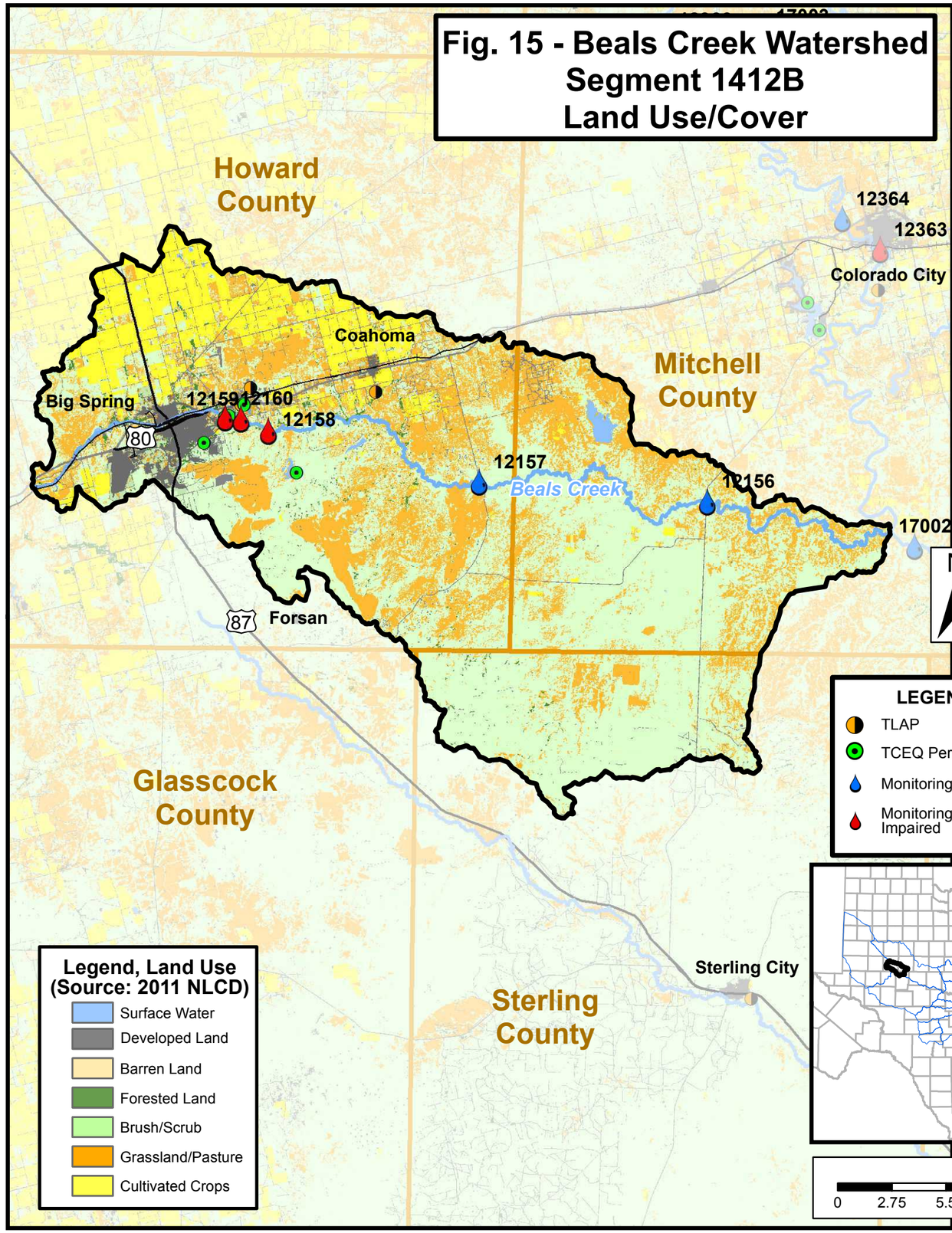

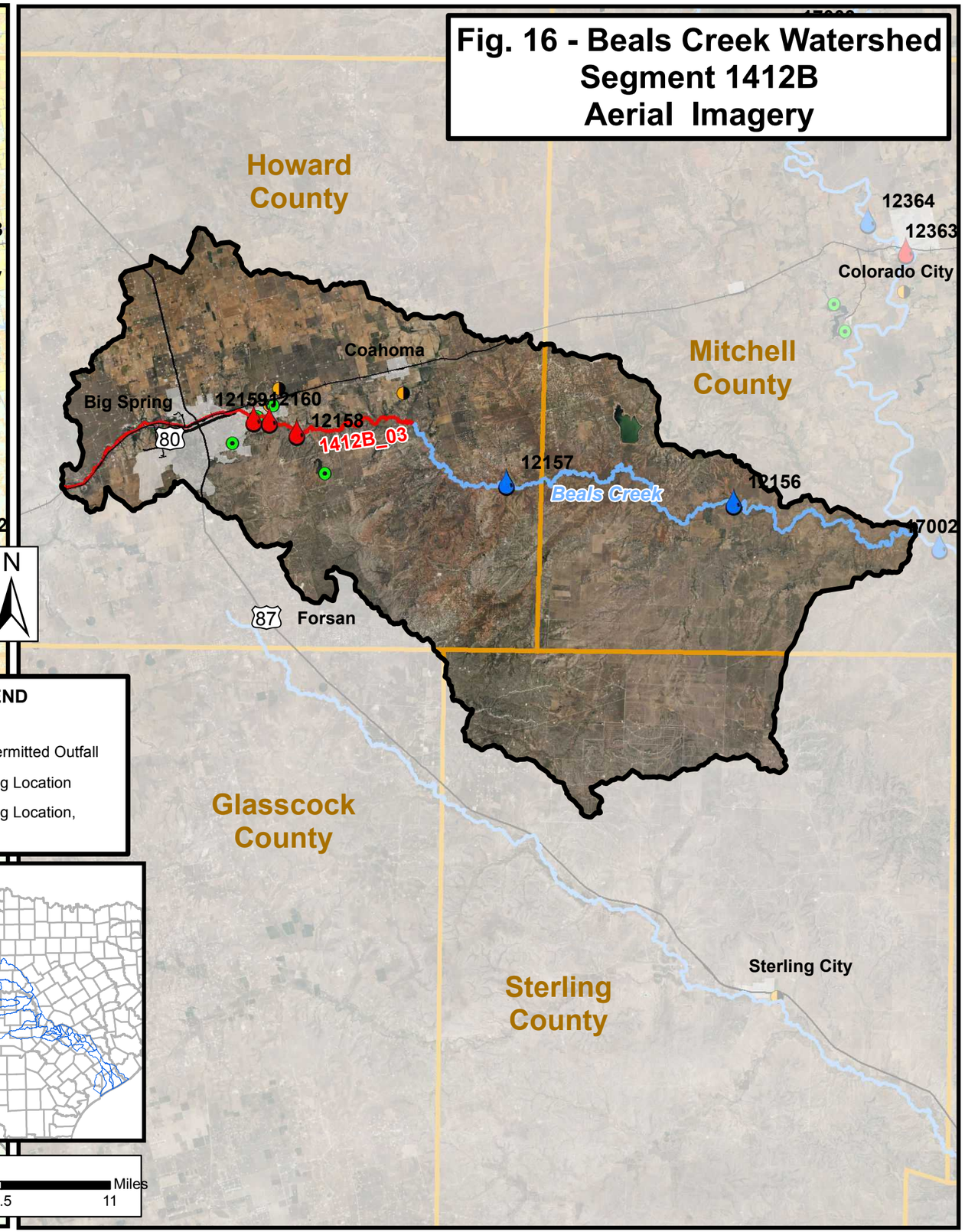

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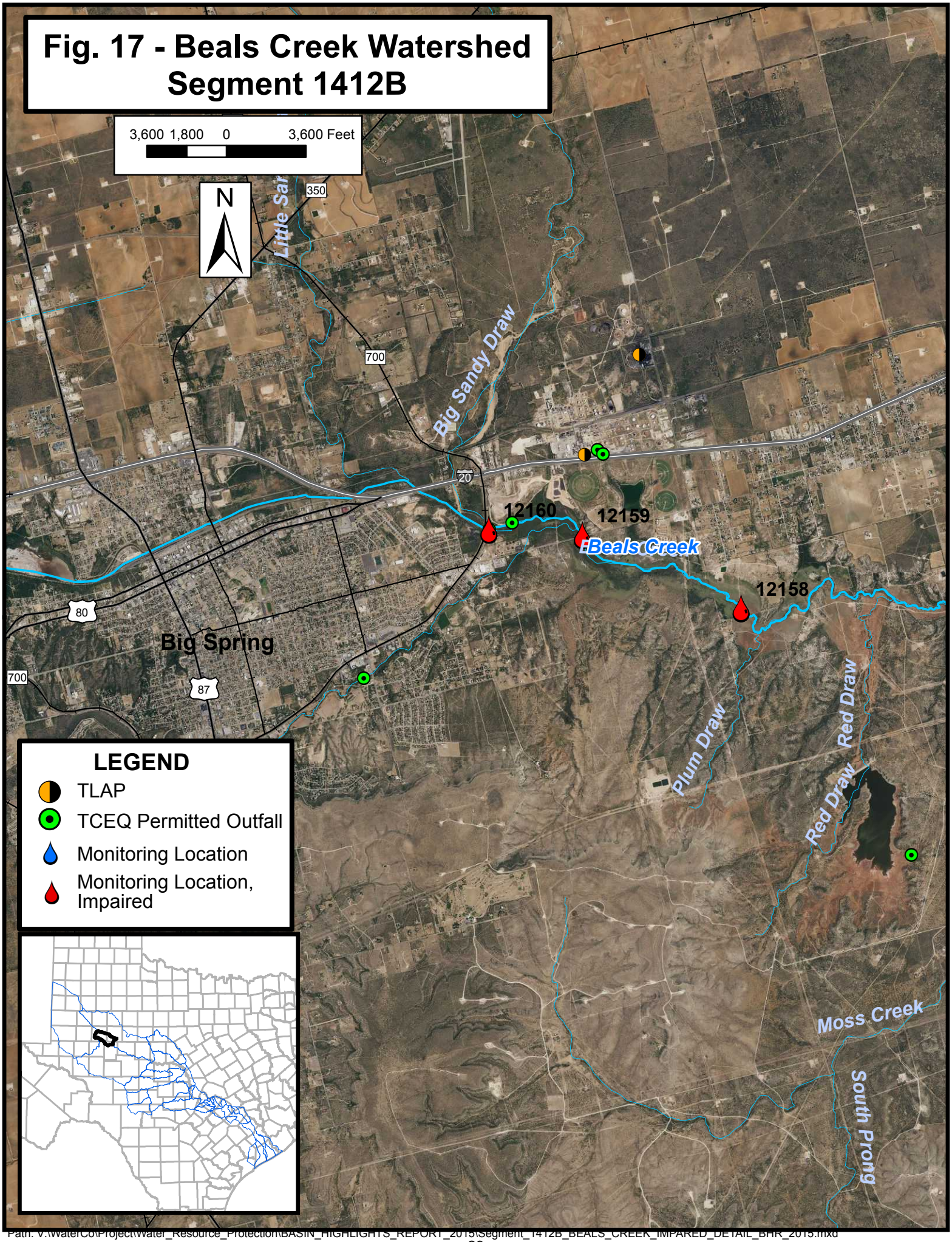
Fig. 17 - Beals Creek Watershed Segment 1412B



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Segment 1413: Lake J. B. Thomas **Impairment: Chloride, TDS and sulfate**

Segment Description

Lake J.B. Thomas is the westernmost impoundment on the Colorado River (Figure 18). The reservoir impounds the Colorado River from the dam in Scurry County up to a normal pool elevation of 2,258 feet above mean sea level. The reservoir has a surface area of approximately 7,808 acres at conservation pool. The reservoir was only 15 percent of capacity (Figure 21) on average during the period of record. It is monitored at Site 21614.

Land Use

The western portion of the watershed is used for farming (Figure 19). Brush and grassland dominate the remainder of the watershed. Oil and gas production are prevalent throughout the watershed.

Impairment Description

Segment 1413 was initially placed on the 2008 303(d) List for elevated levels of chloride. In 2010, the segment was listed for TDS, and in 2012, it was listed for sulfate.

The entire reservoir is one AU (1413_01). Data responsible for the listing are from Site 21614 (Figure 21). Thirteen samples were assessed during the Draft 2014 Integrated Report. The mean value for chloride, TDS and sulfate was 223 mg/L and 867 mg/L and 181mg/L, respectively. The criteria for chloride, TDS and sulfate are 80 mg/L, 500 mg/L and 110 mg/L, respectively.

Potential Causes of Impairment

<u>Nonpoint Sources</u>

- Elevated concentrations of salt constituents in the lake are due to regional geology, prolonged drought and historical oil and gas production activities. Soils in the watershed are highly mineralized and dissolution of these minerals into surface water occurs easily.
- The reservoir capacity during this time ranged from 7.8 to 34.6 percent with an average of 15.6 percent. Evaporation, coupled with low precipitation, has concentrated minerals in the water.
- The watershed contains oil and gas deposits in production since the 1930s. CRMWD identified seepage from the oil and gas production activities, including abandoned or inadequately plugged wells, in the watershed. These seeps typically produce high-saline water and are known to contaminate surface water.

Actions Taken

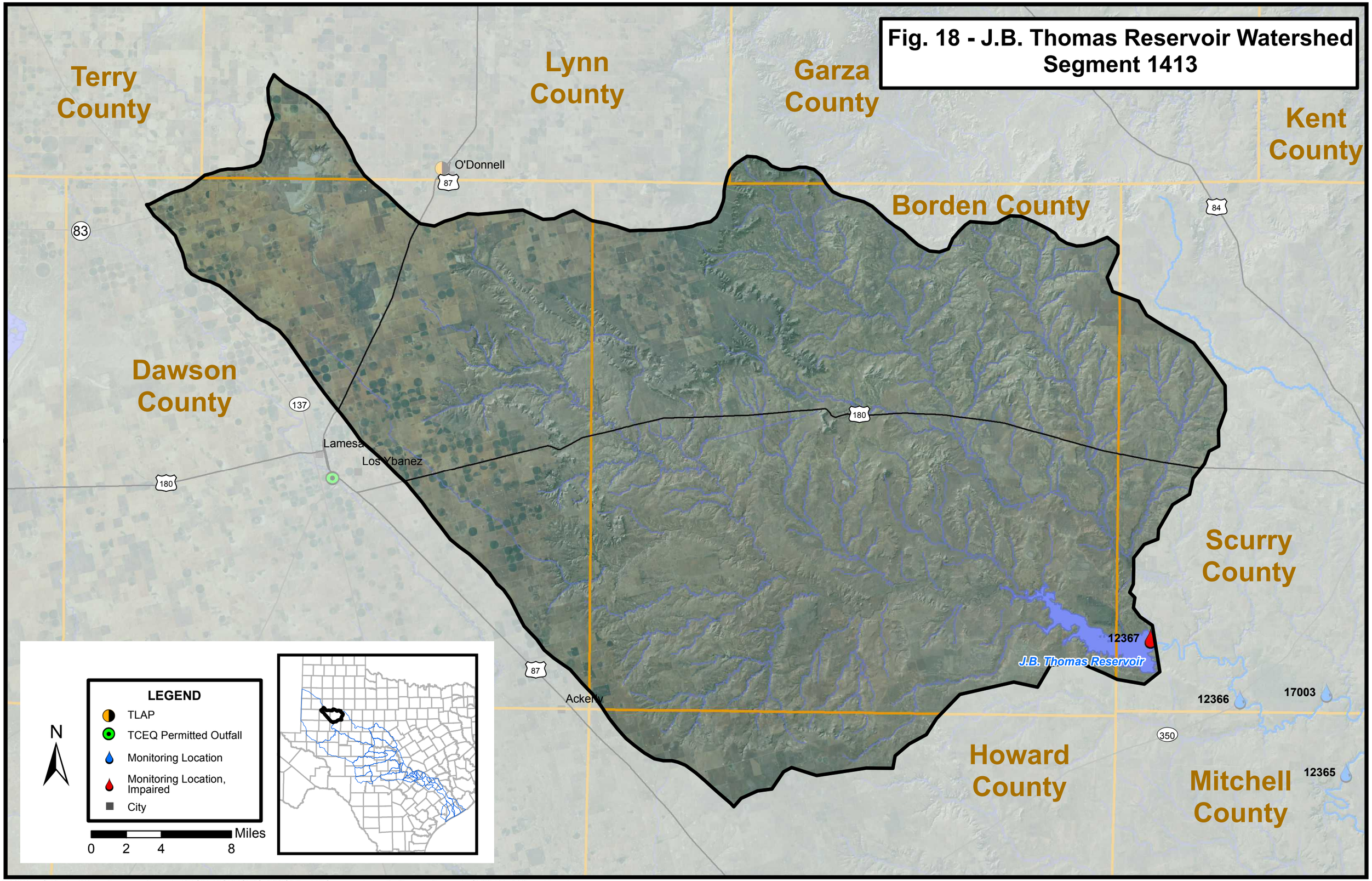
- CRMWD routinely monitors for flow at two seeps near the banks of Lake J.B. Thomas and notifies the RRC when seeps are active.
- CRMWD performed an oil and gas well mapping survey in the upper watershed. The survey, titled Tobacco Creek Water Quality Issues, included sulfate and chloride monitoring. CRMWD provided the results to the RRC to help prioritize regulatory activities.

Potential Stakeholders

- CRMWD
- UCRA
- RRC
- Landowners
- TCEQ
- Texas State Soil and Water Conservation Board

Recommendations

- Continue monitoring efforts to verify the impairment.
- Work with RRC on identifying well-plugging candidates.



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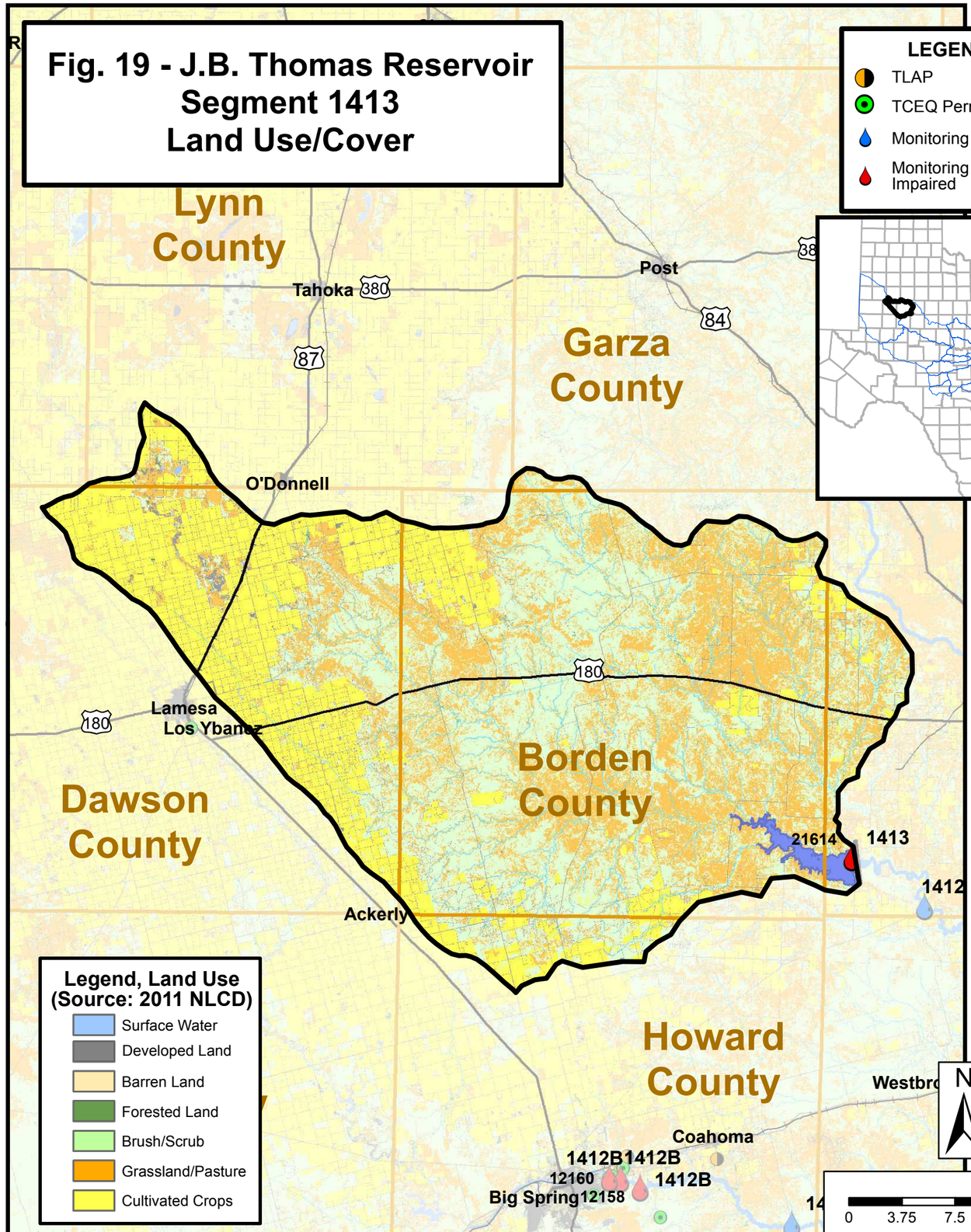

