A summary of water quality in the Colorado River basin during 2013
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>3</td>
</tr>
<tr>
<td>Water Quality Overview</td>
<td>4</td>
</tr>
<tr>
<td>Water Quality Monitoring</td>
<td>5</td>
</tr>
<tr>
<td>Water Quality Assessment</td>
<td>8</td>
</tr>
<tr>
<td>Restoring Impaired Water Bodies</td>
<td>10</td>
</tr>
<tr>
<td>Water Quality Review by Watershed</td>
<td>11</td>
</tr>
<tr>
<td>Upper Colorado River Watershed</td>
<td>12</td>
</tr>
<tr>
<td>Concho River Watershed</td>
<td>18</td>
</tr>
<tr>
<td>Lake Buchanan Watershed</td>
<td>22</td>
</tr>
<tr>
<td>Lake LBJ Watershed</td>
<td>26</td>
</tr>
<tr>
<td>Lake Travis Watershed</td>
<td>30</td>
</tr>
<tr>
<td>Austin Watershed</td>
<td>34</td>
</tr>
<tr>
<td>Lower Colorado River Watershed</td>
<td>38</td>
</tr>
<tr>
<td>Coastal Watershed</td>
<td>42</td>
</tr>
<tr>
<td>Public Participation</td>
<td>48</td>
</tr>
<tr>
<td>Appendix A — Texas Surface Water Quality: What Is It and How Is It Measured?</td>
<td>50</td>
</tr>
</tbody>
</table>
The Texas Clean Rivers Program is a statewide water quality monitoring and assessment program that provides funding and resources for regional watershed protection efforts. The program is administered by the Texas Commission on Environmental Quality (TCEQ) in partnership with river authorities and other regional governments. As Clean Rivers Program partners, the Lower Colorado River Authority (LCRA) and Upper Colorado River Authority (UCRA) monitor 105 sites and coordinate with the City of Austin Watershed Protection Department, United States Geological Survey and TCEQ regional offices to ensure efficient use of monitoring resources in the Colorado River basin. The data collected by these agencies are used to determine if water bodies meet Texas Surface Water Quality Standards.

In 2012, TCEQ evaluated 95 water bodies in the Colorado River basin. Based on the TCEQ assessment, the overall water quality in the basin is good. However, 22 of the assessed water bodies did not meet surface water quality standards. High bacteria levels, low levels of dissolved oxygen, and high chloride and total dissolved solids were among the causes of the impairments.

TCEQ, the Texas State Soil and Water Conservation Board and the above-mentioned agencies are addressing the impairments through restorative projects. Three watershed protection plans and two Total Maximum Daily Load (TMDL) projects continued in 2013. Verification monitoring was performed on several impaired water bodies.

The ongoing drought has had detrimental effects on regional water supplies and water quality in the Colorado River basin. Reduced flows and lake levels increase water temperatures and dissolved solids, and decrease dissolved oxygen levels. E.V. Spence Reservoir and Lake J.B. Thomas, in the upper basin, contain salinity levels comparable to Matagorda Bay due to mineral concentrations. Lake O.C. Fisher near San Angelo went dry and reservoir levels in lakes Buchanan and Travis reached historical lows in 2013 as inflows in 2011, 2012 and 2013 were the first, sixth and second lowest years on record, respectively.

In 2013, LCRA and its Clean Rivers Program partners continued to reach out to the public to educate and help resolve local water quality issues. Four Water Quality Advisory Committee meetings were held in the basin. These meetings, held in San Angelo, Brady, Austin and Wharton, provided a venue for local stakeholders to learn about water in their region and provide input on projects in their communities.
The Colorado River basin encompasses about 40,000 square miles from the Texas Panhandle to Matagorda Bay. Geology, soils, climate and human activities influence the river as it traverses the state. Mineralized soils in the upper Colorado and Concho river basins contribute to elevated chloride and sulfate levels in the water. Some reservoirs in the upper basin have salinity levels comparable to Matagorda Bay because of the long-term effects of the drought and a concentration of minerals. Major springs south of San Angelo create stable flows for the South Concho River and provide much needed water for the region.

The middle portion of the basin includes the Highland Lakes: Buchanan, Inks, LBJ, Marble Falls, Travis and Austin. Major tributaries — the Pedernales, Llano and San Saba rivers — have historically provided stable flows that played an important role in diluting salinity and suspended sediments from upstream. However, the recent drought has caused record low flows in the region. Inflows into the Highland Lakes during 2011, 2012 and 2013 were the first, sixth and second lowest years on record, respectively. Reservoir levels in the upper basin and lakes Buchanan and Travis reached historical lows in 2013 (Table 1). These persistent drought conditions impact water quality directly. Reduced flows increase water temperatures and dissolved solids and decrease dissolved oxygen levels, which can negatively impact aquatic life.

The limestone canyons of the Hill Country give way to deep clay soils downstream of Austin. Water in this region tends to be turbid due to high amounts of suspended solids. Drought has also impacted the river downstream of Austin. Treated wastewater effluent from Austin and the surrounding area provided much of the flow in 2013. Nutrient loading from wastewater discharges caused growth of aquatic plants downstream of Austin.

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Percent Full</th>
<th>Watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake J.B. Thomas</td>
<td>1.4</td>
<td>Upper Colorado River</td>
</tr>
<tr>
<td>E.V. Spence Reservoir</td>
<td>3.7</td>
<td>Upper Colorado River</td>
</tr>
<tr>
<td>O.C. Fisher Lake</td>
<td>0</td>
<td>Concho River</td>
</tr>
<tr>
<td>Twin Buttes Reservoir</td>
<td>1.6</td>
<td>Concho River</td>
</tr>
<tr>
<td>O.H. Ivie Reservoir</td>
<td>13.8</td>
<td>Upper Colorado River</td>
</tr>
<tr>
<td>Lake Brownwood</td>
<td>57.3</td>
<td>Pecan Bayou</td>
</tr>
<tr>
<td>Lake Buchanan</td>
<td>37.7</td>
<td>Lower Colorado River</td>
</tr>
<tr>
<td>Lake Travis</td>
<td>36.6</td>
<td>Lower Colorado River</td>
</tr>
</tbody>
</table>

*Table 1. Reservoir Levels on Jan. 11, 2014.*

*Colorado River downstream of Austin where mats of hydrilla and water hyacinth became established in summer 2013.*

*Lake Travis, Dec. 11, 2013.*
Water quality monitoring typically includes physical and chemical measurements such as levels of dissolved oxygen, suspended sediments, nutrients, temperature or pesticides in water. It can also include the collection of fish, aquatic insects and habitat data to measure aquatic life and assess the health of streams and reservoirs.