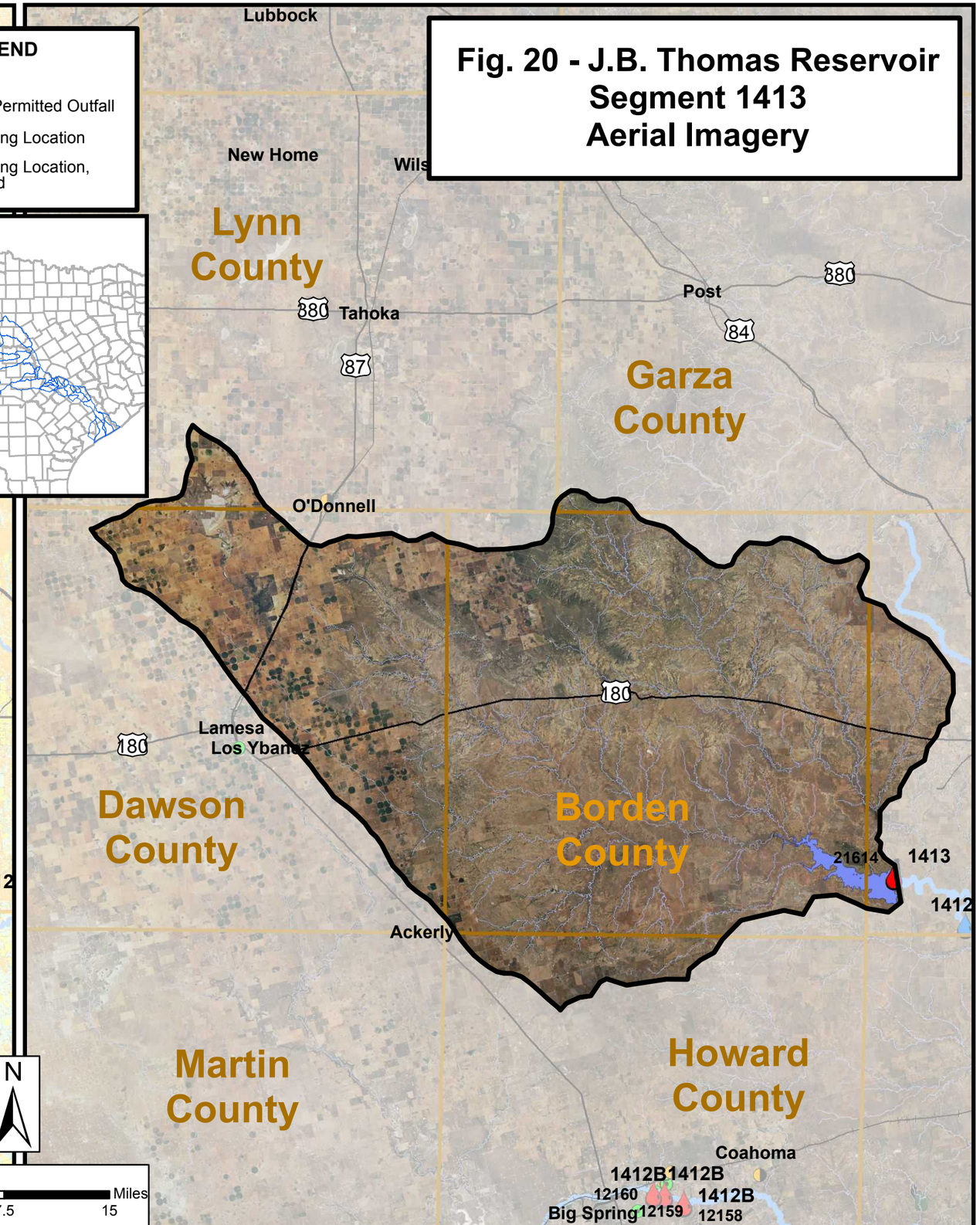

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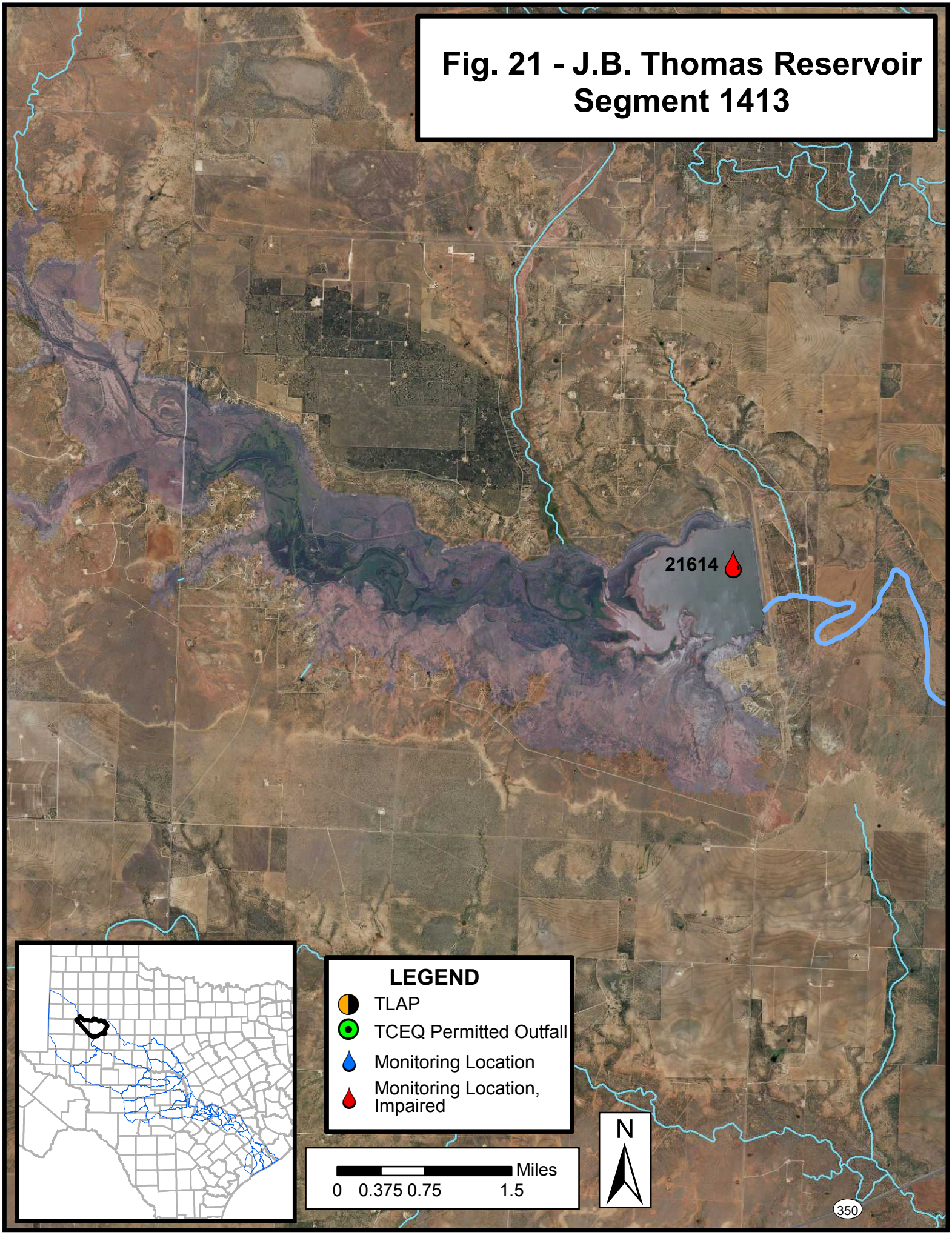

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Segment 1416: San Saba River **Impairment: Bacteria**

Segment Description

Segment 1416 begins from the San Saba River's confluence with the Colorado River, and continues upstream to the confluence of the north and middle forks of the San Saba River near the Menard County line (Figure 22). The river is approximately 168 miles long and was monitored at the following sites during the period of record:

12392 – San Saba River at State Highway 16.
17004 – San Saba River immediately downstream of U.S. Highway 87.
20662 – San Saba River at County Road 340.

The impaired AU, 1416_01 (Figure 24), begins at the confluence with the Colorado River upstream to the river's crossing with U.S. Highway 190. Data responsible for the listing are from Site 12392.

Land Use

Brush is the dominant vegetation in the upper part of the watershed. Cultivated crops and forested land are prevalent in the lower half of the watershed (Figure 23). The land immediately surrounding Site 12392 is used for livestock grazing and pecan production. Jordan Cattle Auction Barn has a Texas Land Application Permit (TLAP) and is located 4 miles upstream of Site 12392 on State Highway 190 (Figure 25). The city of San Saba is half a mile south of Site 12392. About 50 percent of the city's stormwater drains to the site. There are no TCEQ permitted discharges immediately upstream of the monitoring site.

Impairment Description

TCEQ placed Segment 1416 on the 2008 303(d) List for not supporting contact recreation due to elevated levels of *E. coli*. TCEQ assessed 44 samples collected from Site 12392 between 1999 and 2006. The resulting geometric mean for *E. coli* was 197 MPN, exceeding the criteria of 126 MPN.

Elevated levels of *E. coli* continued in subsequent assessments. Geometric means were 196, 155, and 167 MPN for 2010, 2012 and 2014. The impairment remains a Category 5c, meaning more information should be gathered before implementing a TMDL or other water improvement project.

Potential Causes of Impairment at Site 12392

Nonpoint Sources

- Agriculture – The land immediately upstream of the monitoring site it is used for hay production and grazing livestock. Three pecan orchards are located immediately upstream of the site. There is very little riparian area. Upstream of the monitoring site, cattle have access to the river and use it as a water source.

- Wildlife – Signs of deer and other wildlife have been found near the site. Feral hogs also have become established in the area. Animal waste or soil disturbance from pig rooting may contribute to the high bacteria levels.

- Urban Runoff – The city of San Saba is less than a mile south of the site. The western portion of the city drains stormwater into the river upstream of the site.

Actions Taken

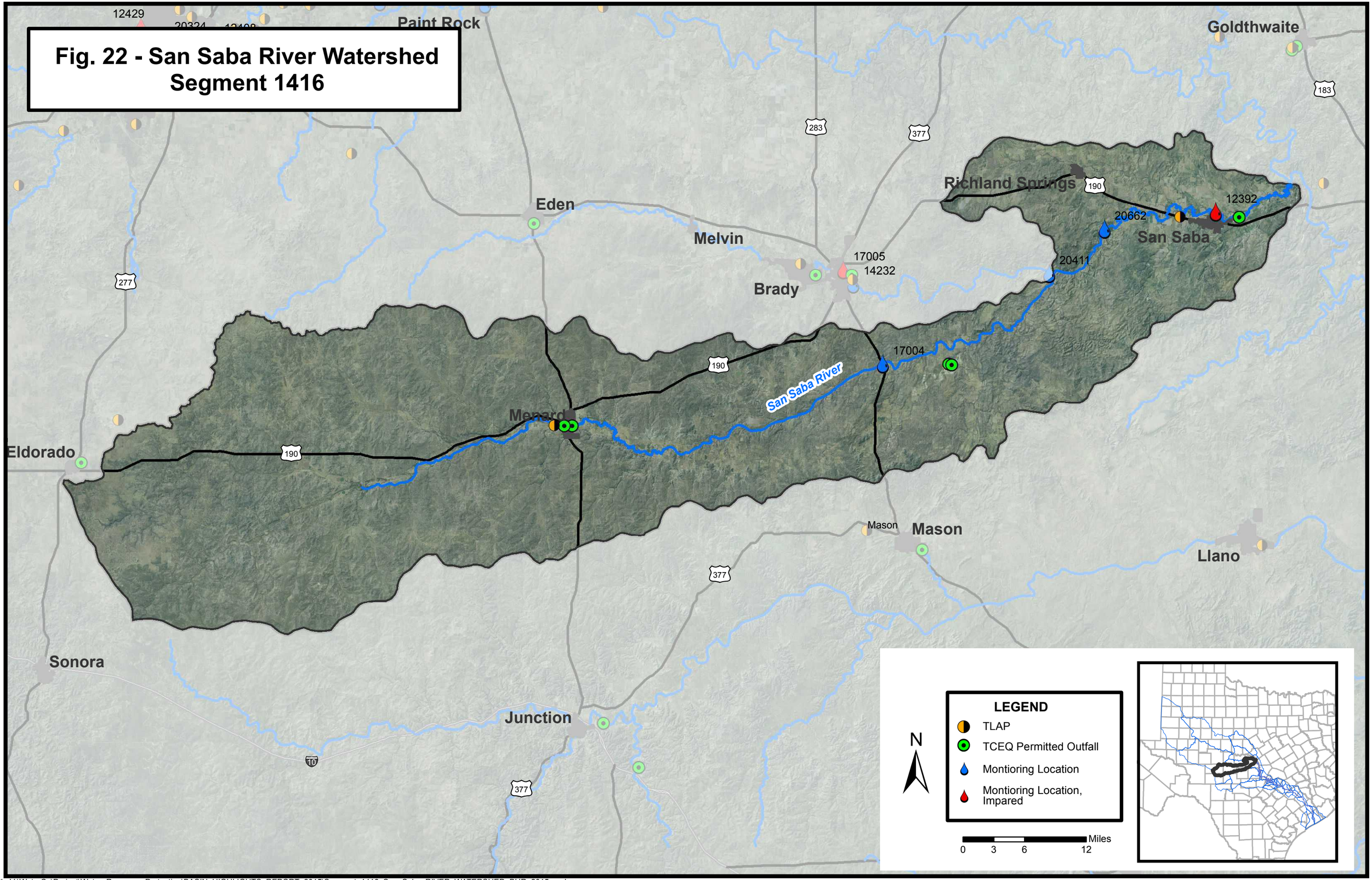
- In 2012, TCEQ Region 9 began monitoring site 20662 – 22 miles upstream of the impaired site – to determine if the high bacteria was specific to site 12392. Monitoring at both sites between 2012 and 2014 yielded a geometric means of 29 MPN and 264 MPN at sites 20662 and 12392, respectively, indicating that bacteria sources are local. Monitoring at Site 20662 was discontinued in 2015.
- In December 2014, LCRA began a special project to monitor six sites on the San Saba River, including 12392. Samples will be collected monthly for six months.

Potential Stakeholders

- City of San Saba
- Local landowners
- Texas State Soil and Water Conservation Board
- Texas Department of Agriculture
- Texas AgriLife Extension
- Natural Resource Conservation Service
- Texas Parks and Wildlife Department
- Pecan growers
- Jordan Auction Barn

Recommendations

- Pending the results of the LCRA special study, communicate with TCEQ and the Texas State Soil and Water Conservation Board to determine the river's suitability as a candidate for a WPP.



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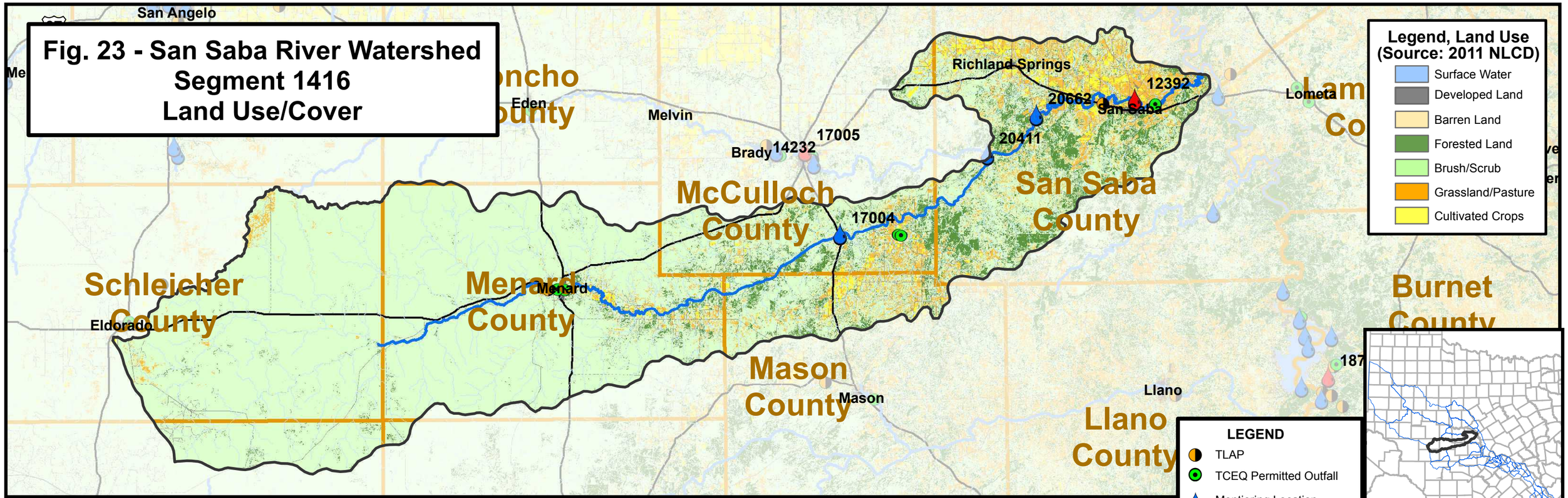

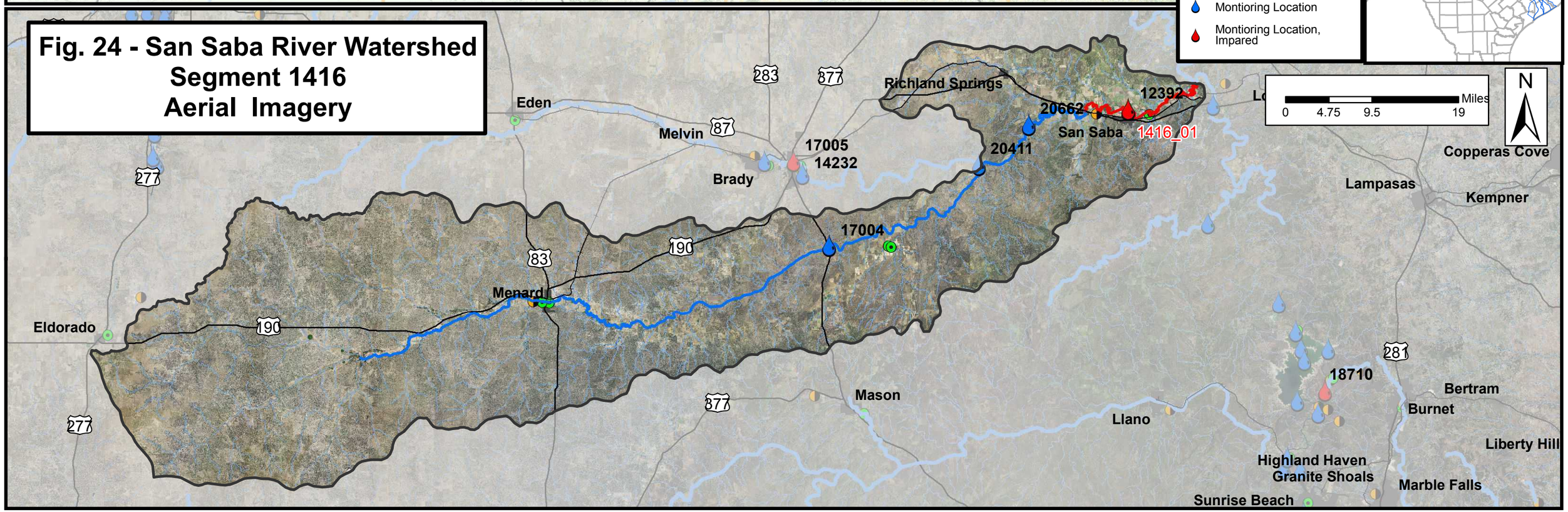

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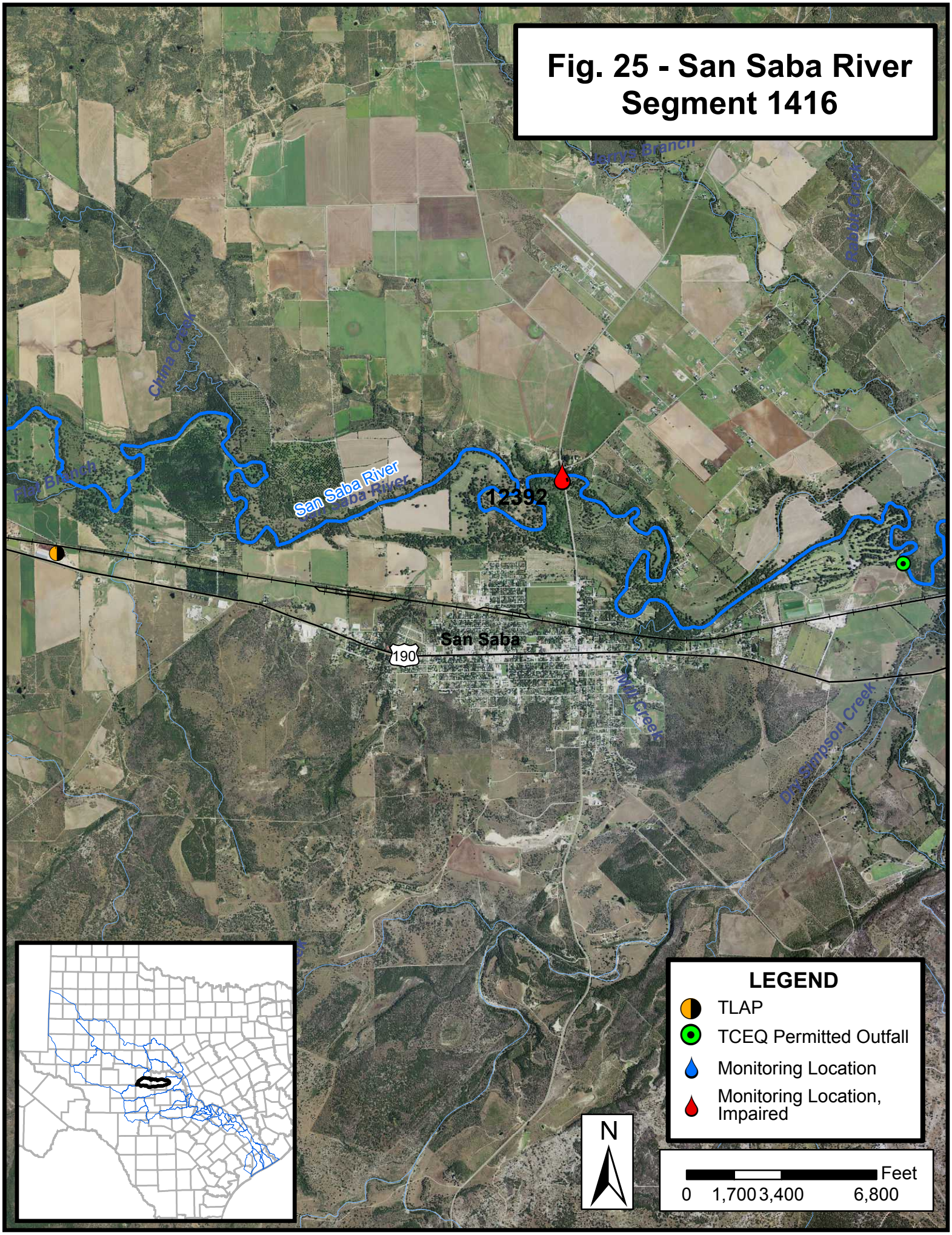

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Segment 1416A-C: Brady Creek **Impairment: Dissolved oxygen**

Segment Description

The Brady Creek watershed is about 784 square miles and is located in Concho, McCullough and San Saba counties. The cities of Brady, Melvin and Eden are located in the middle and upper regions of the watershed.

Brady Creek, a tributary of the San Saba River is approximately 90 miles long. TCEQ divides the stream into three subsegments (Figure 26):

- 1416A – From the confluence of the San Saba River southwest of San Saba upstream to Brady Lake Dam.
- 1416B – Brady Lake.
- 1416C – Brady Creek upstream of Brady Reservoir.

Brady Creek was monitored at the following sites during the period of record:

12179 – Brady Creek Reservoir midlake near dam.
14232 – Brady Creek on private road 2 miles downstream of FM 714.
17005 – Brady Creek at Elm Street in Brady downstream of the low-water crossing.
20411 – Brady Creek at San Saba County Road 261.
20661 – Brady Creek immediately downstream of County Road 3034.

The impaired AU, 1416A_03, begins at FM 714 and ends upstream at Brady Lake Dam (Figure 28). Data responsible for the listing are from Site 17005. The site is no longer monitored because it is frequently dry due to drought. Site 14232, 2.2 miles downstream, is in AU 02 and is routinely monitored by UCRA. Because of flow regimes, AU 02 and 03 are designated as supporting an intermediate aquatic life use with a dissolved oxygen criterion of 4.0 mg/L in Appendix D of the *Texas Surface Water Quality Standards*.

Land Use

The Brady Creek watershed is composed primarily of brush land. Land just upstream of Brady Lake is used as farm and pasture lands (Figure 27). Below Brady Lake Dam, at the headwaters of 1416A_03, the creek flows through Brady, a community of about 5,200 people. The city's wastewater treatment plant discharges downstream of Site 17005 and upstream of site 14232 (Figure 29). In town, the creek receives stormwater runoff from commercial, residential and industrial properties.

In-stream flows are reduced by Brady Lake and several low-water dams in the city. During the summer, the dams create stagnant pools where elevated nutrients

contribute to algal blooms that result in extreme fluctuations of dissolved oxygen levels. Site 17005 is in such a pool.

Impairment Description

TCEQ first placed Segment 1416A on the 2004 303(d) List for not supporting its designated aquatic life use based on low levels of dissolved oxygen. The 2004 listing, which was based on single-grab samples, was confirmed through limited 24-hour monitoring. Four of six 24-hour events failed to meet the criteria of 4 mg/L and five of six events failed to meet the 24-hour minimum dissolved oxygen criteria of 3 mg/L during the 2008 assessment. Without sampling at Site 17005, the impairment is carried forward in the Draft 2014 Integrated Report.

The Draft 2014 Integrated Report identified concerns for elevated levels of chlorophyll-*a*, total phosphorous and nitrate based on data collected from 14232.

Potential Causes of Impairment at Site 17005

<u>Nonpoint Sources</u>

- Agricultural influences – Farmland 2 miles upstream of Site 17005 is planted in row crops, providing the potential for nutrient contributions from tilled soil and fertilizer.

- Urban influences – All stormwater runoff from the city flows into AU 03 of Brady Creek. Urban runoff likely contributes nutrients that cause algal blooms and dissolved oxygen fluctuations.

Actions Taken

- The Brady Creek Master Plan, produced in 2004 by UCRA, identified and implemented BMPs to decrease the impact of stormwater on the creek.

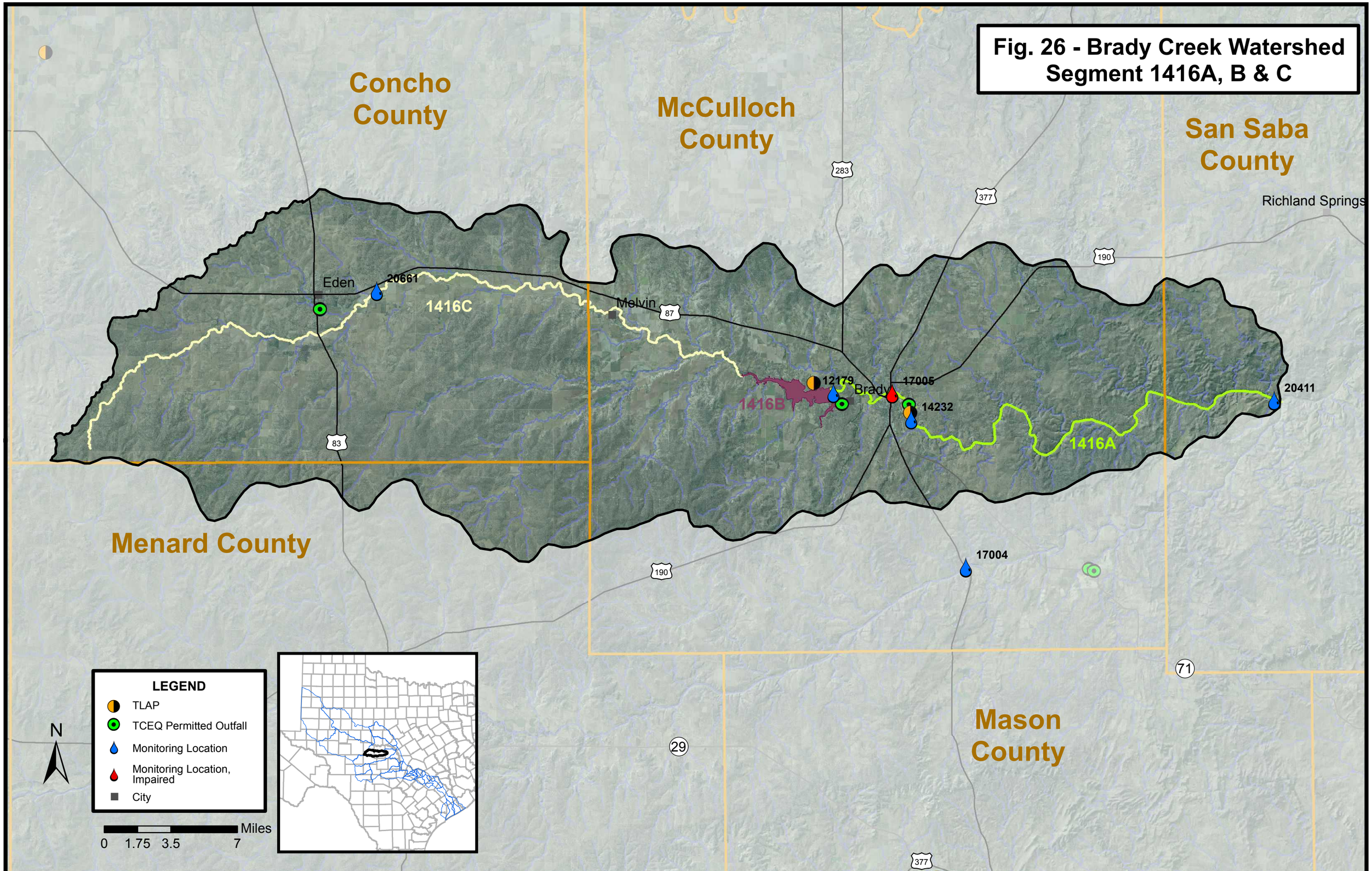
- UCRA received Clean Water Act 319(h) grant funding from TCEQ to develop the Brady Creek WPP. To date, the following actions have been taken:
    - Brady Creek Watershed Characterization approved in January 2010.
    - Brady Creek Public Participation Plan approved in December 2010.
    - Texas Institute for Applied Environmental Research draft modeling study submitted in October 2013.
    - Draft Brady Creek WPP, which calls for circulation of treated effluent through downtown Brady and installation of stormwater separators, was submitted to TCEQ on Sept. 8, 2014.

Stakeholders From the Brady Creek WPP

- City of Brady
- City of Eden
- City of Melvin
- Concho County
- Concho County Soil and Water Conservation District
- LCRA
- McCullough County
- McCullough County Soil and Water Conservation District
- TCEQ
- Texas Parks and Wildlife Department
- Texas State Soil and Water Conservation Board
- UCRA

Recommendations

Because monitoring resources were moved from Site 17005 to Site 14232 in 2007, re-establish Site 17005 or another site in AU 03 to determine if dissolved oxygen conditions have improved in the assessment unit as a result of the WPP implementation. Work with TCEQ staff to determine if data from Site 14232 can be used to delist.



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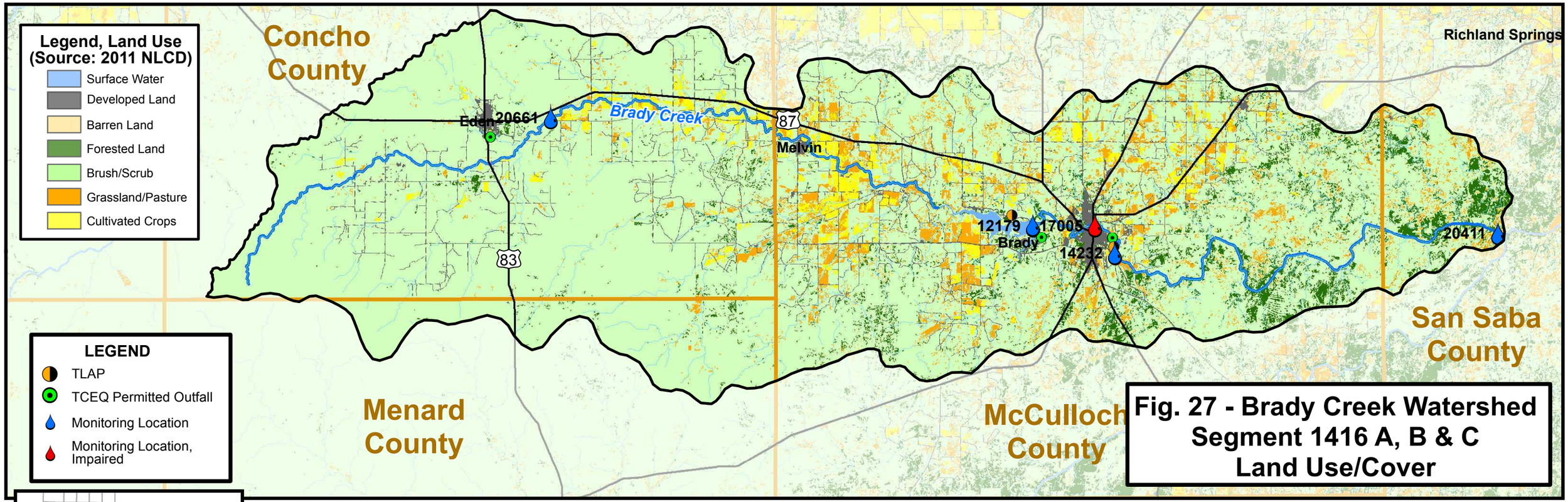

Fig. 27 - Brady Creek Watershed
Segment 1416 A, B & C
Land Use/Cover

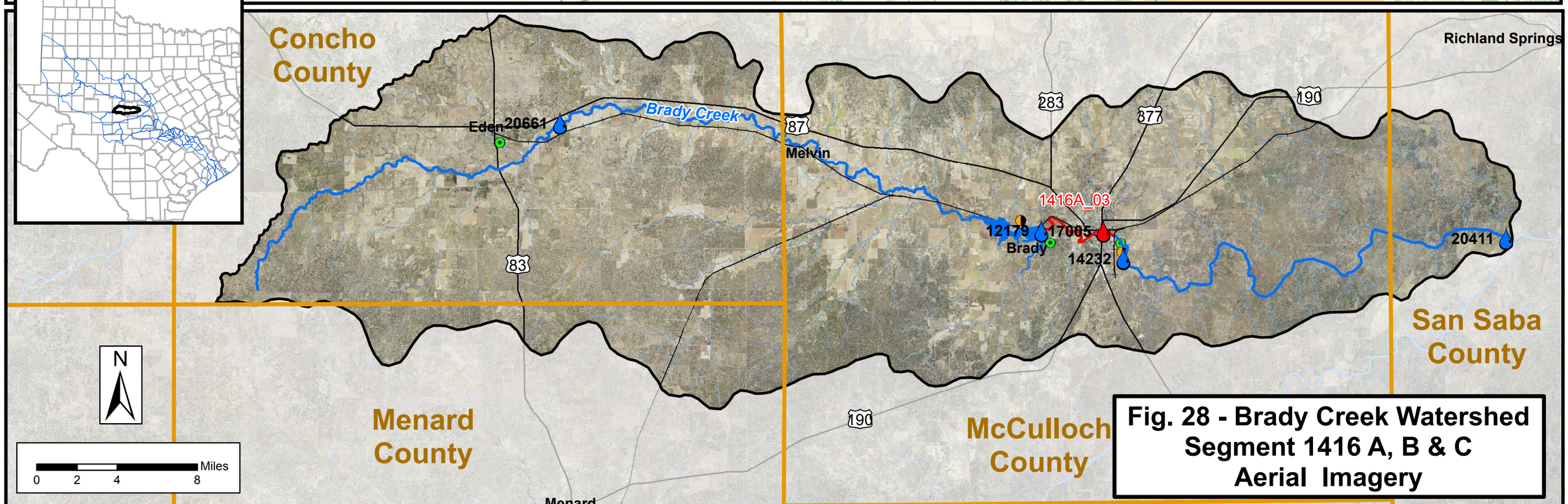

Fig. 28 - Brady Creek Watershed
Segment 1416 A, B & C
Aerial Imagery

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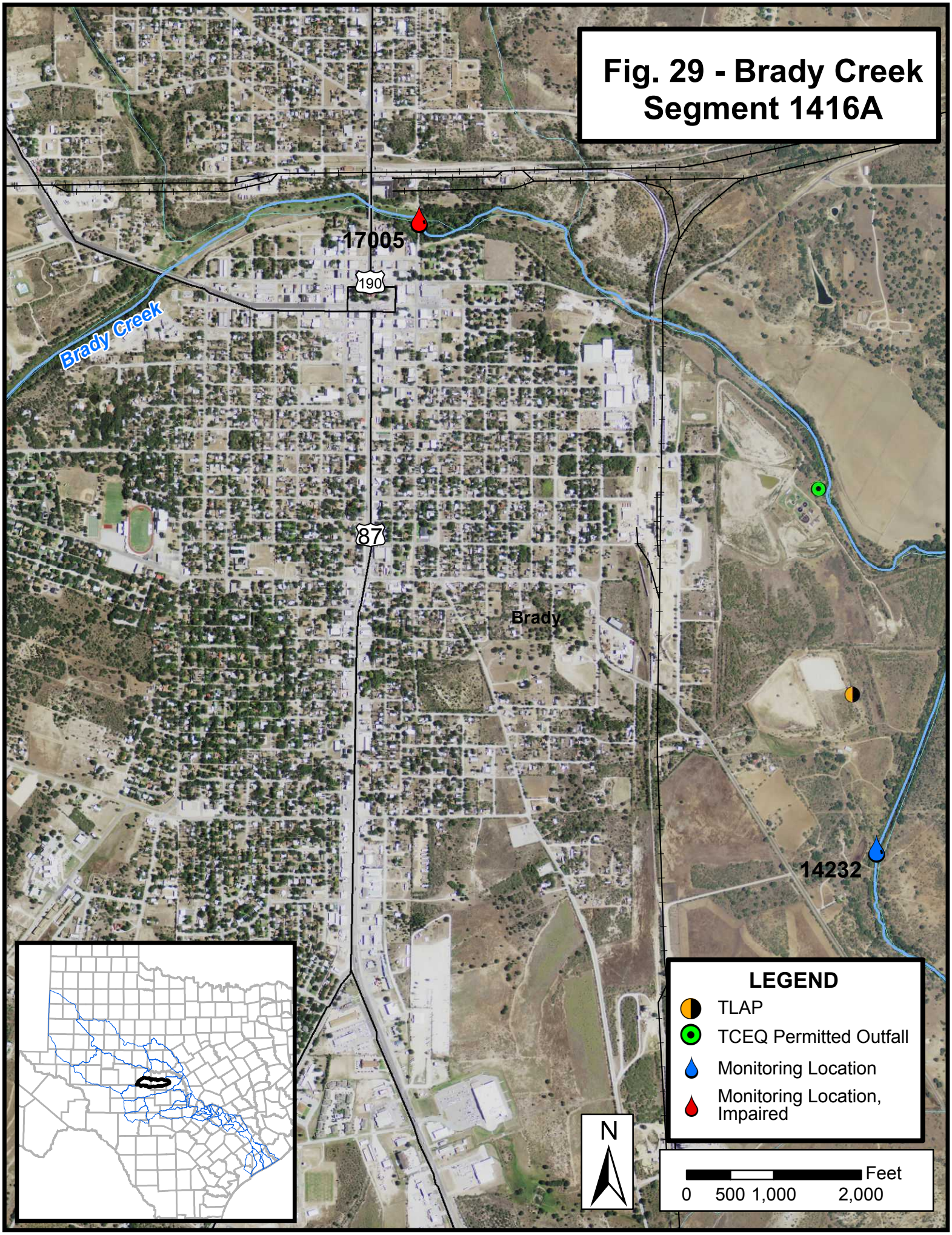

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Segment 1421: Concho River **Impairment: Bacteria and dissolved oxygen**

Segment Description

The Concho River watershed is about 6,700 square miles. A series of dams near San Angelo capture water from the river's three forks for municipal water supply for the city. Segment 1421 begins upstream of the confluence of the Concho River and Fuzzy Creek in Concho County. The segment extends upstream to the O.C. Fisher Reservoir outlet works on the North Concho River and to the Lake Nasworthy outlet works on the South Concho River in San Angelo (Figure 26). The segment is approximately 64 miles long.

Segment 1421 was routinely monitored by at the following sites during the period of record:

12254 – Lipan Creek about 984 yards upstream of the confluence of the Concho River.
12255 – Kickapoo Creek at FM 380.
12257 – Dry Hollow Creek at headwaters of Chandler Lake.
12401 – Concho River Bridge on U.S. Highway 83 at Paint Rock.
12402 – Concho River at FM 381.
12403 – Concho River at FM 1692, south of Miles.
12404 – Concho River at Mullins Crossing Road, 4.5 miles northeast of Veribest.
12405 – Concho River at Veribest Park.
12707 – Concho River at FM 380 near Veribest.
12408 – Concho River downstream from Loop 306 east of San Angelo.
12409 – Concho River .4 miles downstream of North Concho and South Concho confluence.
12412 – North Concho River 22 yards above Irving Street Bridge.
12416 – South Concho River at U.S. Highway 87 in San Angelo.
15886 – North Concho River at Caddo Street Bridge in San Angelo.
17348 – South Concho River upstream of the Lone Wolf pump station.

The impaired AU 1421_08 (Figure 28), on the North Concho River, begins at the confluence of the North Concho and South Concho rivers upstream to O.C. Fisher Reservoir Dam. The biological impairments are from data collected at Site 12412. The bacteria and dissolved oxygen impairments are from sites 12412 and 15886.

Land Use
The watershed surrounding 1428_08 is heavily urbanized (Figure 29). Industrial, commercial and residential developments are located on either side of the river in San Angelo (population 97,000). Below San Angelo, land is primarily used for farming, pasture, confined animal feed operations and dairies (Figure 27).

Impairment Description
Aquatic Life
TCEQ first placed 1421_08 on the 303(d) List in 2008 for not supporting a high aquatic life use due to low levels of dissolved oxygen. Data collected from sites 12412 and 15886 between December 2001 and November 2008 showed 15 of 28 diel events failed to meet the average criteria of five mg/L. Thirteen of 28 events also failed the 24-hour minimum criteria of 3 mg/L. Subsequent assessments found the impairments continued through 2014 with about half the sampling events not meeting *Texas Surface Water Quality Standards* for the average and minimum dissolved oxygen criteria.

Contact Recreation
TCEQ first placed Site 1421_08 on the 303(d) List in 2008 for not supporting contact recreation due to high *E. coli* levels. The geometric mean of 34 *E. coli* samples was 152, 224, 172 and 135 MPN, in 2008, 2010, 2012 and 2014, respectively. The impairment remains a Category 5c, meaning more information should be gathered before implementing TMDL or other water improvement project. The Draft 2014 Integrated Report identified concerns for high levels of nitrate and chlorophyll-*a* and low dissolved oxygen throughout Segment 1421.

Potential Causes of Impairment at Sites 12412 and 15886
Nonpoint Sources
Low flow, urban stormwater runoff and lack of suitable habitat contribute to the impairments. Urban stormwater runoff from San Angelo has been a serious problem for many years. Fish kills commonly occurred after rain events until stormwater filters were installed as part of a TCEQ and UCRA nonpoint-source pollution abatement program that began in the mid-1990s.

Fish kills due to runoff are rare now. Low dissolved oxygen levels are still prevalent in some sections of the river and designated aquatic life uses may be inappropriate based on recent aquatic life monitoring.

Actions Taken
The Concho River WPP implementation plan resulted in three BMPs to address urban storm water runoff:

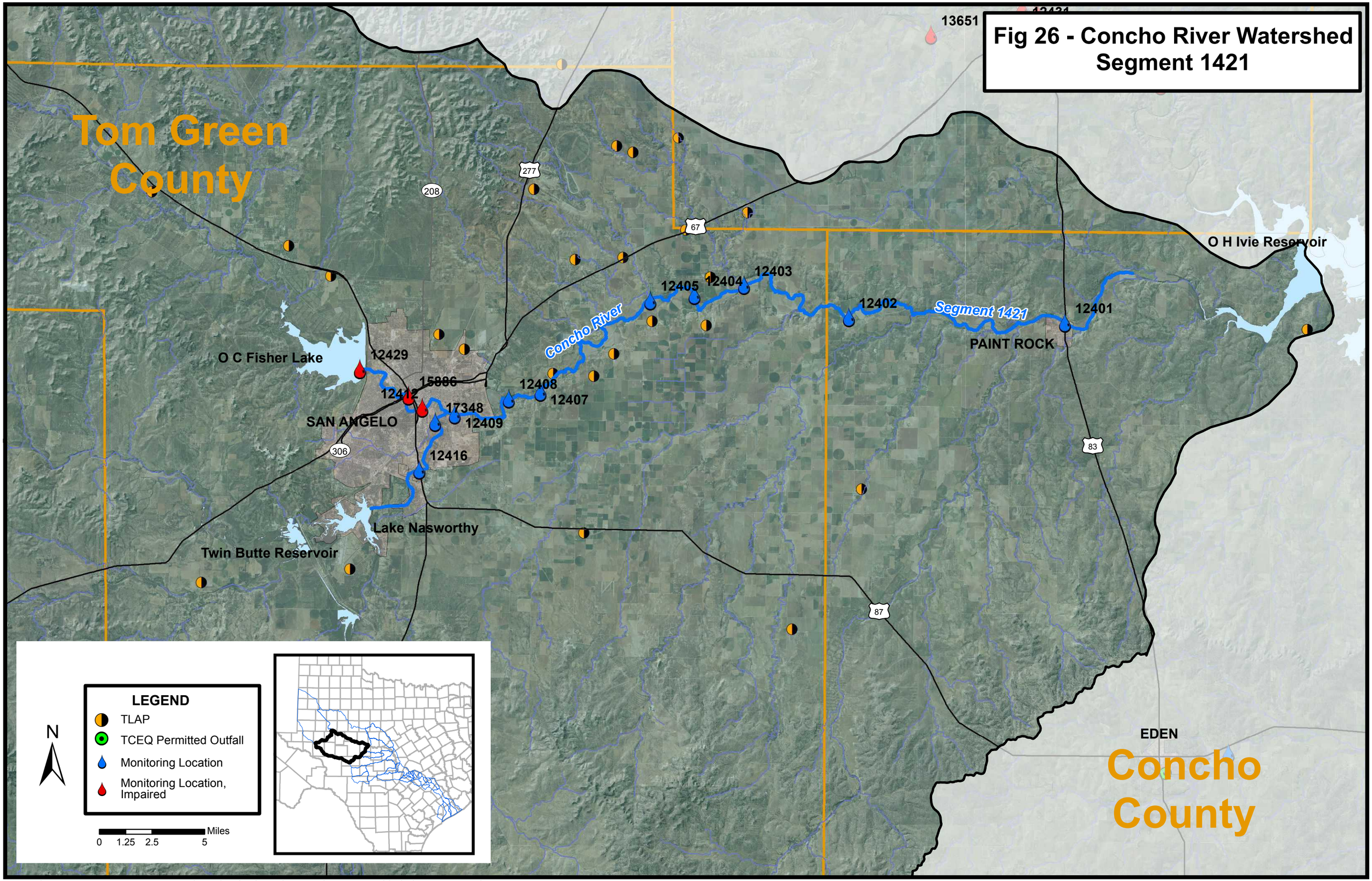
- Municipal stormwater ordinance development for the City of San Angelo.
- Anoxic sludge was dredged from portions of AU 1421_08 in March 2010.
- A bank stabilization project in AU 1421_08 from 2011 and 2013.