Monitoring data collected by Clean Rivers Program partners is collected under a TCEQ-approved quality assurance project plan (QAPP) to ensure that it is consistent with regulatory requirements. The data have many uses, including the development of the surface water quality standards, determining if water bodies meet those standards and development of wastewater permit limits. The following entities perform monitoring under an approved QAPP in the Colorado River basin: TCEQ, LCRA, UCRA, City of Austin, U.S. Geological Survey (USGS).

In addition to professionally collected data, more than 100 volunteers collect data in the basin through the Colorado River Watch Network, a program administered by LCRA. Volunteers often monitor in areas not routinely sampled by professionals, and their data serves as an important screening tool.

Colorado River Watch Network volunteers involved with the Austin Youth River Watch program teach about water quality testing at Onion Creek.
Colorado River Basin Water Quality Monitoring Locations

- Lower Colorado River Authority
- Upper Colorado River Authority
- Texas Commission on Environmental Quality
- U.S. Geological Survey
- City of Austin
Every two years, TCEQ compares all available quality assured data to the surface water quality standards — or to screening levels when no standards have been established — and publishes the results in the Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d). The Integrated Report defines the status of each water body as one of the following:

1. **Meets or Supports** — Sufficient data are available to assess. The water body meets all applicable surface water quality standards and fully supports its uses.

2. **Concern** — a) Sufficient data are not available to perform a full assessment and the limited data indicate surface water quality standards are not being met, or b) Surface water quality standards have not yet been established. If water quality data indicate a concern, resources are allocated to collect more data and verify the concern.

3. **Impaired** — Sufficient data are available and show that the water body does not meet surface water quality standards. If monitoring data indicate a water body does not support one or more of its designated uses, then it is said to be impaired. Details of the impairment are published in the TCEQ Integrated Report and 303(d) List.

Appendix A contains a detailed explanation of Texas Surface Water Quality Standards and the TCEQ assessment process. This report focuses on numbers 1 and 3 above, and does not include details of water bodies with a concern status.

TCEQ Commissioners approved the Draft 2012 report on Feb. 13, 2013, and EPA approved it on May 9, 2013. The 2012 Integrated Report included an evaluation of 95 water bodies in the Colorado River basin. Twenty-two received an impaired designation (Table 3) from TCEQ.
<table>
<thead>
<tr>
<th>Parameter(s)</th>
<th>Year Listed</th>
<th>Actions Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
<td>2008</td>
<td>Maintain monitoring</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2010</td>
<td>High salinity levels prevent proper analysis of bacteria.</td>
</tr>
<tr>
<td>Selenium in water</td>
<td>2010</td>
<td>Maintain monitoring</td>
</tr>
<tr>
<td>Chloride</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>Sulfate</td>
<td>2012</td>
<td>Maintain monitoring</td>
</tr>
<tr>
<td>TDS</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>2000</td>
<td>EPA approved a TMDL in 2007. Implementation is ongoing.</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>2008</td>
<td>A watershed protection plan was completed in 2011 and is pending EPA approval.</td>
</tr>
<tr>
<td>bacteria</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>2004</td>
<td>A watershed protection plan is underway. A completed report expected spring, 2014.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2008</td>
<td>Additional monitoring is being performed to determine spatial distribution of bacteria.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2006</td>
<td>A recreational use attainability analysis is pending TCEQ approval.</td>
</tr>
<tr>
<td>Aluminum in water</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>Sulfate</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>Impaired benthics</td>
<td>2002</td>
<td>TCEQ plans a use attainability analysis once the drought is over and base flows resume.</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>2010</td>
<td>Monitoring frequency increased</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2002</td>
<td>TMDL development underway</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2002</td>
<td>TMDL development underway</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2006</td>
<td>TMDL development underway</td>
</tr>
<tr>
<td>Impaired benthics</td>
<td>2002</td>
<td>Monitoring postponed until construction of Waller Tunnel is complete.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2004</td>
<td>TMDL development underway</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2004</td>
<td>EPA approved a TMDL in 2009. Implementation is ongoing.</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>2010</td>
<td>A special study was discussed at the 2014 coordinated monitoring meeting.</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>1999</td>
<td>A use attainability analysis was completed in 2008 and is under review by TCEQ.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2006</td>
<td>Maintain monitoring</td>
</tr>
<tr>
<td>Bacteria</td>
<td>2006</td>
<td>Maintain monitoring</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>2008</td>
<td>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.</td>
</tr>
</tbody>
</table>
TCEQ and the Texas State Soil and Water Conservation Board prioritize impaired water bodies and set goals for improving water quality through the Watershed Action Planning (WAP) process. Clean Rivers Program partners and local stakeholders help identify potential causes for impairments and gage community support of watershed improvement projects. The WAP database, which is managed by TCEQ, tracks progress as work is performed on the prioritized water bodies.

Once a water body is selected through the WAP process, the first step to restoring it is to determine the cause(s) of the impairment. This usually involves verification monitoring or a special study that includes a historical water quality data review, targeted monitoring or a detailed watershed analysis. One of the following projects may be initiated to address the impairment once the cause of the impairment is identified:

- **Total Maximum Daily Load (TMDL)** — A scientific model used to determine the amount or “load” of a pollutant that a water body can receive yet still support its designated uses. Once the load is allocated among all potential sources, an implementation plan outlines strategies to reduce pollutants. Implementation plans are enforceable through regulatory compliance.

- **Watershed Protection Plan (WPP)** — A stakeholder-driven process to address causes of the identified impairments and develop strategies to reduce pollutant loads. Compliance with WPP strategies is voluntary rather than regulatory.

- **Use Attainability Analysis (UAA)** — Where TMDL and WPP strategies are designed to improve water quality by limiting pollutants, a UAA can help determine whether the level of use originally assigned to the water body is appropriate. For example, in the late 1980s most perennial rivers and streams were assigned a high aquatic life use. Since then, routinely collected data have shown that some water bodies do not meet a high aquatic life use, not because of pollution but because of natural conditions that prevent high aquatic life use from being attained. TCEQ performs UAAs to establish an appropriate level of aquatic life use in the Texas Surface Water Quality Standards.

- **Recreational Use Attainability Analysis (RUAA)** — Similar to a UAA, it confirms the level of recreational use that takes place in a stream. UAAs and RUAAAs can result in a revision to the Texas Surface Water Quality Standards.
This section highlights water quality in the eight major contributing watersheds in the Colorado River basin with emphasis on major water bodies, impairments and efforts to bring water bodies into compliance with Texas Surface Water Quality Standards.

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Square Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Colorado River</td>
<td>6,000</td>
</tr>
<tr>
<td>Concho River</td>
<td>6,700</td>
</tr>
<tr>
<td>Lake Buchanan</td>
<td>7,850</td>
</tr>
<tr>
<td>Lake LBJ</td>
<td>5,000</td>
</tr>
<tr>
<td>Lake Travis</td>
<td>1,830</td>
</tr>
<tr>
<td>Austin</td>
<td>700</td>
</tr>
<tr>
<td>Lower Colorado River</td>
<td>2,200</td>
</tr>
<tr>
<td>Coastal</td>
<td>2,800</td>
</tr>
</tbody>
</table>

Table 3. Colorado River basin and its eight major contributing watersheds.
Upper Colorado River Watershed

Water Quality Monitoring Site
Cities
 Counties
Stream Segments
Stream Segment Boundaries
Upper Colorado River Watershed
Rivers & Streams
Roads
Lakes

WATER QUALITY REVIEW BY WATERSHED
The Upper Colorado River watershed encompasses about 6,000 square miles. Annual average precipitation ranges from 14 inches in the western portion of the watershed to 21 inches in the eastern portion. Because of the semiarid conditions and prolonged drought in the region, many tributaries and drainage features are ephemeral or intermittent. Lakes J.B. Thomas, E.V. Spence and other reservoirs in the upper basin contained only a fraction of their capacity. In 2013, UCRA and TCEQ monitored 21 sites in the following water bodies:

**Segment 1411 — E.V. Spence Reservoir**  
**Segment 1412 — Colorado River below Lake J.B. Thomas including Beals Creek**  
**Segment 1413 — Lake J.B. Thomas**  
**Segment 1426 — Colorado River below E.V. Spence Reservoir**  
**Segment 1433 — O.H. Ivie Reservoir**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Water Body</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1411</td>
<td>E.V. Spence Reservoir</td>
<td>Total dissolved solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sulfate</td>
</tr>
<tr>
<td>1412</td>
<td>Colorado River below Lake J.B. Thomas</td>
<td>Bacteria</td>
</tr>
<tr>
<td>1412B</td>
<td>Beals Creek</td>
<td>Selenium in water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bacteria</td>
</tr>
<tr>
<td>1413</td>
<td>Lake J.B. Thomas</td>
<td>Total dissolved solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sulfate</td>
</tr>
<tr>
<td>1426</td>
<td>Colorado River below E.V. Spence Reservoir</td>
<td>Total dissolved solids</td>
</tr>
</tbody>
</table>

*Table 4. Impairments for the Upper Colorado River Watershed.*
Segment 1411 — E.V. Spence Reservoir

E.V. Spence Reservoir is an impoundment on the Colorado River near the city of Robert Lee. The reservoir has a history of high total dissolved solids (TDS) and sulfate and in 1998 TCEQ placed it on the 303(d) List for these parameters.

A TMDL was adopted by TCEQ in 2000 and approved by EPA in 2003. The TMDL implementation plan includes measurements for brush management, management of diversions from the reservoir and plugging leaking oil wells. The management measures continue to be implemented, but concentrations of sulfate and TDS remain high as the water level falls due to the drought. The reservoir contained only 3.7 percent of its capacity at the end of 2013. For more information on the E.V. Spence TMDL, visit the TCEQ website at tceq.texas.gov/waterquality/tmdl.

Golden algae (Prymnesium parvum) blooms are common in E.V. Spence Reservoir. Based on sampling by Texas Parks and Wildlife Department (TPWD), golden algae numbers remained high in the reservoir in 2013. TPWD will continue to monitor in 2014.

Golden algae (Prymnesium parvum) has caused a number of fish kills in Texas water bodies. While golden algae can occur in stock tanks and reservoirs, it is usually kept in check by competition with other algal species. A bloom of golden algae is often triggered by significant temperature swings, cloudy weather or rising salinity levels. A minor bloom may kill or harm some fish, but serious kills can result when golden algae increases dramatically and produces toxins that coat fish gills, leading to asphyxiation.

For more information, visit tpwd.state.tx.us/landwater/water/environconcerns/hab/.

E.V. Spence Reservoir at 4 percent of capacity. (Photo: John Burch)

Foam along the shore of Lake Nasworthy during a March 2014 golden algae bloom.
Segment 1412 — Colorado River below Lake J.B. Thomas, including Beals Creek

This segment of the Colorado River is impaired for contact recreation because of high levels of *E.coli*. Potential sources of bacteria at the monitoring site near Colorado City include urban runoff, leaking wastewater lines and failing septic systems. A portion of the area upstream of the monitoring site consists of farms and rangeland. Runoff from these operations and wildlife in the area could be sources of bacteria in the river as well. Routine monitoring is scheduled to continue in 2014.

Beals Creek, a tributary that enters the river downstream of Colorado City, is impaired for bacteria and selenium in water. Potential sources of bacteria include wildlife and failing septic systems located along the creek in Big Spring. Potential sources of selenium include runoff from an industrial area of Big Spring or from geological features. Based on USGS and Texas Water Development Board data, moderate concentrations of selenium have been found in groundwater and soils in the area. TCEQ continued to monitor selenium in 2013, but further study is necessary to definitively determine a source.

*Beals Creek, a tributary of the Colorado River, is impaired for selenium and bacteria. (Photo: John Burch)*
Segment 1413 — Lake J.B. Thomas

Lake J.B. Thomas is impounded on the Colorado River in Scurry County. The lake is impaired for TDS, sulfate and chloride. The concentrations are due to regional geology, low lake levels caused by 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 readily. Evaporation coupled with low precipitation has concentrated minerals in the reservoir.