Stakeholders From the Concho River WPP

- City of San Angelo
- CRMWD
- Downtown merchants
- North Concho River property owners
- Texas Parks and Wildlife Department
- TCEQ
- UCRA

Recommendations

- Continue monitoring.
- Work with TCEQ to develop an appropriate aquatic life use designation.
- Continue to implement BMPs outlined in the Concho River WPP.



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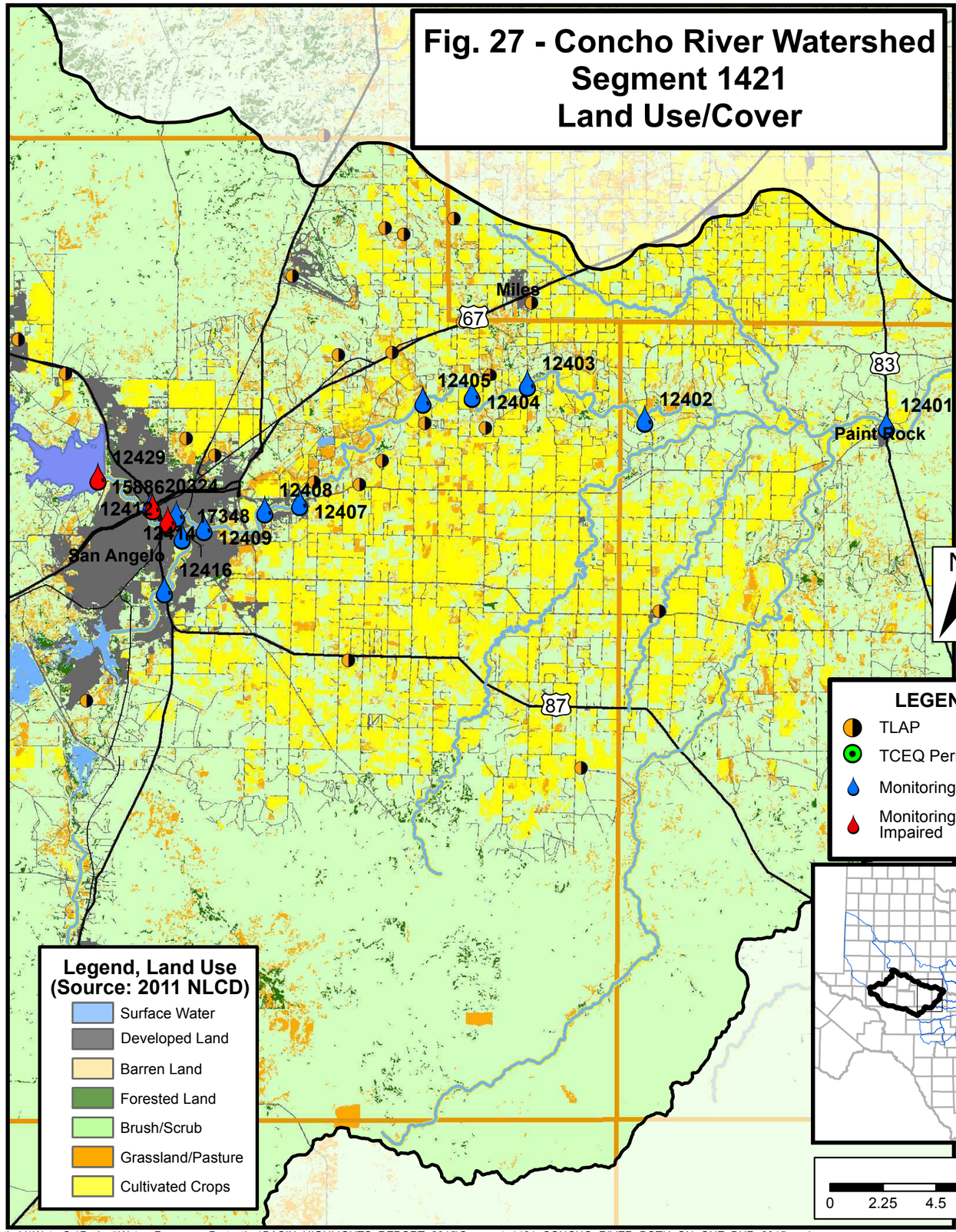

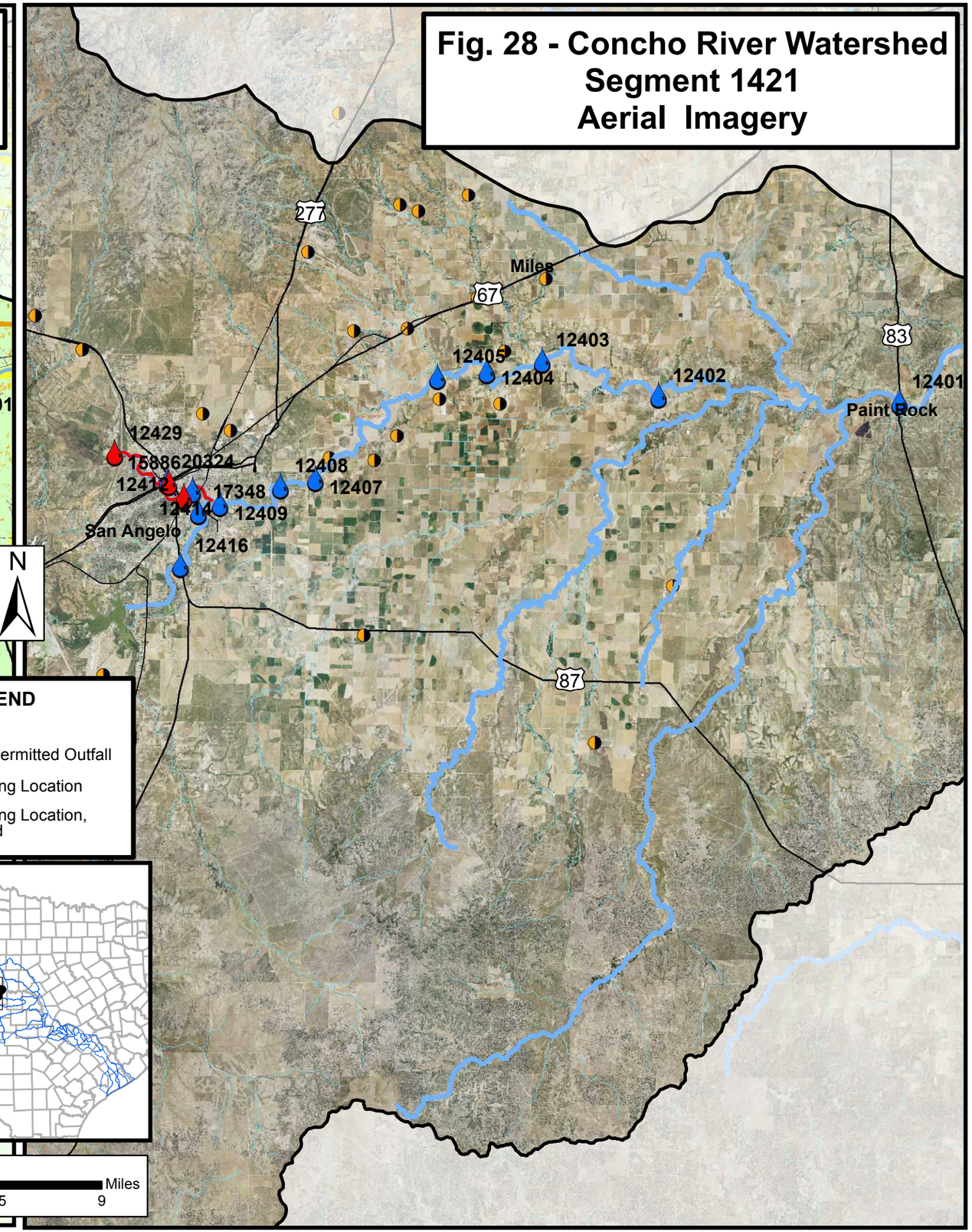

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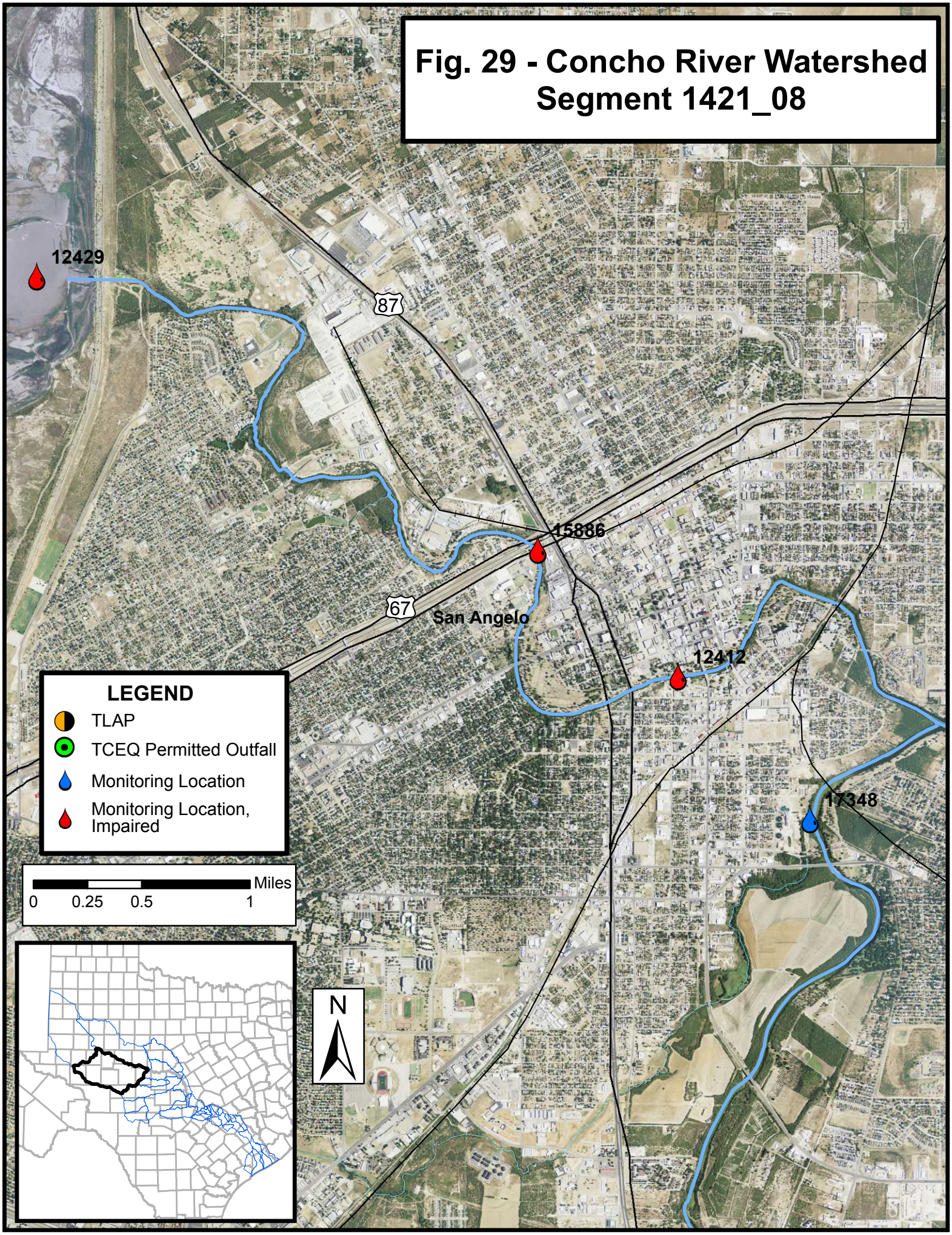

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Segment 1425: O.C. Fisher Lake **Impairment: Chloride and TDS**

Segment Description

O.C. Fisher Lake is located on the west side of the city of San Angelo in the Concho River watershed. It begins at the O.C. Fisher Dam and continues upstream to impound the North Concho River to normal pool elevation of 1908 feet above mean sea level. Constructed in 1952, it is operated by the U.S. Army Corp of Engineers (USACE). The conservation pool covers 5,440 surface acres with a storage capacity of 119,200 acre-feet. The lake contained only a fraction of its capacity during the reporting period and went dry in 2011.

The lake is monitored at Site 12429, 425 meters west of the dam release control tower near midlake (Figure 30).

Land Use

San Angelo State Park is adjacent to the south side of the lake on about 8,000 acres of land leased from USACE. Adjacent to the lake on the north side is Angelo State University's (ASU) Management, Instruction and Research Center. It consists of about 6,000 acres of land leased from USACE and is operated by the Agriculture Department of ASU.

Over 95 percent of the watershed of the North Concho River consists of primarily mesquite and juniper shrub and scrub type vegetation (Figure 31). The land is used mainly for livestock grazing and wildlife operations. The watershed also contains some small grain and cotton farm operations that utilize groundwater irrigation.

Oil and gas production are prevalent throughout the watershed and have been since the early 1900s. No other major industries are present within the watershed.

Impairment Description

O.C. Fisher Lake has intermittently exceeded general use criteria since 2002. The impairment first appeared on the 2002 Texas 303(d) List due to chloride and TDS concentrations. It remained on the 303(d) List after the 2004 and 2006 assessments with natural sources noted as the sources of impairment. In 2008, the segment was found to be impaired for chloride, but TDS criteria were met. In 2010 and 2012, it met all dissolved solids criteria. Based on the Draft 2014 303(d) List, the segment exceeds the criteria for chloride and TDS again.

TCEQ characterizes the impairments as Category 5c by, which means more information should be collected before implementing a TMDL or other water protection effort. The Draft 2014 Integrated Report identified concerns for total phosphorus and chlorophyll-*a* in the segment.

Potential Causes of Impairments

Point Sources

Sterling City and the San Angelo State Supported Living Center located in Carlsbad have permitted wastewater treatment facilities that land-apply treated effluent.

Nonpoint Sources

Historical oil and gas production and dissolution of naturally occurring chlorides from shallow geologic formation may be sources of chloride in the watershed. The most likely causal agent for elevated chlorides and TDS is the interaction of inflows to the lake, evaporation from the lake and drought conditions. A Texas Institute of Applied Environmental Research study in 2008 concluded that chloride and TDS concentrations increased with decreasing lake levels. The study noted that periodic improvements in chloride and TDS concentrations correlated to freshwater inflows.

The lake has been dry or nearly dry since 2011 (Figure 33).

Actions Taken

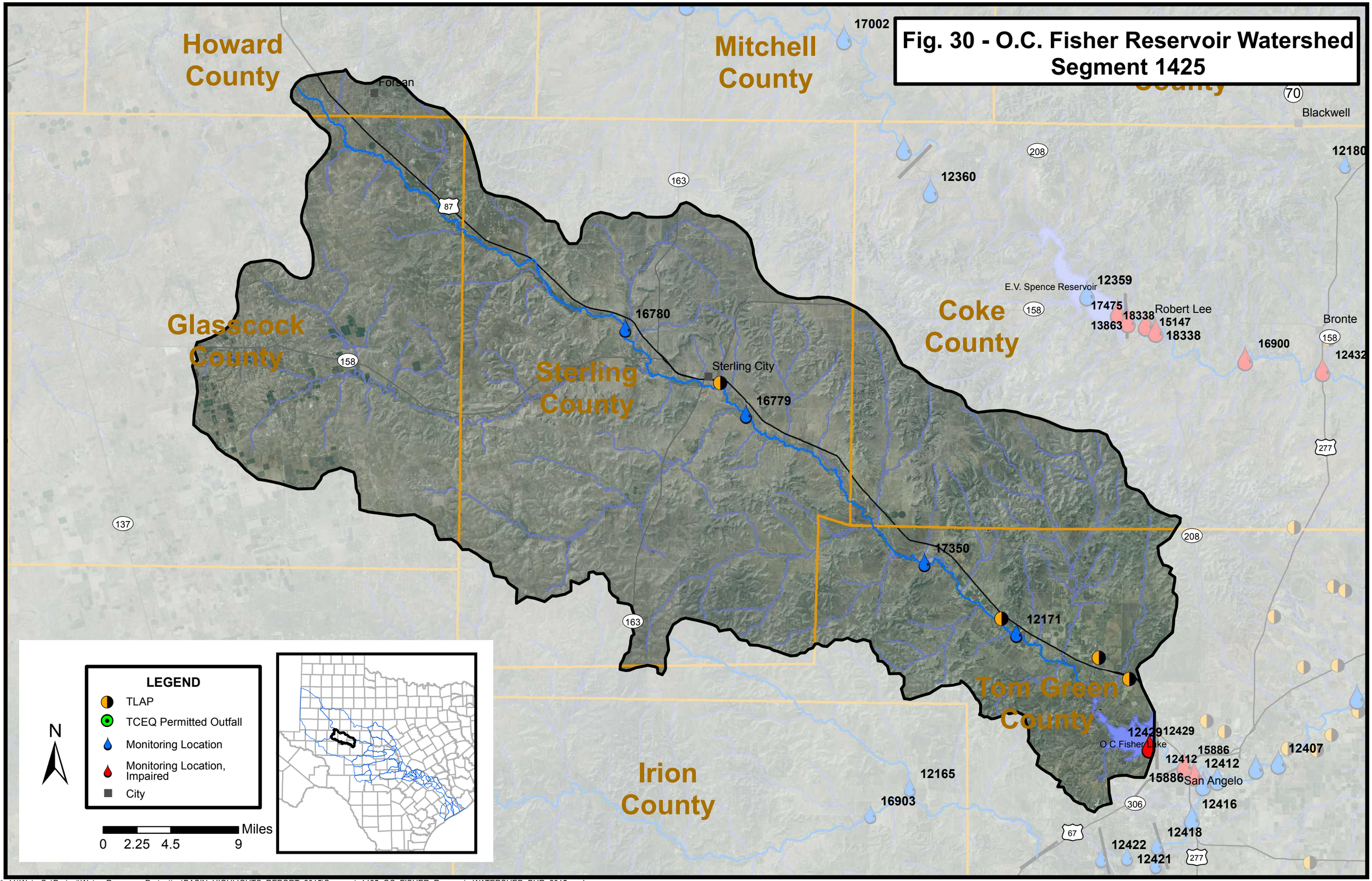
No action has been taken because the impairment has been attributed to naturally occurring sources and limited inflows, evaporation and drought.

Potential Stakeholders

- San Angelo State Park
- Texas Parks and Wildlife Department
- ASU
- City of San Angelo
- TCEQ
- UCRA
- LCRA

Recommendations

- Continue water quality monitoring when lake levels allow.