The lake’s watershed contains oil and gas deposits in production since the 1930s. Seeps resulting from oil and gas production, including abandoned or inadequately plugged wells, have been identified in the watershed. These seeps typically contain highly saline water, which can contaminate surface water.

Figure 2 shows how chloride correlates inversely with the water level in Lake J.B. Thomas. At the end of 2013, the reservoir contained only 1.4 percent of its capacity and chloride levels twice the concentration of sea water.

![Figure 2. Chloride concentrations in Lake J.B. Thomas at different reservoir storage levels from 2001-2011.](image-url)
Segment 1426 — Colorado River below E.V. Spence Reservoir

The Colorado River below E.V. Spence Reservoir has a history of high chloride and TDS. In 2000, TCEQ placed it on the 303(d) List. A TMDL was performed to address the problem. It was adopted by TCEQ and approved by EPA in 2007. A TMDL implementation plan was completed in October 2007. The plan uses point source controls, reservoir operations, brush control and oil well plugging to reduce pollutants. The segment continues to exhibit elevated TDS based on the 2012 Water Quality Inventory largely due to low flows in the river.

Using a grant from TCEQ, UCRA held six stakeholder meetings in 2013 to coordinate public participation and update the implementation plan. UCRA will continue to facilitate the review process in 2014. However, water quality conditions are not expected to improve without significant inflow.

Segment 1433 — O.H. Ivie Reservoir

O.H. Ivie Reservoir is an impoundment at the confluence of the Colorado and Concho rivers. When full, the reservoir holds 554,335 acre-feet of water. As with other reservoirs in the upper Colorado River basin, it remained at a fraction of capacity — 14 percent — during 2013. Water in O.H. Ivie Reservoir meets all surface water quality standards.
The Concho River watershed is approximately 6,700 square miles. Semiarid conditions exist in most of the watershed and many of the tributaries are ephemeral or intermittent.

The principal rivers are the North, Middle and South Concho rivers, and the main Concho River downstream of San Angelo. The rivers are impounded near San Angelo to form O.C. Fisher Reservoir, Twin Buttes Reservoir and Lake Nasworthy. Long-term drought in the region has depleted reservoir levels (Table 1).

Below San Angelo, the Concho River flows intermittently past irrigated fields into O.H. Ivie Reservoir, about 60 miles downstream. The North, Middle and main Concho river valleys are characterized by broad floodplains that contain fluvial deposits of gravel, sand and clay and form shallow aquifers. The South Concho River, including Spring and Dove creeks, is characterized by much narrower and steeper valleys. Baseflow for these waterways originates from springs on the northern edge of the Edwards-Trinity Aquifer. The North Concho River is impaired for low dissolved oxygen and elevated bacteria levels. In 2013, 29 sites were routinely monitored on the following water bodies:

- **Segment 1421 — Concho River**
- **Segment 1421A — Dry Hollow**
- **Segment 1421B — Kickapoo Creek**
- **Segment 1421C — Lipan Creek**
- **Segment 1422 — Lake Nasworthy**
- **Segment 1423 — Twin Buttes Reservoir**
- **Segment 1423A — Spring Creek**
- **Segment 1423B — Dove Creek**
- **Segment 1424 — Middle Concho and South Concho rivers**
- **Segment 1424A — West Rocky Creek**
- **Segment 1424B — Cold Creek**
- **Segment 1425 — Lake O.C. Fisher**
- **Segment 1425A — North Concho River**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Water Body</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1421</td>
<td>Concho River</td>
<td>Dissolved oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bacteria</td>
</tr>
</tbody>
</table>

*Table 5. Impairments for the Concho River Watershed.*
Segment 1421 — Concho River

Segment 1421 includes the Concho River downstream of San Angelo and parts of the north and south forks of the Concho River in San Angelo up to O.C. Fisher Lake and Twin Buttes Reservoir. Below San Angelo, the segment extends downstream approximately 45 river miles to Paint Rock in an area known as the Lipan Flats. The area is comprised of rich farmland and sits atop of the Lipan Aquifer, known for groundwater with high nitrogen concentrations.

Monitoring data collected near San Angelo indicate low levels of dissolved oxygen and high levels of bacteria. TCEQ placed the river on the 303(d) List in 2008. As presented in the Concho River Basin Watershed Protection Plan submitted to the state Soil and Water Conservation Board in May 2011, the bacteria impairment is likely attributable to avian sources.

Segment 1422 — Lake Nasworthy

Lake Nasworthy is an impoundment on the South Concho River, just below Twin Buttes Reservoir. Water released from Twin Buttes Reservoir is the primary source of water for the lake. The lake holds approximately 14,000 acre-feet of water when it’s at conservation pool level and is one of the few lakes in the region that contains water. Lake Nasworthy met all applicable surface water quality standards, according to the 2012 Integrated Report.

Segment 1423 — Twin Buttes Reservoir

Twin Buttes Reservoir is an impoundment on the south and middle forks of the Concho River and on Spring and Dove creeks. Monitoring data show that water quality in Twin Buttes Reservoir is good and meets applicable surface water quality standards.
Segment 1424 — Middle and South Concho Rivers

Although the South Concho and Middle Concho rivers are included in the same segment, the two rivers have very different characteristics. The South Concho River is a perennial spring-fed stream created by several large springs that form its headwaters. The Middle Concho River flows intermittently and has been dry during most of 2013. No impairments have been identified for either water body.

Segment 1425 — O.C. Fisher Lake

O.C. Fisher Lake is an impoundment on the North Concho River west of San Angelo. Due to long-term drought, the lake completely dried up in 2011. It has not recovered and was little more than a puddle during 2013. Without water, no monitoring occurred in 2013. However surface water quality standards were met based on the most recently available data.