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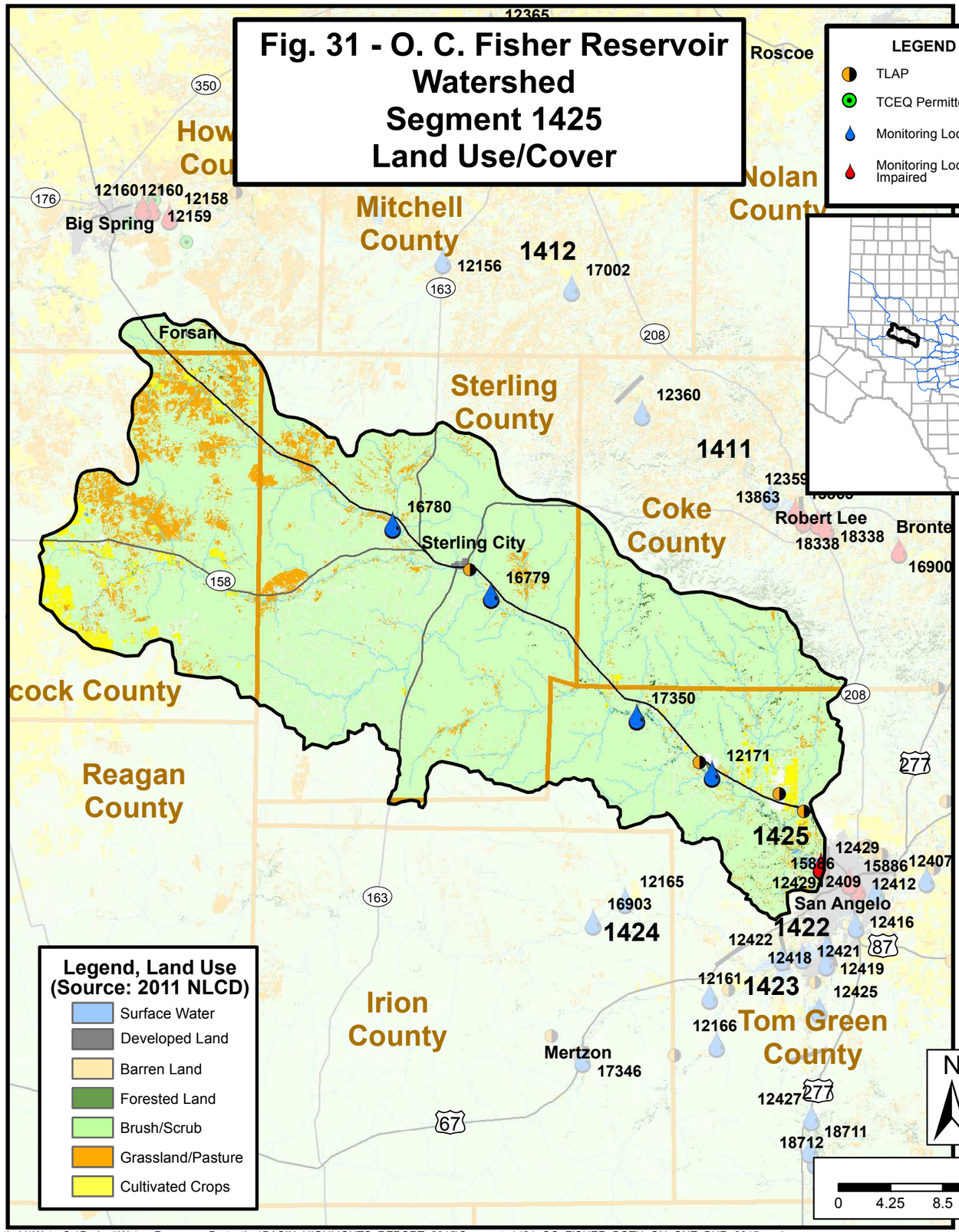

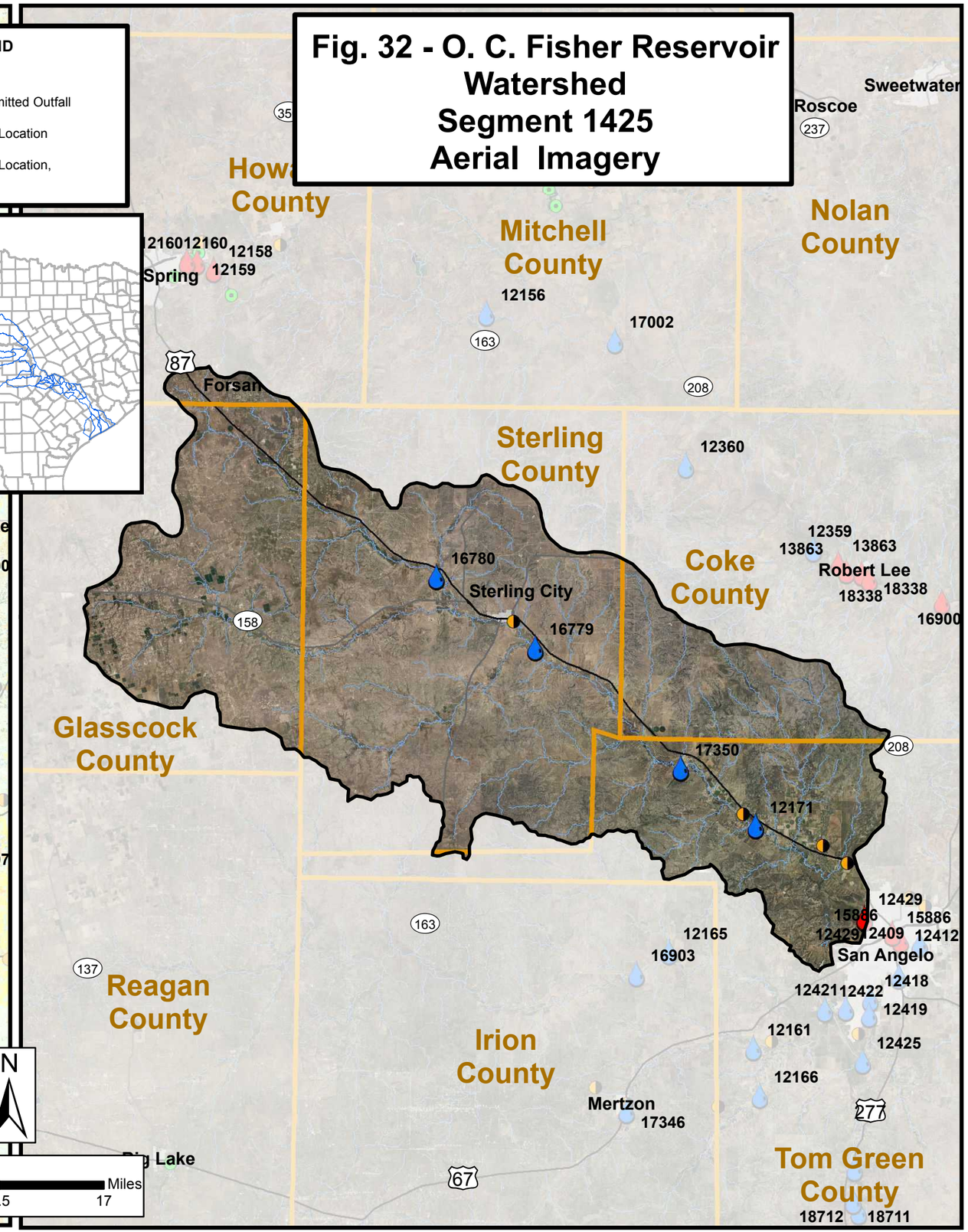

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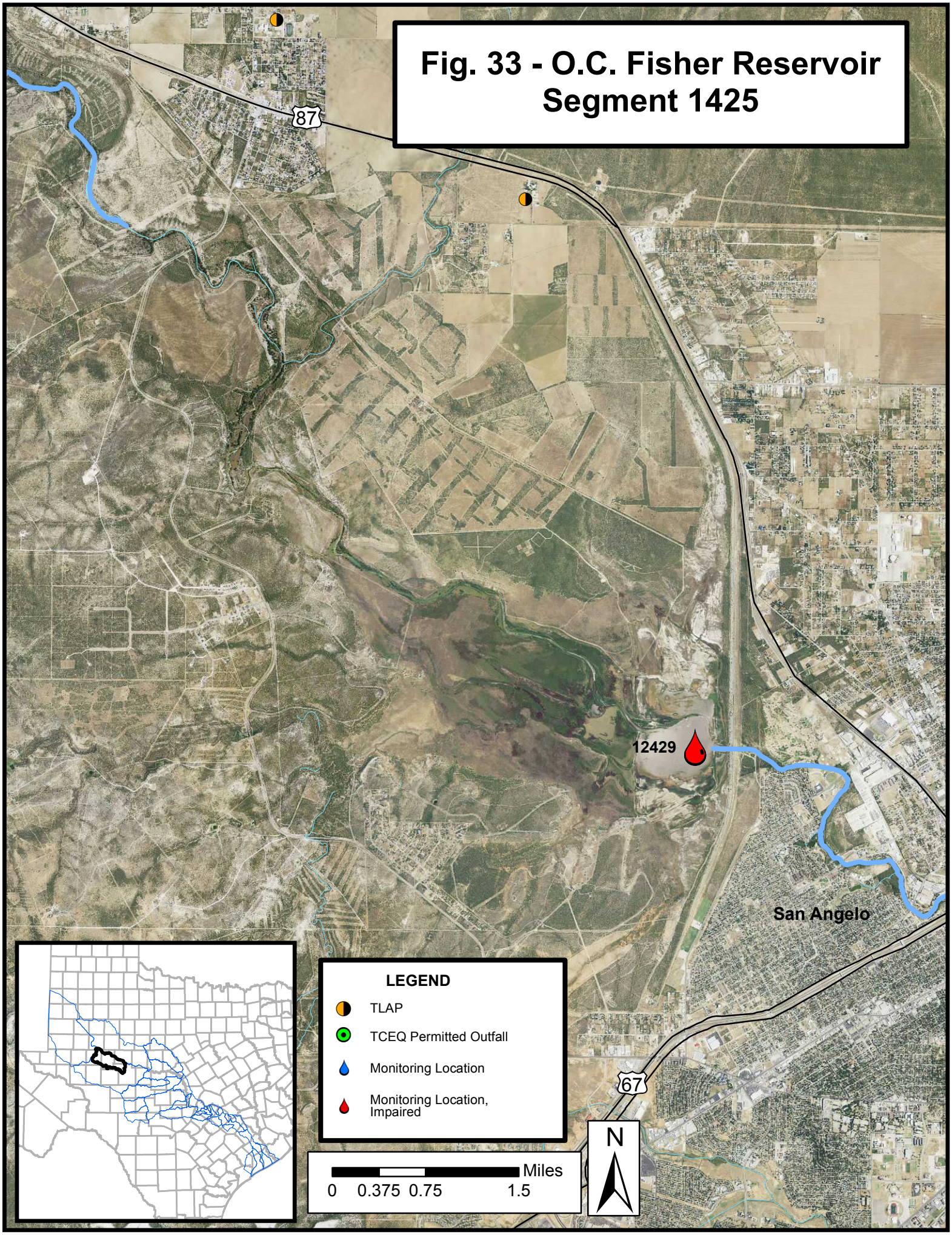

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Segment 1426: Colorado River below E.V. Spence Reservoir **Impairment: Chloride and TDS**

Segment Description

The Colorado River below E.V. Spence Reservoir is about 66 miles long. The segment begins 2.3 miles below the river's confluence with Mustang Creek in Runnels County (near the upper end of O.H. Ivie Reservoir) and continues upstream to Robert Lee Dam in Coke County (Figure 34). Under nondrought conditions, Segment 1426 receives the majority of its base flow from E.V. Spence Reservoir releases. The segment covers more than 2,000 square miles.

Segment 1426 is comprised of four AUs, 1426_01, 1426_02, 1426_03, and 1426_04 (Figure 36). It was monitored at the following sites during the period of record:

17244 – Colorado River at Blair Ranch downstream of confluence with Mustang Creek.
12430 – Colorado River at bridge on U.S. Highway 83 in Ballinger.
13651 – Colorado River at FM 2111 upstream from Rocky Creek.
16901 – Colorado River at FM 3115 south of Maverick.
12432 – Colorado River at U.S. Highway 277 south of Bronte.
16900 – Colorado River at Double Barrel Road.
18338 – Colorado River at downstream of State Highway 208 in Robert Lee.
17475 -- Colorado River downstream of Robert Lee Dam.

Land Use

Brush vegetation with a significant portion used for cultivated crops characterize the majority of the land in the segment's watershed (Figure 35). Oil and gas exploration and production are the dominant industries in the region.

Impairment Description

All four AUs in Segment 1426 are impaired for elevated chloride and TDS. TCEQ first listed the segment for chloride in 2002 and TDS in 1999. A TMDL titled *Two Total Maximum Daily Loads for Chloride and Total Dissolved Solids in the Colorado River Below E.V. Spence Reservoir* was adopted by TCEQ and approved by the EPA in 2007. TCEQ has been carrying out the TMDL Implementation Plan, which also was approved in 2007. TCEQ revised the TMDL Implementation Plan in 2014 and is awaiting approval.

In addition to the chloride and TDS impairments, chlorophyll-*a* and golden algae are listed as concerns in the Draft 2014 Integrated Report.

Potential Causes of Impairments

Point Sources

- The cities of Robert Lee, Bronte, Winters and Ballinger are permitted to land-apply their treated wastewater effluent.

Nonpoint Sources

- Leaking oil wells.
- Former brine disposal pits.
- Produced brine injection wells.
- Mineral dissolution of naturally occurring, shallow geological formations.
- Saltcedar transports salts from groundwater to leaves, which then concentrate salts at the surface of the soil when leaves drop each year.

Action Taken

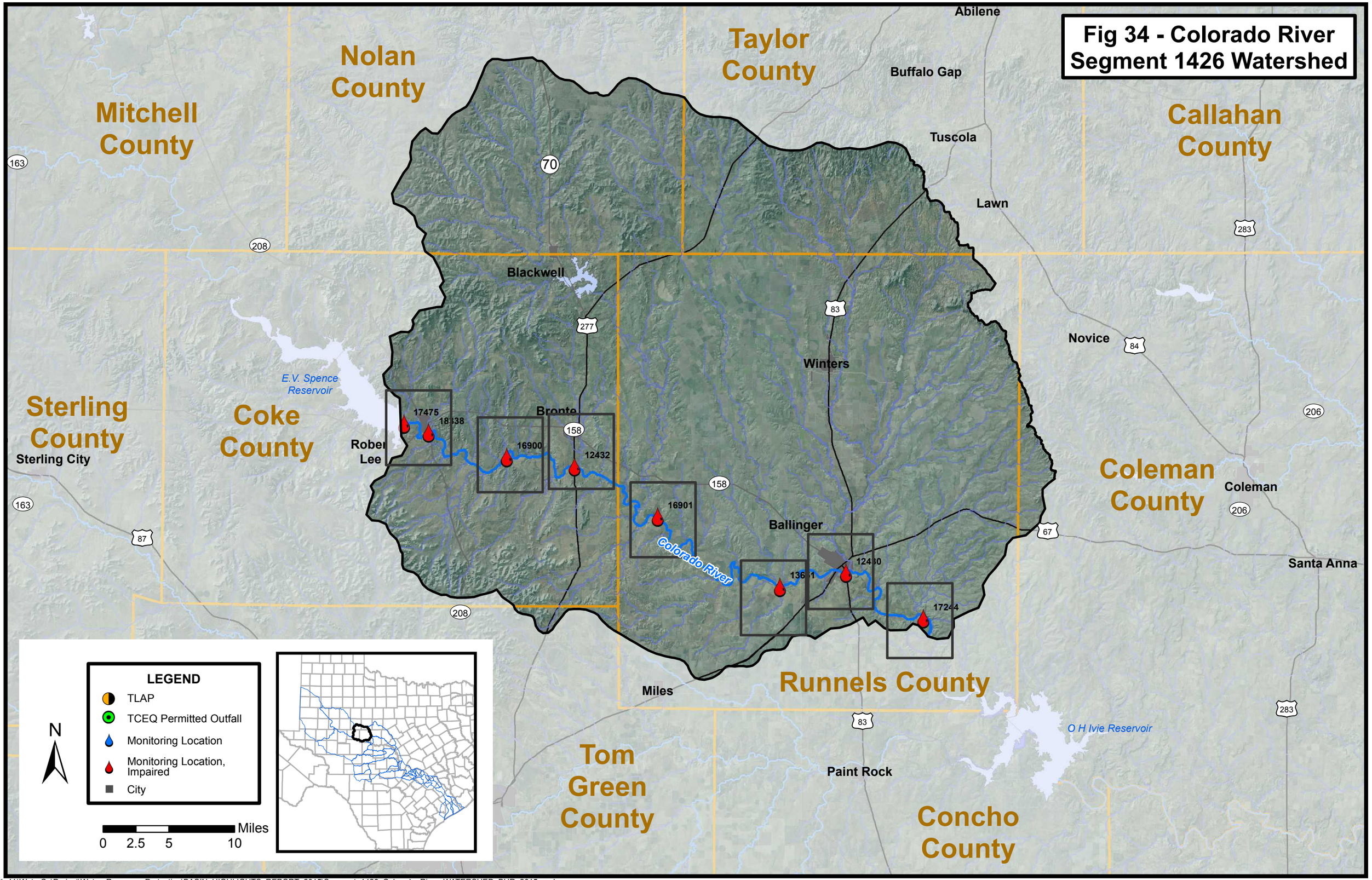
- The RRC drilled monitoring wells up-gradient and down-gradient of known seeps in the watershed to investigate the impact on surface water. It has plugged more than 180 wells in Runnels and Coke counties, many of them upstream of E.V Spence Reservoir.
- RCC plans to operate an interception recovery trench-abatement system near Ballinger for the recovery of chlorides.
- Since EPA approval in 2003, the TCEQ has been carrying out the TMDL Implementation Plan and water quality modeling.
- Saltcedar eradication programs in the watershed include aerial application of herbicide and biological treatment. The biological treatment includes introducing saltcedar leaf beetles.

Potential Stakeholders

- TCEQ
- RRC
- CRMWD
- Texas State Soil and Water Conservation Board
- UCRA
- Cities of Big Robert Lee, Ballinger, Winters and Bronte
- U.S. Fish and Wildlife Service
- Oil and gas operators
- Agricultural interests

Recommendations

- Continue identifying and plugging abandoned oil wells, gas wells and leaking wells.
- Continue saltcedar management strategies.
- Seek funding to implement BMPs identified by RRC.
- Continue routine surface water quality monitoring.
- Continue E.V. Spence Reservoir management measures.



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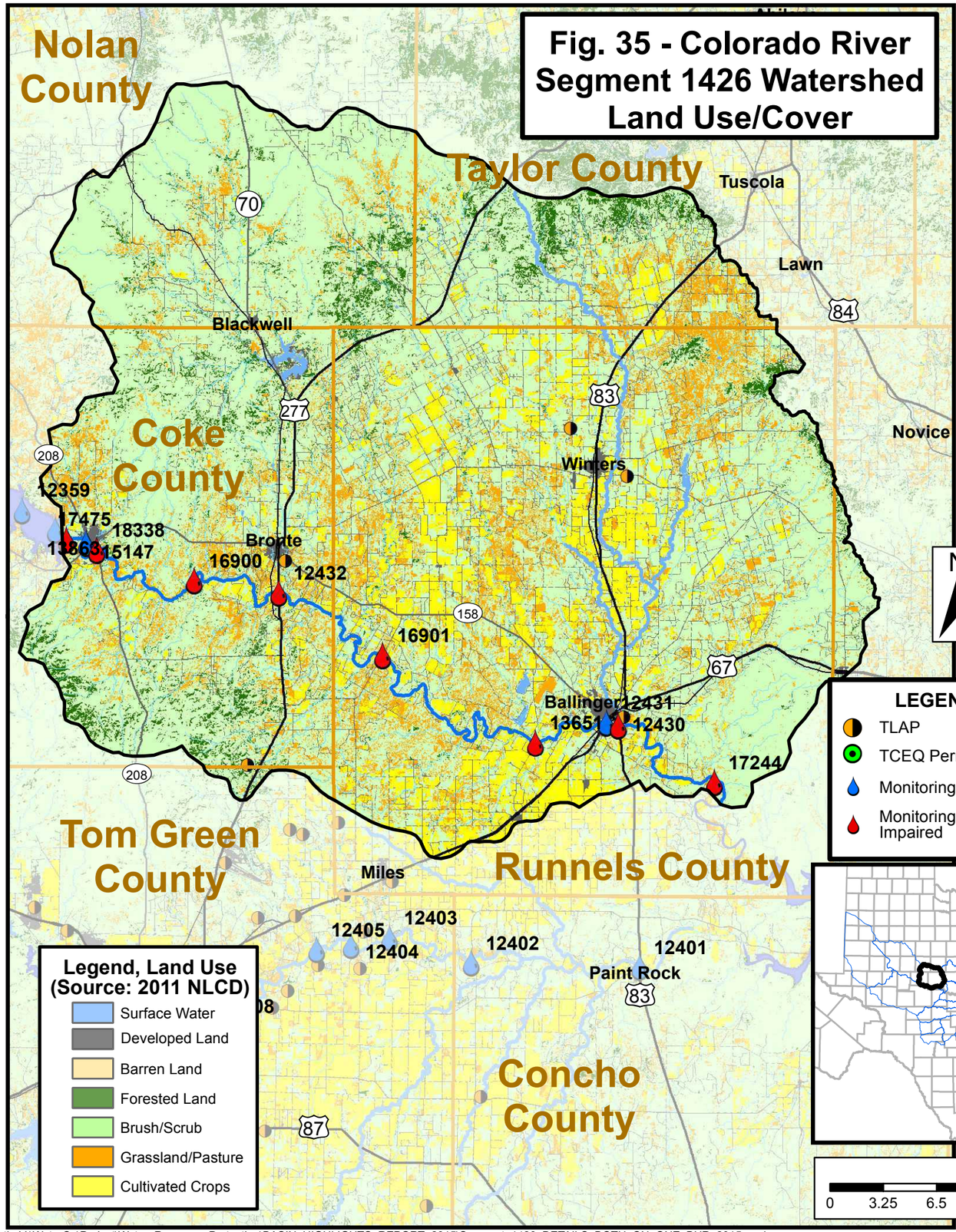

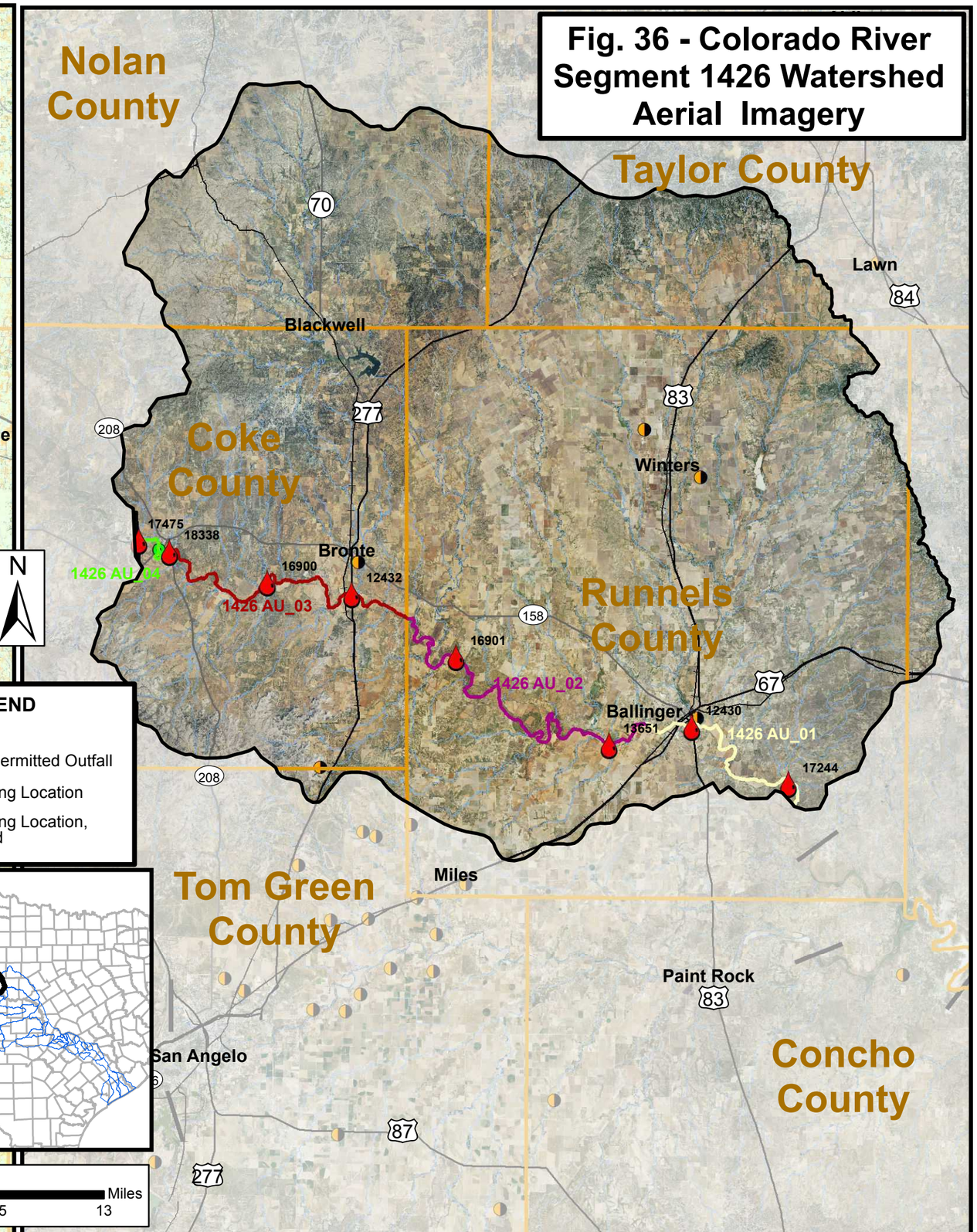

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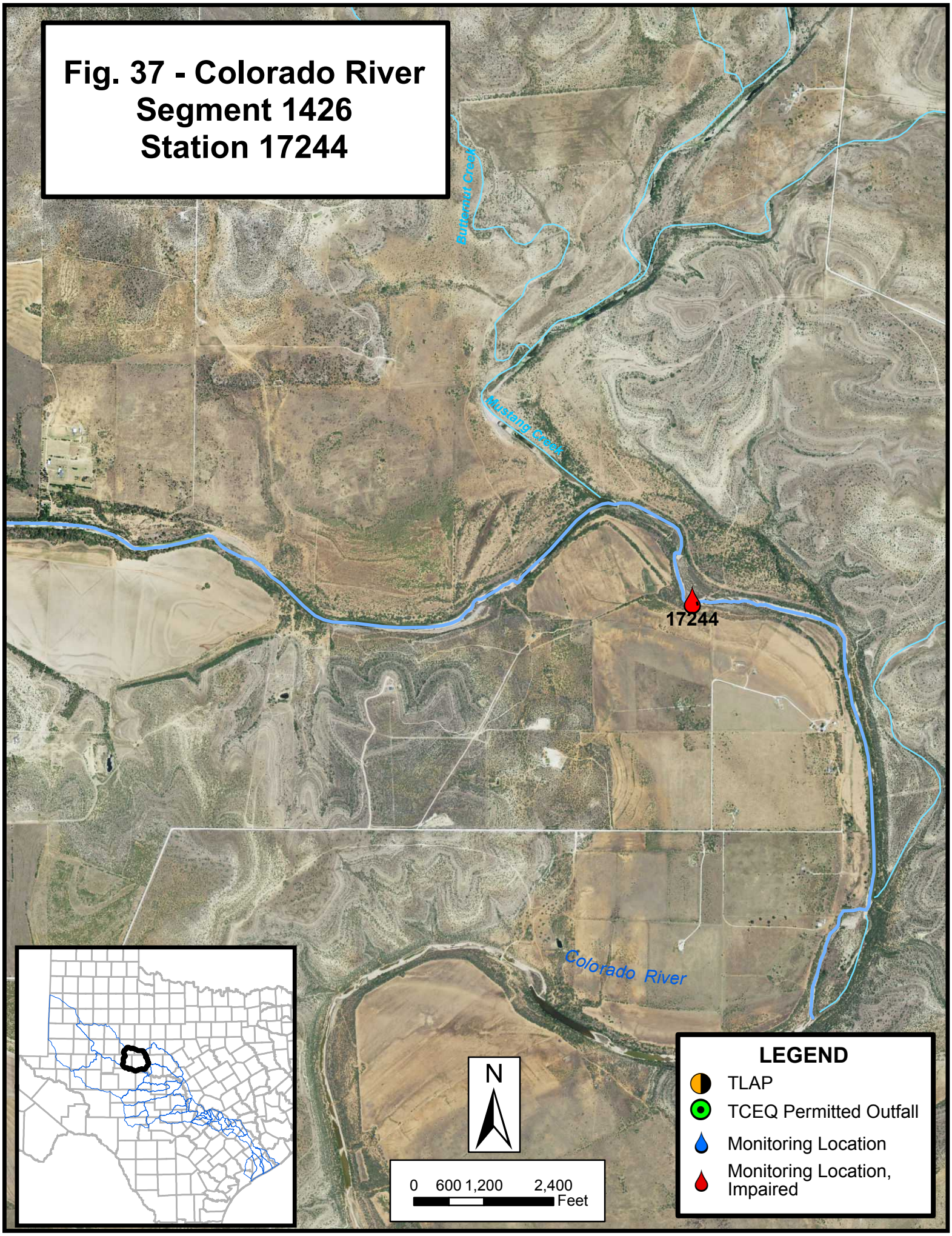

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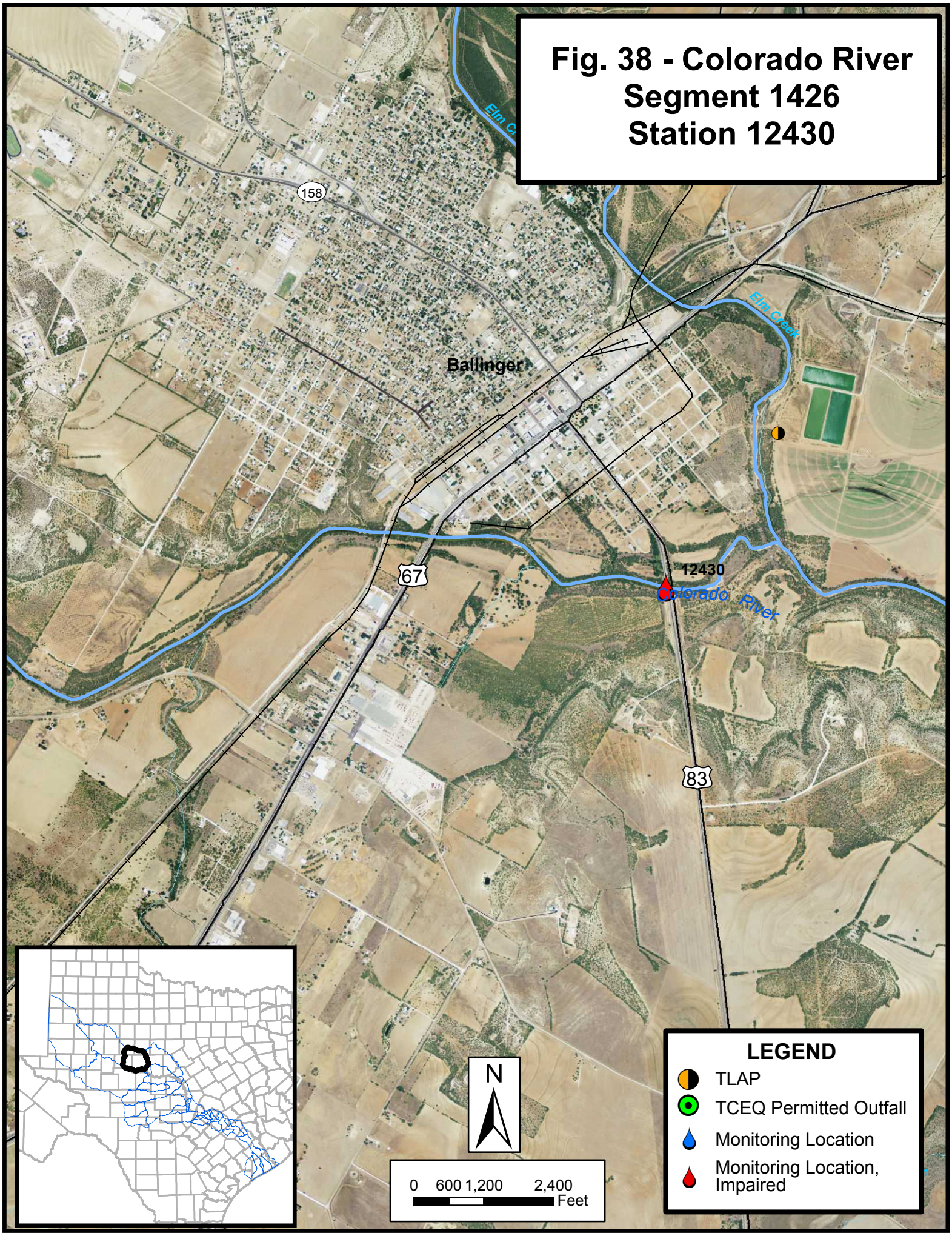

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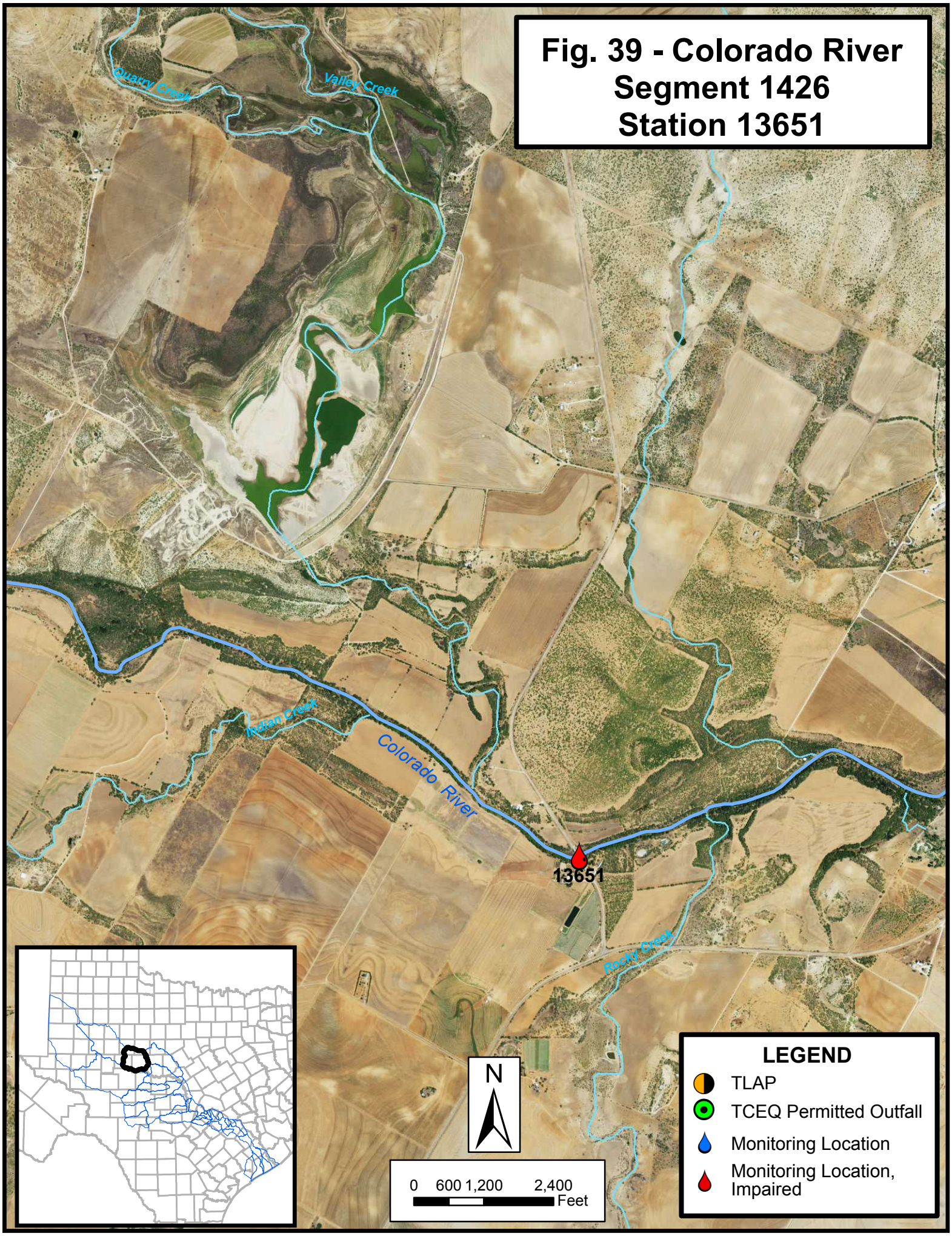

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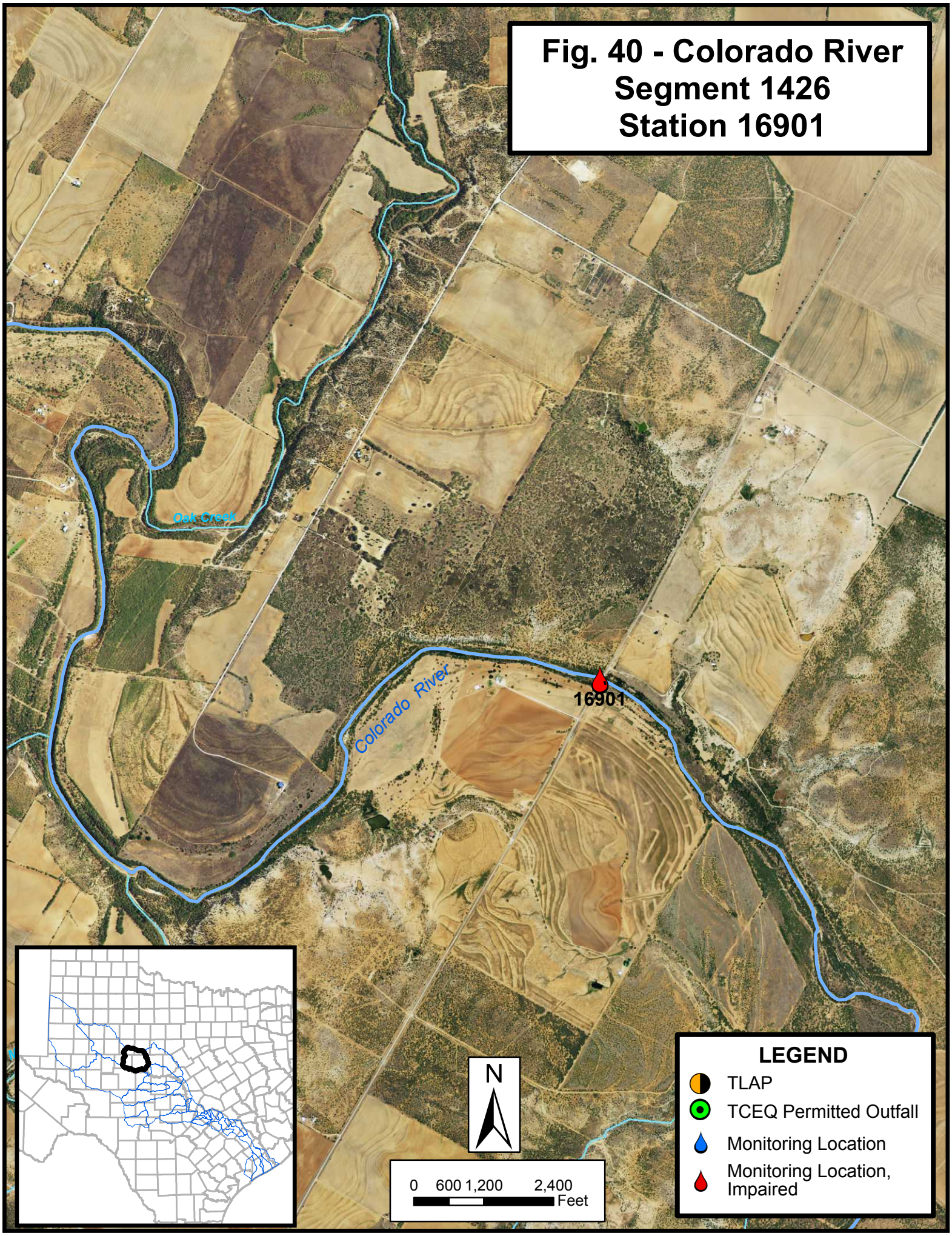

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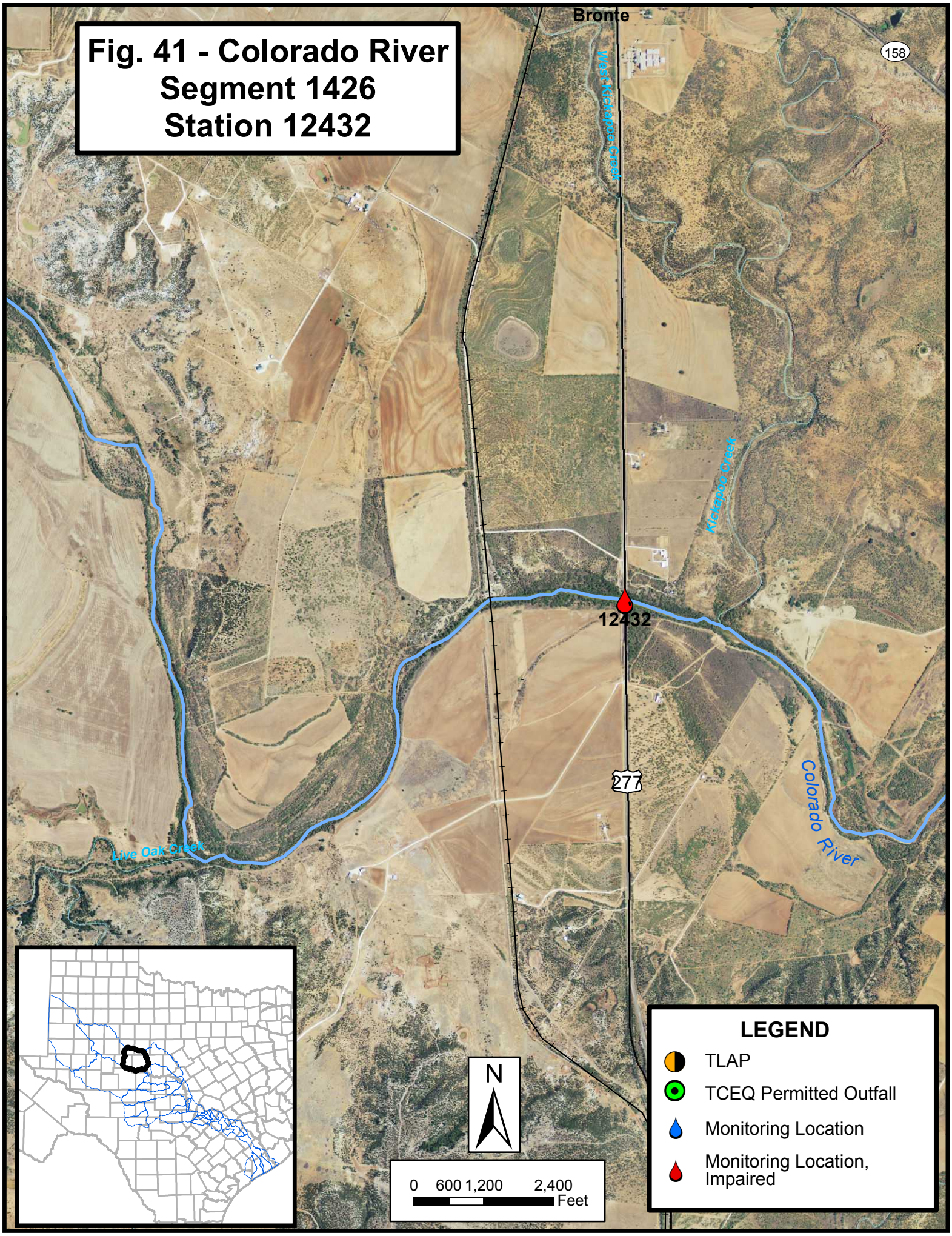

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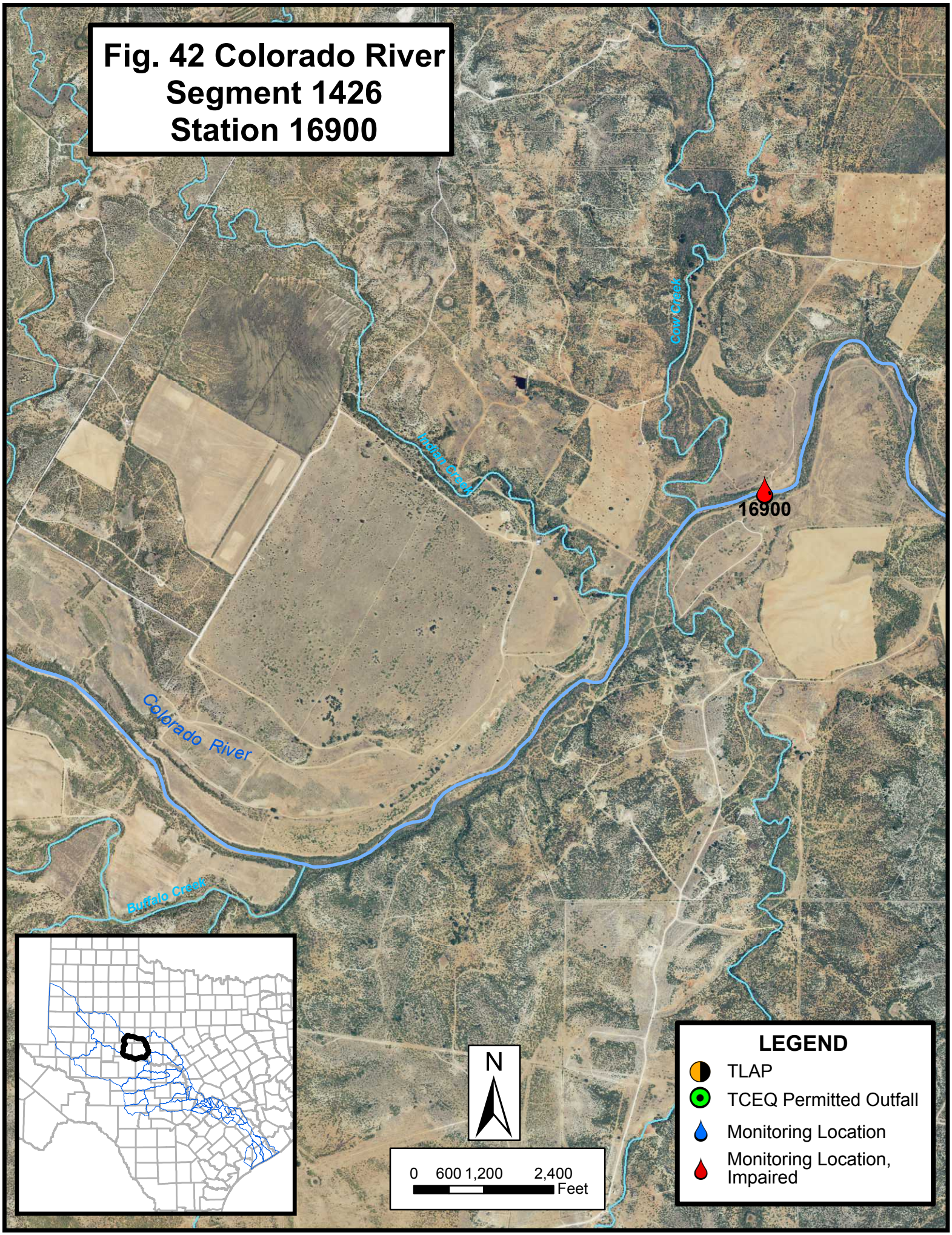