Segment 1425A — North Concho River

The North Concho River upstream of O.C. Fisher Lake has historically flowed intermittently. The ongoing drought has taken a toll on the stream though. Because there wasn't enough water to sample, monitoring only took place once in 2013. Historical water quality data showed that the river met surface water quality standards.
The Lake Buchanan watershed begins where the Colorado River flows from the dam at O.H. Ivie Reservoir. Freshwater from Pecan Bayou, the San Saba River and small perennial streams dilute the dissolved solids common in the upper basin. Water quality in the majority of the watershed meets surface water quality standards. The three exceptions are Pecan Bayou, the San Saba River and Brady Creek. Pecan Bayou and the San Saba River have elevated bacteria levels and Brady Creek contains low levels of dissolved oxygen. In 2013, LCRA and TCEQ routinely monitored 26 sites in the following water bodies:

- Segment 1408 — Lake Buchanan
- Segment 1409 — Colorado River above Lake Buchanan
- Segment 1410 — Colorado River below O.H. Ivie Reservoir
- Segment 1416 — San Saba River
- Segment 1416A — Brady Creek
- Segment 1417 — Lower Pecan Bayou
- Segment 1418 — Lake Brownwood
- Segment 1419 — Lake Coleman
- Segment 1420 — Pecan Bayou above Lake Brownwood
- Segment 1431 — Mid Pecan Bayou
- Segment 1432 — Upper Pecan Bayou

Table 6. Impairments for the Lake Buchanan Watershed.
Segment 1408 — Lake Buchanan

Lake Buchanan is an impoundment of the Colorado River in Burnet and Llano counties. At 22,335 surface acres, it is the largest of the Highland Lakes. Drought conditions experienced in the region since 2008 have lowered the reservoir to record levels. It contained less than 40 percent of capacity during much of 2013. Monitoring data indicate that the lake meets all applicable surface water quality standards.

Segment 1409 — Colorado River above Lake Buchanan

The Colorado River above Lake Buchanan begins at the confluence with the San Saba River in San Saba County. Chloride and TDS are diluted as the San Saba River and smaller perennial streams supply fresh water into the Colorado River. Bedrock is the dominant substrate and water in this region tends to be clearer than upstream. This stretch of the river met all designated uses, according to the TCEQ 2012 Integrated Report.

Segment 1410 — Colorado River below O.H. Ivie Reservoir

The Colorado River below O.H. Ivie Reservoir is located between the confluence of the Colorado and San Saba rivers and the O.H. Ivie Reservoir Dam. The segment is approximately 138 miles long. Water is released from O.H. Ivie Reservoir to slowly flow through farmland and ranches where it is used to irrigate hay, wheat, cotton and pecan orchards. Segment 1410 met all designated uses, according to the TCEQ 2012 Integrated Report.

Segment 1416 — San Saba River

The San Saba River begins in Schleicher County where the river’s North Valley Prong and Middle Valley Prong converge. It flows approximately 168 miles downstream to the confluence with the Colorado River in San Saba County. It does not support contact recreation based on E.coli data collected near the town of San Saba.

TCEQ first placed the river on the 303(d) List in 2008. In 2012, in an effort to determine if the source was local, TCEQ added another monitoring site approximately 20 miles upstream of the existing site. Data collected in 2012 and 2013 indicate the upstream site meets surface water quality standards while the data collected at the original site continues to exceed surface water quality standards. Potential
causes of impairment include a cattle auction barn located four miles upstream of the original monitoring site, stormwater runoff from the town of San Saba, or agricultural and wildlife nonpoint sources. Monitoring at both sites will continue, and project planning will take place as part of the WAP process in 2014.

**Segment 1416A — Brady Creek**

The Brady Creek watershed in Concho, McCulloch and San Saba counties is approximately 784 square miles. Water quality monitoring performed by UCRA in the early 2000s indicated persistently low levels of dissolved oxygen. TCEQ designated the creek as impaired on the 2004 303(d) List.

In 2004, funded by a Clean Water Act 319(h) grant administered by TCEQ, UCRA created the Brady Creek Master Plan. The plan identified stormwater runoff and low flows as causes of the impairment and implemented stormwater controls in urban areas. In March 2009, UCRA received another grant from TCEQ to develop the Brady Creek WPP, which encompassed the entire watershed. UCRA began monitoring, and a stakeholders group was organized in 2010. Ambient and stormwater monitoring from nine sites was completed in 2012. In 2013, computer models were used to simulate land use, potential mitigation projects and wastewater discharge scenarios. Three stakeholder meetings were held in 2013. The final watershed plan will be presented to stakeholders in spring 2014. For more information on the Brady Creek WPP, visit ucratx.org.

**Segments 1417, 1418, 1419, 1420 and 1432**

The Pecan Bayou headwaters are southeast of Abilene. The flat terrain in the 2,200-square mile watershed creates sluggish flows. Several small tributaries provide intermittent flows to the bayou. Jim Ned Creek, a major tributary, forms Lake Coleman and merges with Pecan Bayou to form Lake Brownwood, near the City of Brownwood. According to the 2012 Integrated Report, five of the six classified segments in Pecan Bayou meet surface water quality standards. However, Segment 1431, below Brownwood, does not due to elevated bacteria.

**Segment 1431 — Mid Pecan Bayou**

Mid Pecan Bayou begins downstream of Brownwood. The 13-mile segment is surrounded by land used for hay production and row crops and there is a concentrated animal feeding operation in the upper end of the segment. The City of Brownwood WWTP discharges treated effluent into Willis Creek, about 1.5 miles upstream of the monitoring site. In 2013 the city began to evaluate wastewater reuse options, a measure that could impact stream flow.

Segment 1431 was first placed on the 2006 303(d) List for not supporting contact recreation due to elevated levels of E. coli. High bacteria counts were found in subsequent assessments. Potential sources of bacteria and nutrients include the City of Brownwood WWTP discharge, urban stormwater runoff, the concentrated animal feeding operation and wildlife. The state Soil and Water Conservation Board and EPA funded a Recreational Use Attainability Analysis in 2010 to determine what type of contact recreation occurred in the segment. Texas AgriLife Extension Service and Texas Institute for Applied Environmental Research completed the study in January 2012. The study is pending TCEQ approval. A copy of the report may be found at tceq.texas.gov/waterquality/standards/ruaas/midpecanbayou1431.
Lake LBJ Watershed
The Lake LBJ watershed encompasses about 5,000 square miles beginning where the Colorado River is released from Buchanan Dam. Immediately below Buchanan Dam, the river flows into Inks Lake, a pass-through reservoir. Below Inks Dam the river flows about 10 miles to the community of Kingsland, where it merges with the Llano River before flowing into Lake LBJ.

The rock and limestone geology of the Edwards Plateau creates clear-flowing streams such as the Llano and James rivers. Many of the spring fed streams in the watershed are perennial, though the drought that began in the region in 2011 continued into 2013 and flows were greatly diminished. Water quality in the watershed is good with the exception of Clear Creek, a tributary of Inks Lake that does not meet surface water quality standards due to pH, sulfate, TDS and aluminum in water. In 2013, LCRA and TCEQ routinely monitored 18 sites on the following water bodies:

**Segment 1406 — Lake LBJ**
**Segment 1407 — Inks Lake**
**Segment 1407A — Clear Creek**
**Segment 1415 — Llano River (including the north and south forks)**

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*Table 7. Impairments for the Lake LBJ Watershed.*
Segment 1406 — Lake LBJ

Lake LBJ is impounded where the Colorado and Llano rivers converge in Burnet and Llano counties. The reservoir was completed in 1951 to supply hydroelectric power to the area. Development around the lake is constant and the communities of Granite Shoals, Sunrise Beach, Horseshoe Bay and Kingsland have grown into small cities surrounding the lake. The Highland Lakes Watershed Ordinance and the OSSF Ordinance, which are administered by LCRA, help reduce the impact of development around the lake (pp. 27-28). Lake LBJ meets all surface water quality standards.

![Lake LBJ shoreline residential development in Horseshoe Bay.](image)

Segment 1407 — Inks Lake

Inks Lake is a 777-acre impoundment immediately downstream of Buchanan Dam. The lake is home to Inks Lake State Park and is a popular destination for water recreation. Monitoring data indicate the lake met all applicable surface water quality standards based on the 2012 Integrated Report.

Segment 1407A — Clear Creek

Clear Creek is an intermittent tributary of Inks Lake. The creek is about 4.5 miles long and is impaired for pH, TDS, sulfate and aluminum in water. The source of the pollutants is runoff from property that once was a graphite mine. A 23-acre tailings pile — a remnant of the abandoned mine — is located on the banks of the creek. Storm water runoff from the pile has resulted in low pH and heavy metals in the creek. The property is owned by Greensmiths, Inc., which purchased the facility in 2000 and began using reclaimed tailings materials to landscape golf courses. Greensmiths has engineered structures to prevent runoff and has received a zero-discharge permit from TCEQ. The creek has flowed intermittently since 2011. Limited sampling performed in 2013 showed water quality still did not meet surface water quality standards.
Segment 1415 — Llano River (including the north and south forks)

The Llano River begins in Junction, where the North Llano and South Llano rivers converge. With an average annual flow of 40 cubic feet per second, the North Llano River remains perennial, but flow is sluggish during most summers. Flows in the South Llano River have historically been about double those in the North Llano River because of large springs west of Junction.

Below Junction, the Llano River flows through the Llano Uplift, an area that contains granite and limestone outcrops that produce clear flowing streams. The Llano River met all applicable surface water quality standards according to the 2012 Integrated Report.

Upper Llano River Watershed Protection Plan

In 2011, the Texas Tech University Llano River Field Station received a Clean Water Act 319(h) grant from the state Soil and Water Conservation Board to develop a WPP for North Llano and South Llano rivers. Since then, the Texas Tech field station and Texas Water Resources Institute began working with the South Llano Watershed Alliance and others to develop a plan to identify desired watershed conditions and prioritize management practices to protect the watershed. Chemical and biological monitoring was performed on 14 river sites and six spring sites. The monitoring was completed in 2013. Two meetings of the WPP Coordination Committee were held in 2013. The committee and other stakeholders helped identify local issues and prioritize protective strategies. The plan is scheduled to be complete in 2014. For more information on the Llano River WPP, visit southllano.org.
Lake Travis Watershed
The Lake Travis watershed in the Texas Hill Country includes the Pedernales River and lakes Travis and Marble Falls. It is approximately 1,830 square miles. The watershed lies within the Edwards Plateau, a region distinguished by rocky terrain and clear perennial streams. Growth and development have dramatically changed the landscape in the region during the last 20 years. Water quality remains good and there are no impairments.

Lack of rainfall since 2008 has lowered the lake to levels not seen since the drought of record during the 1950s. Inflows to the Highland Lakes in 2013 were the second lowest on record; 2011 and 2008 were first and third, respectively. In 2013, LCRA and TCEQ routinely monitored 13 sites on the following segments:

* Segment 1404 — Lake Travis
* Segment 1405 — Lake Marble Falls
* Segment 1414 — Pedernales River
* Segment 1414B — Cypress Creek

**On-Site Sewage Facility Ordinance**

On-site sewage facilities (OSSF) or septic systems are an integral part of rural America. They can be an efficient way to remove household waste and protect the environment when properly designed and maintained. In 1971, TCEQ delegated regulatory authority of OSSF in the Highland Lakes to LCRA. Since then, LCRA has regulated the installation and operation of more than 21,000 systems in the four-county area. This oversight ensures the best available technology is used to treat septic wastes so pollutants such as bacteria, phosphorus and nitrogen don’t leach into surface water.

*Septic tank installation.*
Mansfield Dam impounds Lake Travis on the Colorado and Pedernales rivers in western Travis County. The reservoir, which is about 18,929 surface acres, was originally designed to contain floodwaters. Historically, it is one of the clearest reservoirs in the state and is a popular recreation destination. The current drought has significantly lowered the water level in Lake Travis. The lake was only 37 percent full at the end of 2013.

Lake Travis meets all applicable surface water quality standards. Ongoing LCRA initiatives to protect the lake include the Highland Lakes Watershed and OSSF ordinances and the Colorado River Environmental Models (pp.33).

Segment 1405 — Lake Marble Falls

Max Starcke Dam forms Lake Marble Falls on the Colorado River near the City of Marble Falls. With a surface area of 545 acres, it is the smallest reservoir in the chain of Highland Lakes. All surface water quality standards for the lake were attained based on the 2012 Integrated Report.
Segment 1414 — Pedernales River

The headwaters of the Pedernales River are located near Harper in Gillespie County. The river flows 125 miles through Fredericksburg, Stonewall and Johnson City before reaching Lake Travis. In 2013, it contained water intermittently because of the ongoing drought. Monitoring data collected from sites near Fredericksburg and Johnson City show that the river meets all applicable TSWQS.