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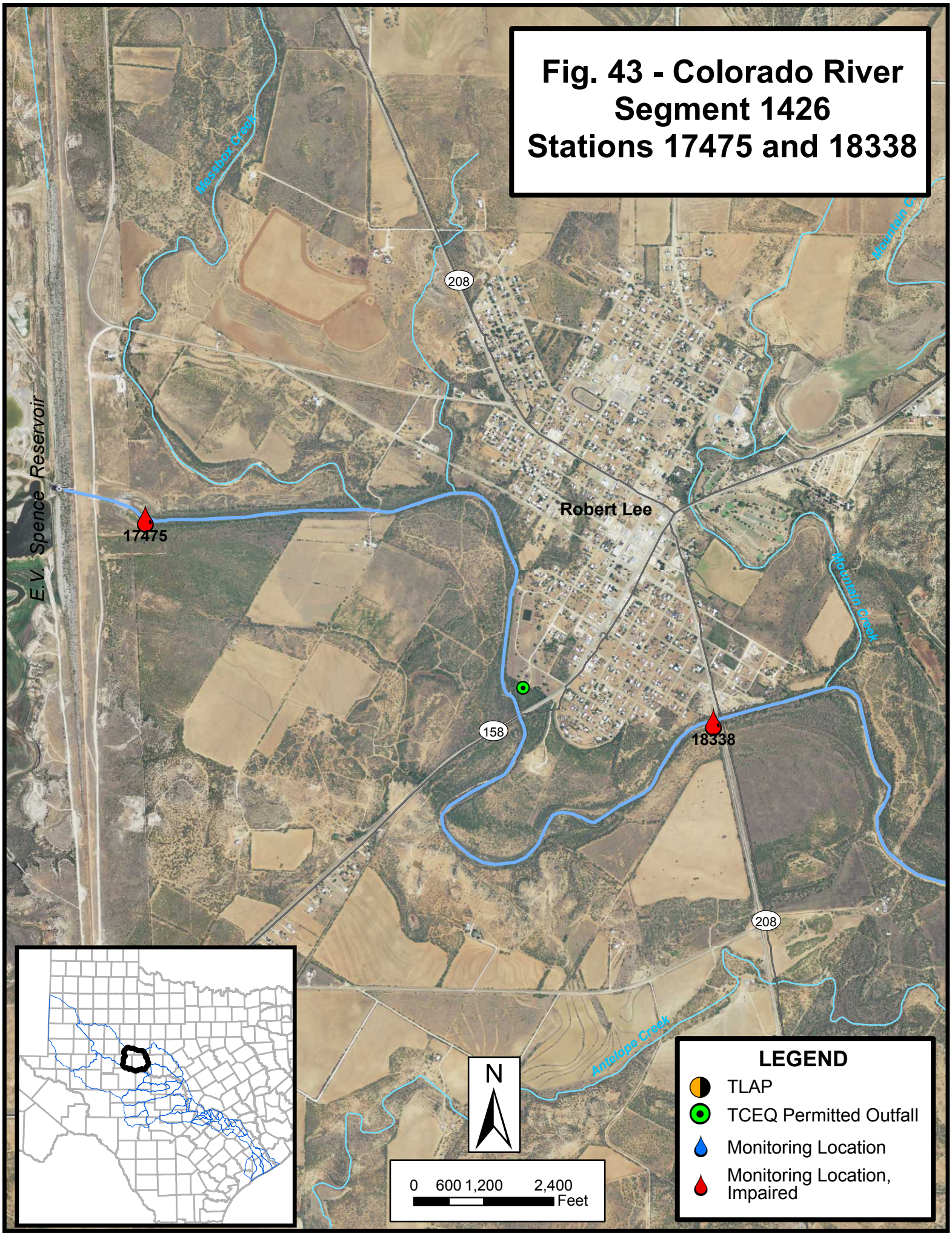

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Segment 1431: Mid Pecan Bayou **Impairment: Bacteria**

Segment Description

Pecan Bayou is a tributary of the Colorado River upstream of Lake Buchanan. Pecan Bayou begins at its confluence with the Colorado River and ends upstream in Callahan County (Figure 44). Segment 1431 begins immediately upstream of the confluence with Mackinally Creek in Brown County and ends just upstream of Willis Creek, east of Brownwood (Figure 46). The segment, about 13 miles long, is composed of one AU. TCEQ monitors the segment at Site 12504 (Pecan Bayou at FM 2126, downstream of Brownwood), but it was monitored by other agencies at the following sites as part of an RUAA project:

12503 – Mid-Pecan Bayou upstream of FM 2126.
12505 – Mid-Pecan Bayou downstream of FM 2126.
12507 – Mid-Pecan Bayou at County Road 257 and 10-Mile Crossing.
20799 – Mid-Pecan Bayou upstream of County Road 257 and 10-Mile Crossing.
20800 – Mid-Pecan Bayou downstream of County Road 257 and 10-Mile Crossing.

Land Use

Brownwood is located at the headwaters of the segment. Immediately downstream of the city, the surrounding watershed is primarily brush and grassland used for pasture and row crops (Figure 45). There is a concentrated animal feeding operation (CAFO) near Site 12504 and the City of Brownwood Wastewater Treatment Plant (WWTP) discharges into Willis Creek about 1.5 miles upstream of Site 12504 (Figure 47).

Impairment Description

TCEQ first placed Segment 1431 on the 2006 303(d) List for not supporting contact recreation due to elevated levels of *E. coli*. High bacteria counts were reported in subsequent assessments. The Draft 2014 Integrated Report shows the geometric mean for *E. coli* as 191 MPN, exceeding the criterion of 126. The Draft 2014 Integrated Report also identified concerns for high levels of nitrate, total phosphorus and chlorophyll-*a*.

Potential Causes of impairment at Site 12504

<u>Nonpoint Sources</u>

- Animal feedlot – Speck Cattle LLC is adjacent to the site and may contribute bacteria. In 2010, TCEQ cited the facility for an unauthorized discharge.

- Livestock – Cattle graze in pastures upstream of the monitoring site. The cattle have access to the stream and may contribute fecal material to the water.

- Wildlife – Deer and feral hogs may be sources of fecal contamination.

- Urban runoff – Site 12504 receives all the stormwater from the City of Brownwood. This likely contributes to bacteria levels in the stream during rain events.

Point Sources

The City of Brownwood WWTP is permitted to discharge 4.5 million gallons per day (MGD) of treated effluent into Willis Creek, a tributary of Pecan Bayou upstream of the monitoring site.

Actions Taken

- A level of aquatic life use support has not been established for the segment. In 2010 and 2011, TCEQ and LCRA collected biological data to establish an appropriate aquatic life use designation. Results from the study indicate the segment will be assigned a high aquatic life use. The designation is scheduled to occur in the 2017 revisions to the *Texas Surface Water Quality Standards*.

- TCEQ Region 3 (Abilene) has pursued enforcement actions against the owners of the CAFO located near Site 12504.

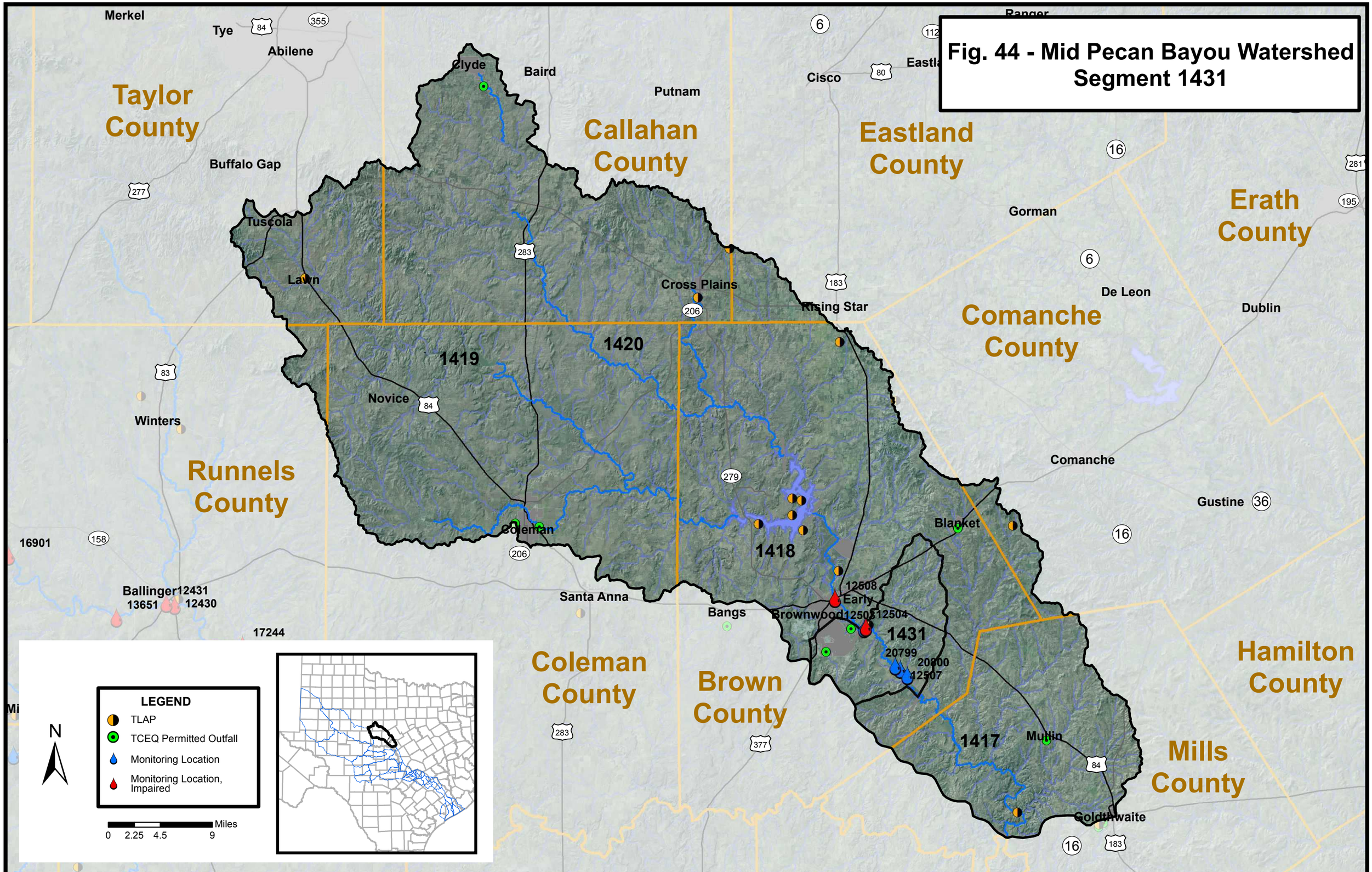
- In August 2010, the Texas Institute for Applied Environmental Research and Texas AgriLife Extension began a RUAA on Segment 1431. They completed the final report in January 2012. TCEQ is reviewing the document.

Potential Stakeholders

- Brown County Soil and Water Conservation District
- CAFO operator
- City of Brownwood
- LCRA
- Local landowners
- Natural Resource Conservation District
- Texas Department of Agriculture
- Texas AgriLife Extension
- Texas Parks and Wildlife Department

Recommendations

- Continue monitoring.
- Wait for TCEQ's review of the RUAA.



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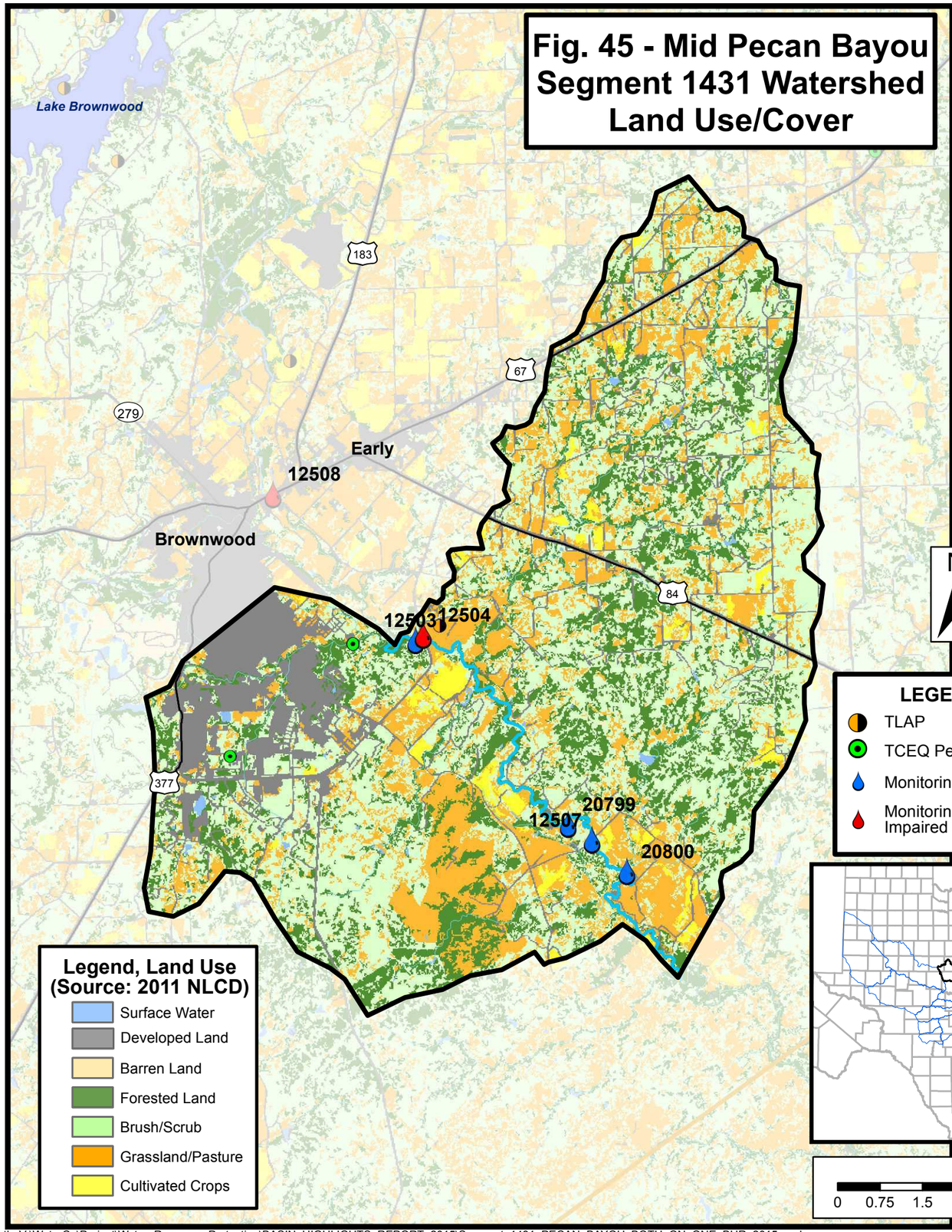

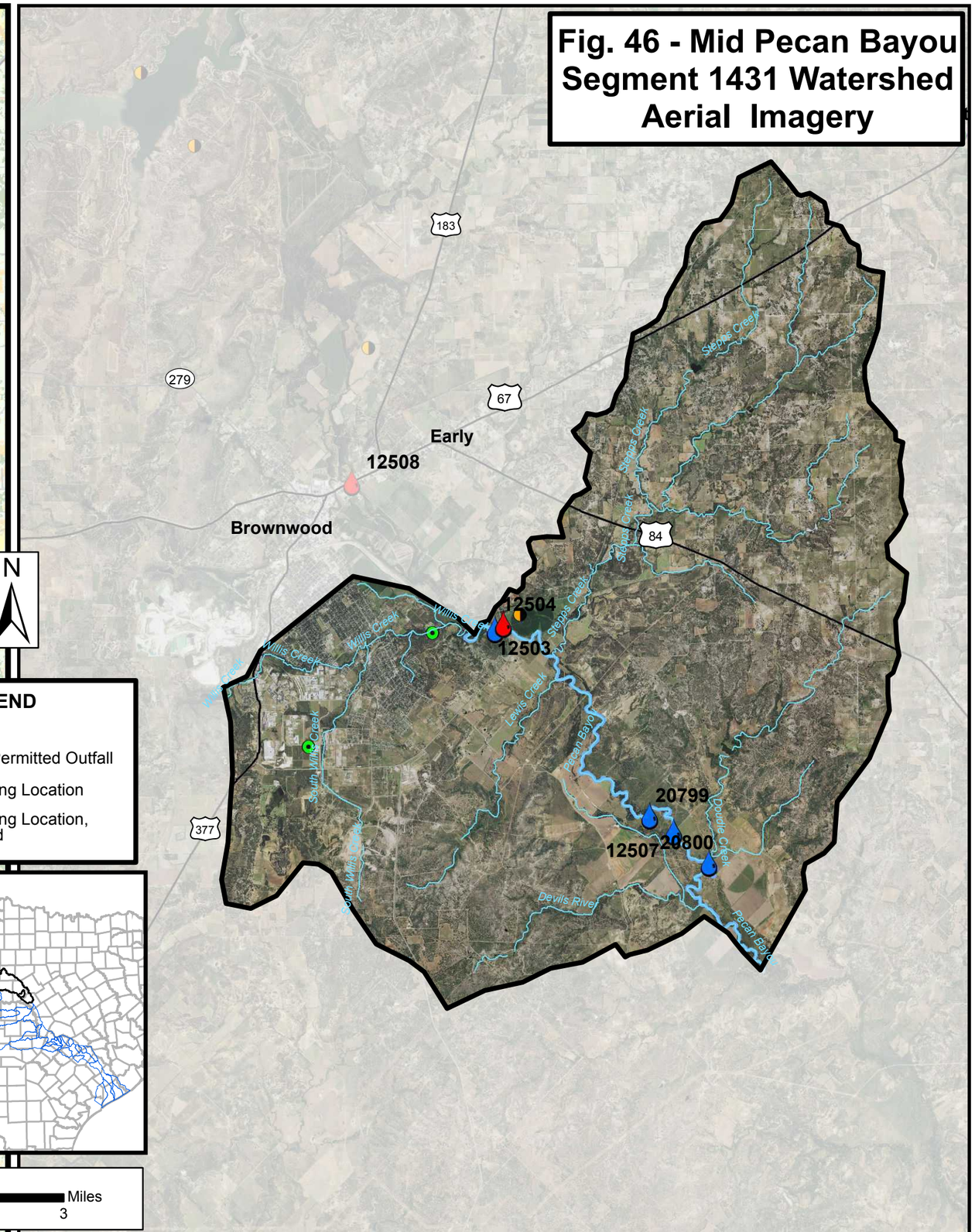

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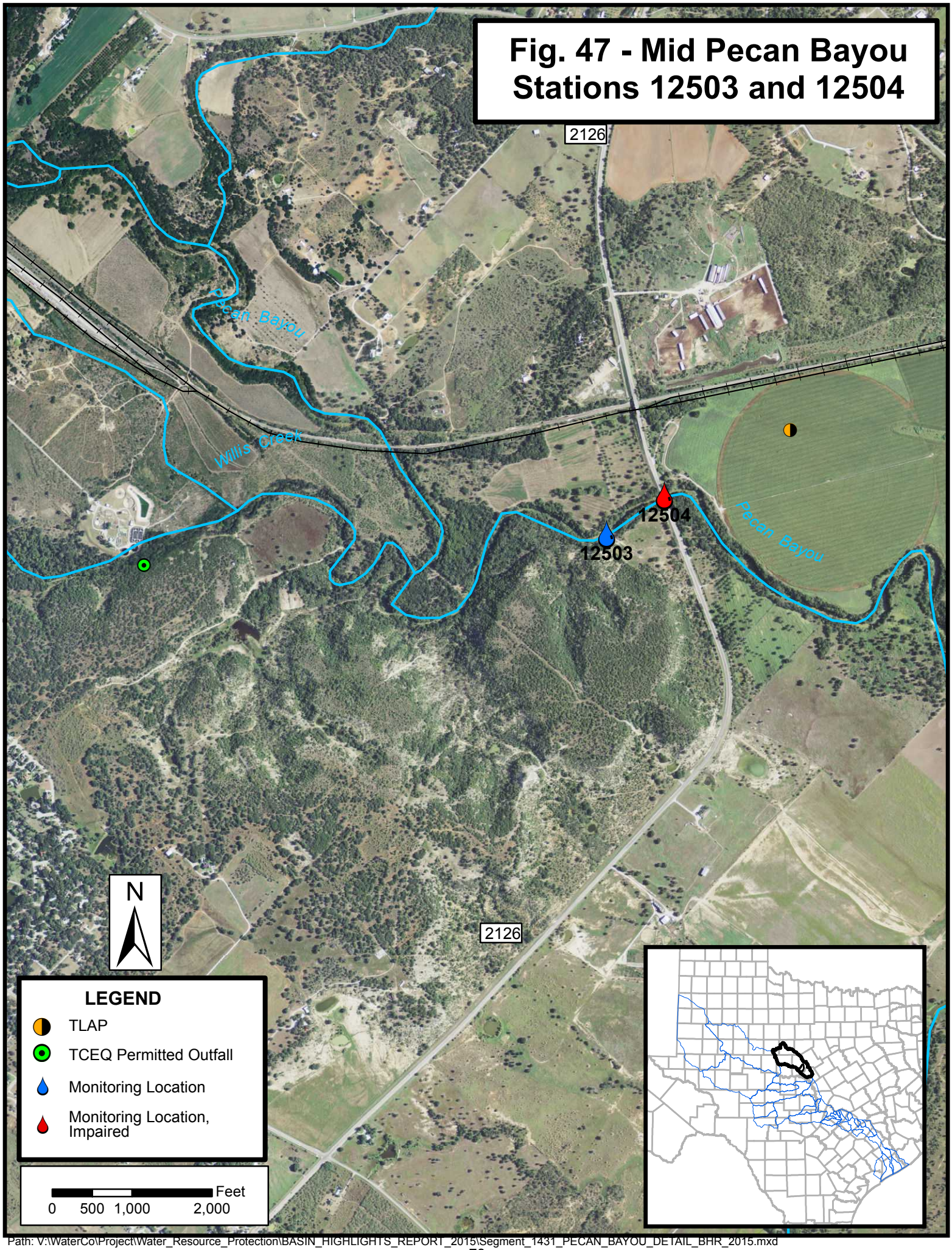

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Segment 1432: Upper Pecan Bayou **Impairment: Bacteria**

Segment Description

Pecan Bayou is a tributary of the Colorado River above Lake Buchanan. Pecan Bayou begins at its confluence with the Colorado River and ends upstream in Callahan County (Figure 48). Segment 1432 begins immediately upstream of the confluence with Willis Creek to Lake Brownwood Dam in Brown County (Figure 50). The segment, which is about 15 miles long, is composed of one assessment unit. It is routinely monitored by TCEQ at Site 12508 (Pecan Bayou at U.S. Highway 377 in Brownwood).