Colorado River Environmental Models

The Highland Lakes provide water storage, recreational opportunities and a livelihood for many Central Texans. Recognizing their importance to the region, LCRA began developing models to evaluate water quality issues, discern trends and predict the impacts of various decisions, actions and future scenarios on the Highland Lakes. The first model was completed on Lake Travis in 2009 followed by lakes Inks, Marble Falls and LBJ in 2011. The Lake Buchanan model was completed in 2013.

The environmental models have been used to demonstrate the impact of different discharge scenarios and help establish wastewater permit limits in the Highland Lakes watersheds. LCRA worked with the cities of Burnet and Fredericksburg during their TCEQ wastewater permit amendment to develop protective measures based on model output. LCRA will continue to develop the models as lake conditions change and to work with Highland Lakes communities to develop reasonable treatment options that protect water quality. For more information on Colorado River Environmental Models visit lcra.org/water/quality/water-quality-permit-review-program/Pages/water-quality-models.aspx.
The Austin Metropolitan watershed encompasses about 700 square miles on the eastern edge of the Edwards Plateau. Austin’s population is estimated at 842,000, making it the most urbanized watershed in the basin. Lake Austin and Lady Bird Lake are narrow and shallow in comparison to the Highland Lakes. They resemble large rivers that cut through Austin and create a natural boundary that bisects and defines the city. The Edwards Aquifer surfaces intermittently in the watershed to form springs, clear streams and groundwater recharge features. Some urban creeks have elevated bacteria levels and the upper end of Lake Austin periodically contains low levels of dissolved oxygen. In 2013, the City of Austin, USGS, TCEQ and LCRA monitored 42 sites on the following water bodies:

**Segment 1403 — Lake Austin**

**Segment 1403A — Bull Creek**

**Segment 1427 — Onion Creek**

**Segment 1427A — Slaughter Creek**

**Segment 1427C — Bear Creek**

**Segment 1428 — Colorado River below Austin**

**Segment 1428K — Walter Long Lake**

**Segment 1429 — Lady Bird Lake**

**Segment 1429A — Shoal Creek**

**Segment 1430 — Barton Creek**

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<td>Bull Creek</td>
<td>Dissolved oxygen</td>
</tr>
<tr>
<td>1403J</td>
<td>Spicewood Tributary to Shoal Creek</td>
<td>Bacteria</td>
</tr>
<tr>
<td>1403K</td>
<td>Taylor Slough South</td>
<td>Bacteria</td>
</tr>
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<tr>
<td>1429C</td>
<td>Waller Creek</td>
<td>Bacteria</td>
</tr>
</tbody>
</table>

*Table 8. Impairments in the Austin Watershed.*
Segment 1403 — Lake Austin

Tom Miller Dam impounds the Colorado River to form Lake Austin. The lake is approximately 1,830 surface acres and is used extensively for recreation. Frequent low dissolved oxygen concentrations near the headwaters at Mansfield Dam lead to an impairment designation in the late 1990s. The cause was releases of oxygen-depleted water from deep in Lake Travis. In 2000, LCRA installed aerators in Mansfield Dam to oxygenate the water before release into Lake Austin. Verification monitoring performed in 2013 showed improvements in dissolved oxygen levels. Sampling will continue in 2014. Monitoring performed by City of Austin in 2013 showed excessive blooms of blue-green algae, likely a result of drought conditions.

Segment 1403A — Bull Creek

Bull Creek is a perennial, spring-fed tributary of Lake Austin. About 40 percent of the watershed is developed. The remaining 60 percent is owned by the City of Austin and is maintained as a preserve protected from further development. Monitoring data show that the upper portion of the stream frequently exhibits low dissolved oxygen levels. It was placed on the 303(d) List in 2010. Water in the upper end of the creek is strongly influenced by groundwater that typically contains low dissolved oxygen. Benthic macroinvertebrate data collected by the City of Austin indicate that Bull Creek maintains high aquatic life use. In 2013, the city initiated a special study to collect additional dissolved oxygen data. Data from the study will enable scientists to better evaluate the temporal and spatial extent of low dissolved oxygen in Bull Creek. Monitoring is scheduled to continue in 2014.

Segment 1429 — Lady Bird Lake

Lady Bird Lake is formed where Longhorn Dam impounds the Colorado River in Austin. The 500 acre lake is surrounded by a densely developed watershed. Lady Bird Lake meets all applicable surface water quality standards according to the 2012 Integrated Report. In 2013, drought conditions caused excessive growth of aquatic plants in the lake.

Segment 1403J — Spicewood Tributary to Shoal Creek

This small tributary is in the upper portion of the Shoal Creek watershed on the North side of Lady Bird Lake. The shallow, spring-fed stream is only a half mile long, but it is important habitat for a small population of threatened Jollyville Plateau salamanders (Eurycea tonkawae). Water quality data collected near the springs indicate elevated levels of bacteria. TCEQ placed it on the 303(d) List in 2002. At the request of the city, TCEQ initiated a TMDL for bacteria late in 2012 (See bacteria TMDL on page 37).

Segment 1403K — Taylor Slough

The Taylor Slough watershed is located on the north side of Lake Austin upstream from Tom Miller Dam. It is in a dense urban landscape composed mostly of single-family residences. Water quality
data collected from Reed Park in the downstream portion of the stream indicate elevated levels of bacteria. TCEQ placed it on the 303(d) List in 2002. TCEQ initiated a TMDL for bacteria late in 2012 (See bacteria TMDL on page 37).

**Segment 1427A — Slaughter Creek**

Located in southern Travis County, the Slaughter Creek watershed is approximately 31 square miles. It is mostly urban. The lower watershed consists primarily of densely clustered residential housing. The creek was placed on the 2002 303(d) List for not meeting a high aquatic life use based on biological samples. A UAA was conducted by TCEQ in 2004. The findings were inconclusive due to drought conditions. The current drought has prevented further sampling of the stream to determine an appropriate aquatic life use.

**Segment 1429C — Waller Creek**

The Waller Creek watershed is on the north side of Lady Bird Lake in downtown Austin. Waller Creek is heavily urbanized. Monitoring data collected from several sites on the creek showed elevated levels of bacteria and in 2002 it was placed on the 303(d) List. Potential sources of bacteria include pet and human waste, leaking wastewater infrastructure and urban runoff. TCEQ initiated a TMDL for bacteria in the upstream portions of the watershed late in 2012 (See bacteria TMDL on page 37).