Land Use

Much of the Segment 1432 watershed is composed of grassland and brush vegetation with forested riparian areas surrounding the upper portion of the creek. The area immediately surrounding the site is a combination of agriculture and urban development (Figure 49) where the bayou flows through the east side of Brownwood. A dam restricts flow just upstream of Site 12508 (Figure 51). The lower 4 miles of watershed include agricultural uses, orchards and pastures.

Impairment Description

TCEQ first placed Segment 1432 on the Draft 2014 303(d) List for not supporting contact recreation due to elevated levels of *E. coli*. The Draft 2014 Integrated Report reports the geometric mean for *E. coli* as 225 MPN, exceeding the criterion of 126. The Draft 2014 Integrated Report also identified concerns for low dissolved oxygen levels and high chlorophyll-*a*.

Potential Causes of Impairment at Site 12508

<u>Nonpoint Sources</u>

- Livestock – Cattle graze in pastures upstream of the monitoring site. The cattle have access to the stream and may contribute fecal material to the water.
- Wildlife – Deer and feral hogs may be sources of fecal contamination.
- Urban runoff – Site 12508 receives stormwater runoff from Brownwood and nearby Earl. This likely contributes to bacteria levels in the stream during rain events.

Actions Taken

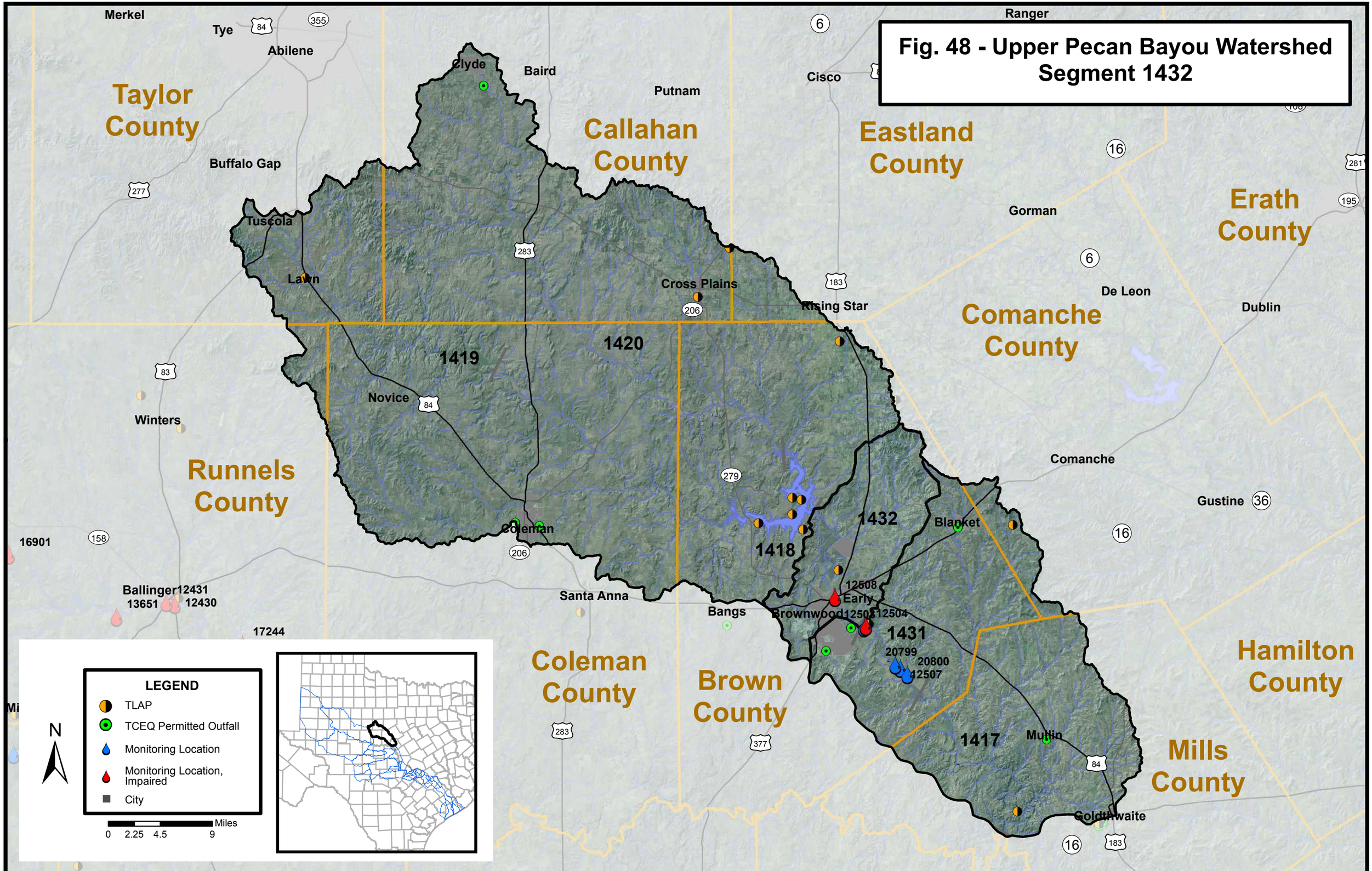
- TCEQ Region 3 proposed adding a new monitoring site upstream of Site 12508 during fiscal year 2016 to determine if the bacteria source is local.

Potential Stakeholders

- Brown County Soil and Water Conservation District
- CAFO operator
- City of Brownwood
- LCRA
- Local landowners
- Natural Resource Conservation District
- Texas Department of Agriculture
- Texas AgriLife Extension
- Texas Parks and Wildlife Department

Recommendation

- Continue monitoring.



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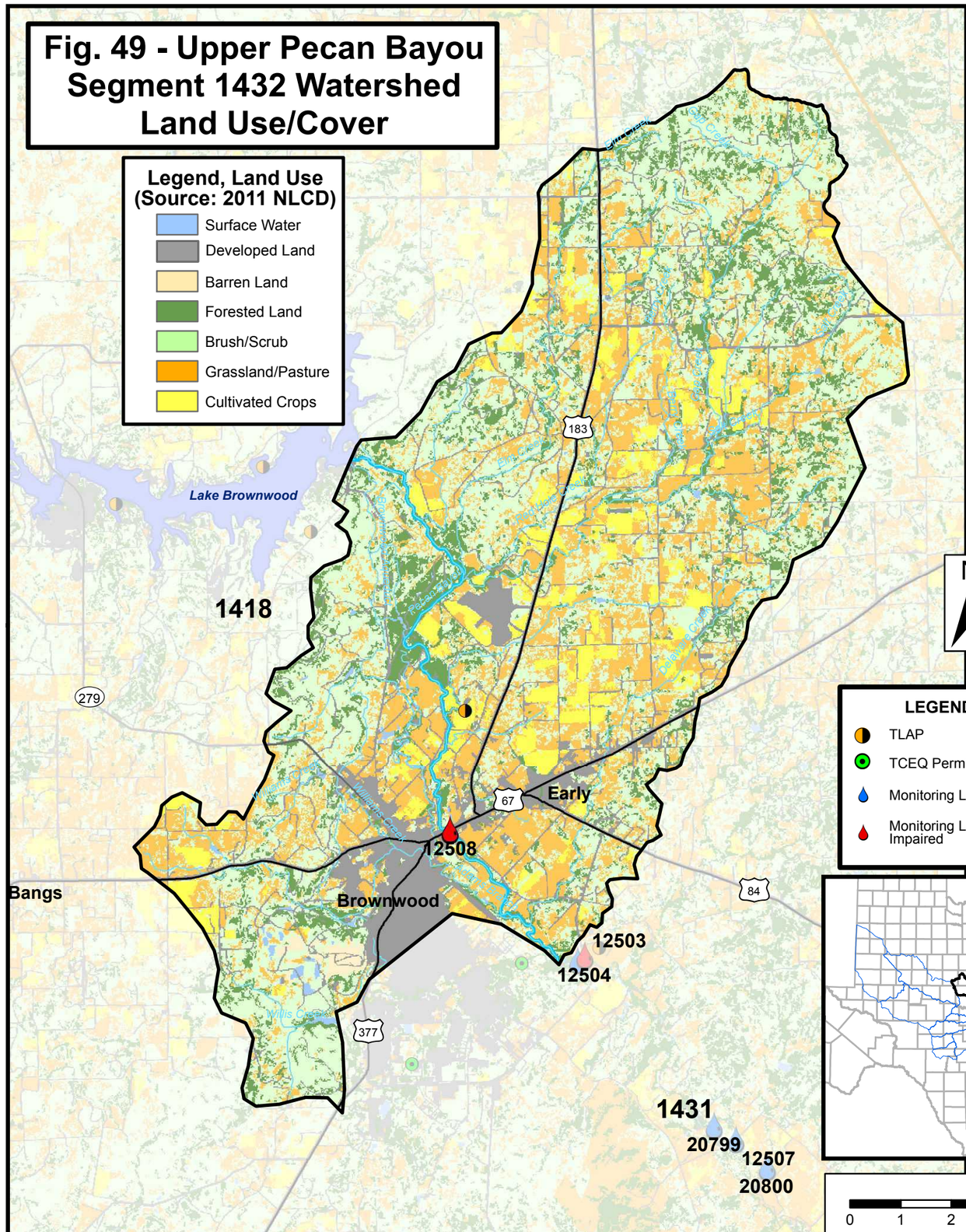

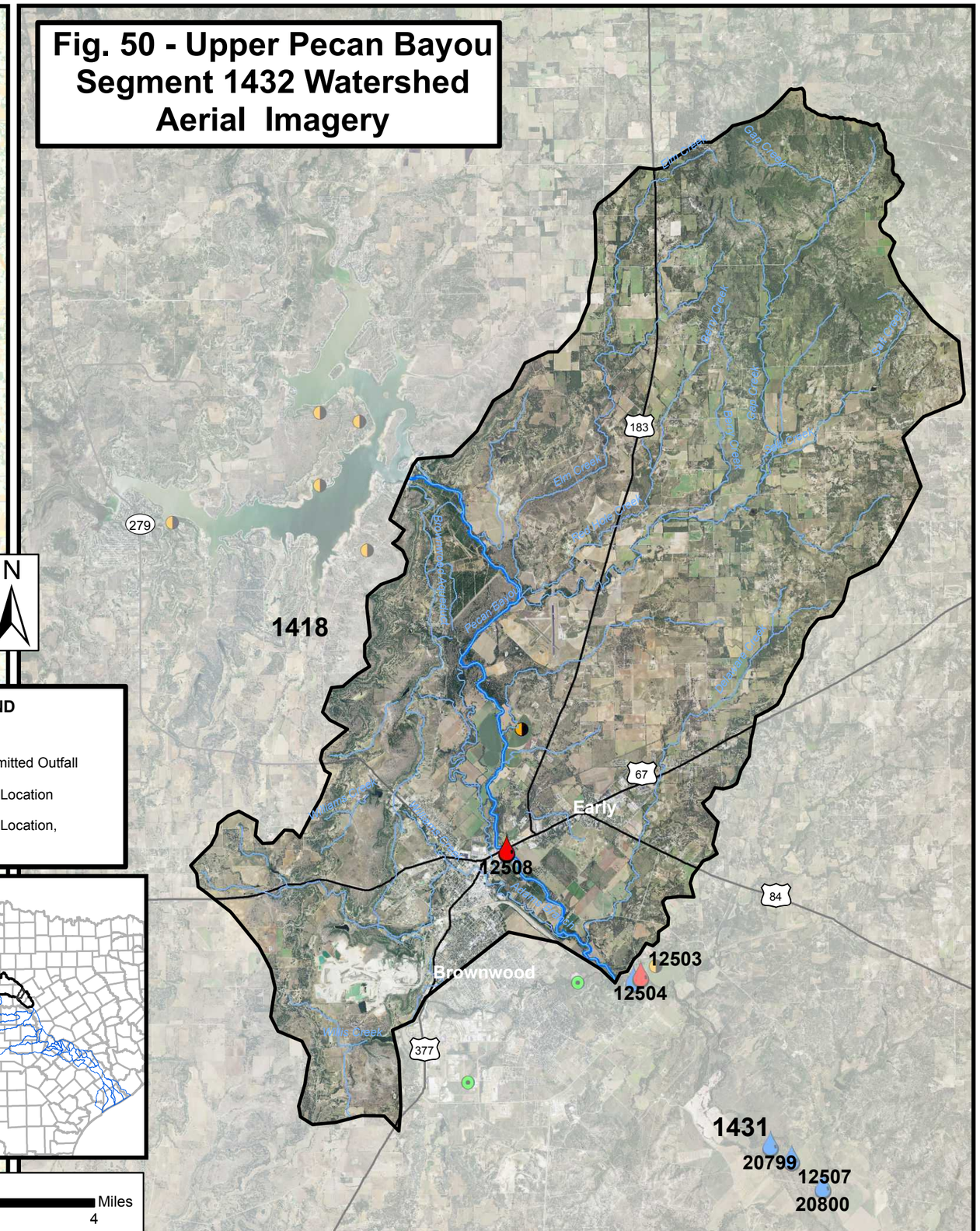

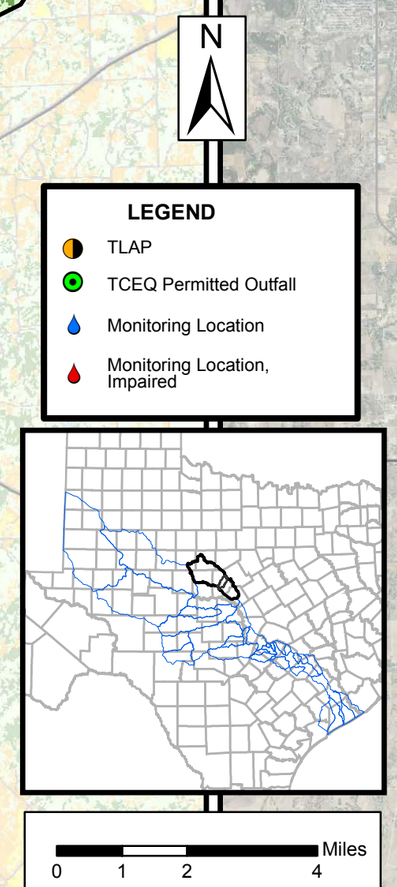

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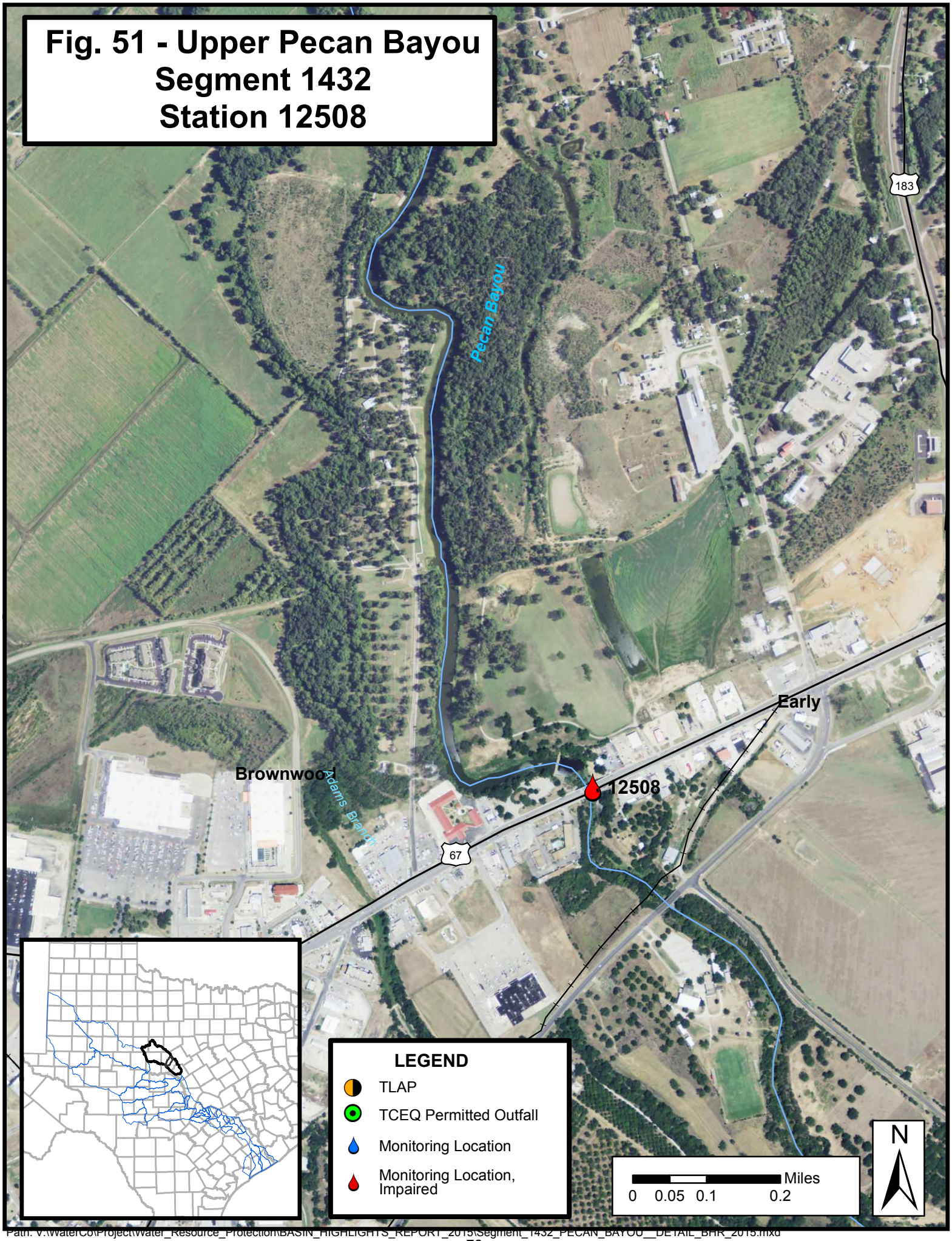

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Appendix A
Segments Delisted in 2014

Segment	Description	Use Impaired	Parameter	Reason Delisted
1401	Colorado River, tidal	Contact Recreation	Enterococcus	Recent data meets standard
1412B	Beals Creek	Aquatic life	Selenium in water	Recent data meets standard

Segment 1401 – Tidal portion of the Colorado River

The farthest downstream segment of the Colorado River, Segment 1401, was first placed on the 2006 303(d) List for not meeting its contact recreation use due to elevated levels of *Enterococcus*. Mean bacteria counts remained above the criteria of 35 MPN in subsequent assessments until 2014. The Draft 2014 Integrated Report reported a geometric mean of 31 MPN based on 41 samples collected for the assessment.

Segment 1412B – Beals Creek

Beals Creek is located near Big Spring in the upper Colorado River basin. TCEQ first placed Beals Creek on the 2010 303(d) List for not meeting its aquatic life use due to elevated levels of selenium in water. The impairment remained on subsequent 303(d) lists due to the limited amount of selenium data being collected. In 2014, new data showed the creek met aquatic life use criteria based on 15 selenium samples collected by TCEQ.

Appendix B

Summary of Texas Surface Water Quality Standards

TCEQ protects water quality by establishing *Texas Surface Water Quality Standards* for all water bodies in the state. The standards are made up of two components: designated uses and criteria. Designated uses are purposes for water, including general use, aquatic life use, contact recreation and public water supply. Criteria are usually numeric (sometimes narrative) limits used to compare water quality data or conditions. The designated uses and their associated criteria are described as follows:

General Use – The category was created to protect overall water quality. Temperature, pH, chloride, sulfate and TDS criteria are used to gauge support for this use. Numeric criteria for these parameters vary among water bodies in the Colorado River basin.

Aquatic Life Use – TCEQ has established different criteria (Table 1) to determine support for aquatic life in freshwater. For each standard, there are four levels: exceptional, high, intermediate and limited. As a general rule, all perennial streams are assumed to have a high aquatic life use designation.

Table 1. Aquatic life use criteria

Level of Aquatic Life Use Attainment	Dissolved Oxygen (grab sample or 24-hour average)	Dissolved Oxygen (24-hour minimum)	Fish Community Index Score	Benthic Community Index Score	Habitat Index Score
Exceptional	6.0	4.0	58-60	>36	26-31
High	5.0	3.0	48-52	29-36	20-25
Intermediate	4.0	2.0	40-44	22-28	14-19
Limited	3.0	2.0	<34	<22	<14

Contact Recreation – This use refers to a water body's ability to safely support physical contact such as swimming. The standard (Table 2) for contact recreation is a measure of bacteria levels. In freshwater, the indicator is *Escherichia coli* bacteria, though fecal coliform bacteria were used as indicators until the early 2000s. In saltwater and coastal areas, *Enterococci* bacteria are used as the indicator. Units of measure for bacteria test results may be reported in most probable number (MPN).

Table 2 – Criteria for Bacteria Based on Texas Surface Water Quality Standards

Bacteria	Geometric Mean Criteria	Single Sample Criteria
Fecal Coliform	200	400
E. coli	126	394
Enterococcus	35	89

Public Water Supply – This use is evaluated by assessing finished drinking water and/or surface water conditions. Finished drinking water is assessed for toxic contaminants at the point of entry to distribution systems. Finished drinking water also is assessed for elevated levels of dissolved minerals: chloride, sulfate and TDS, which have criteria of 300, 300 and 1000 mg/L, respectively. These criteria for dissolved solids are applied statewide and were developed to ensure that water supply utilities could treat and deliver water that is free of taste and odor.