Construction of the Waller Creek Tunnel, a major channelization project in the lower portion of the creek, began in 2011. The tunnel will be used to circulate water from Lady Bird Lake through Waller Creek during non-storm conditions. Once complete, the project is expected to bring significant redevelopment to the watershed. No water quality improvement projects are planned for the lower portion of the creek until the completion of the tunnel in 2014.

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**Bacteria TMDL for four Austin Creeks**

In 2012, TCEQ initiated a bacteria TMDL for Spicewood Tributary of Shoal Creek, Taylor Slough, Waller Creek and Walnut Creek (in the lower Colorado River watershed). TCEQ contracted with the University of Texas Center for Public Policy Dispute Resolution to facilitate public input and develop a TMDL implementation plan in partnership with the City of Austin Watershed Protection Department and other stakeholders. Proposed strategies include riparian zone restoration, wastewater infrastructure maintenance, domestic pet waste education, resident outreach and stormwater treatment. A draft TMDL and implementation plan will be presented to TCEQ Commissioners in summer 2014. For more information, visit [https://www.utexas.edu/law/centers/cppdr/services/tmdl.php](https://www.utexas.edu/law/centers/cppdr/services/tmdl.php).
Lower Colorado River Watershed
The lower Colorado River watershed below Austin encompasses an area of about 2,195 square miles. Water typically flows more slowly here than in the river above Austin because of the flat terrain. Historically, LCRA has released water from the Highland Lakes for downstream irrigation. The releases, which routinely take place in the spring and summer, help flush the river and dilute nutrient loading from WWTP effluent downstream of Austin. Releases have decreased since 2011 due to the drought. Not surprisingly, flows are down and plant growth and nutrient levels have increased in the river below Austin. In 2013, LCRA, TCEQ and the City of Austin monitored 19 sites on the following water bodies:

- **Segment 1402 — Colorado River below La Grange**
- **Segment 1428 — Colorado River below Austin**
- **Segment 1428B — Walnut Creek**
- **Segment 1428C — Gilleland Creek**
- **Segment 1428K — Walter E. Long Lake**
- **Segment 1434 — Colorado River between Utley and La Grange**
- **Segment 1434C — Lake Bastrop**
- **Segment 1434D — Wilbarger Creek**
- **Segment 1434 — Bastrop State Park Lake**

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</tr>
<tr>
<td>1428C</td>
<td>Gilleland Creek</td>
<td>Bacteria</td>
</tr>
</tbody>
</table>

Table 9. Impairments in the Lower Colorado River Watershed.
Segment 1428 — Colorado River below Austin

The Colorado River below Lady Bird Lake begins at Longhorn Dam and ends 41 miles downstream near the river’s intersection with FM 969 northwest of Bastrop. The upper end of the segment is urban. About 113 million gallons of treated wastewater effluent flow into the segment each day. The segment meets surface water quality standards according to the 2012 Integrated Report.

With record low flows downstream of Austin in 2013, aquatic vegetation increased dramatically. Nitrogen and phosphorus from wastewater effluent provided nutrients for plant growth and low flows prevented scouring of the riverbed. As a result, large mats of vegetation became established from Austin to Columbus. Floods in Austin in October and November 2013 washed much of the vegetation downstream.

Walnut Creek is a tributary of the Colorado River below Longhorn Dam. Data collected from several sites in the creek indicate elevated levels of bacteria, and as a result, the stream was placed on the 303(d) List in 2002. Potential sources of bacteria include urban runoff and leaking wastewater lines. The City of Austin Watershed Protection Department conducted verification monitoring in 2010 and mapped on-site sewage facilities in an effort to isolate potential sources. A TMDL project began on Walnut Creek and three other Austin creeks in 2012 (pp. 37). The project will continue in 2014.
Segment 1428C — Gilleland Creek

Gilleland Creek, a tributary of the Colorado River downstream of Austin, was placed on the 303(d) List in 1999 due to elevated bacteria levels. Flow in the creek is predominantly from treated wastewater. LCRA developed the Gilleland Creek TMDL through a contract with TCEQ. It was adopted by TCEQ Commissioners in 2007 and approved by EPA in 2009. The TMDL Implementation Plan — including waste load allocations, stormwater prevention and education — was approved by TCEQ Commissioners in 2011. Monitoring indicates bacteria levels are lower at some sites, but remain above surface water quality standards. Implementation and verification monitoring is ongoing. For more information about the Gilleland Creek TMDL, visit tceq.texas.gov/waterquality/tmdl/nav/69-gillelandcreekbacteria.

Segments 1434 and 1402 — Colorado River from Utley to Bay City

These two segments of the Colorado River begin at FM 969 near Bastrop and end downstream near Bay City. The water in this section of the river is usually turbid due to sandy loam and clay soils of the region. Based on the 2012 Integrated Report, all surface water quality standards for the segment are met. Drought conditions and low flows caused aquatic plant growth in the river from Austin to Bay City in the summer, 2013.

Segment 1402C — Buckners Creek

Located on the south side of the Colorado River near La Grange, the Buckners Creek watershed is about 176 square miles. The stream’s headwaters are near the community of Rosanky in Bastrop County. It ends 26 miles downstream at its confluence with the Colorado River. The Buckners Creek watershed is rural. Monitoring data indicated an impairment for low levels of dissolved oxygen and TCEQ placed it on the 2010 303(d) List. Potential causes of low dissolved oxygen include decomposition of organic matter coupled with slow flows and inadequate mixing. No monitoring is scheduled for Buckners Creek in 2014. The stream is a good candidate for a special study. It will be discussed in the 2014 WAP process.
Coastal Watershed

Map showing the Coastal Watershed with various symbols indicating Water Quality Monitoring Sites, Cities, Counties, Stream Segments, Stream Segment Boundaries, Upper Colorado River Watershed, Roads, Lakes, and Rivers & Streams. The map includes cities such as El Campo, Bay City, Point Comfort, and Matagorda Bay, as well as counties like Wharton and Matagorda.

Legend:
- Water Quality Monitoring Site
- Cities
- Counties
- Stream Segments
  - Stream Segment Boundaries
- Upper Colorado River Watershed
- Roads
- Lakes
- Rivers & Streams

N 0 9.5 19 Miles

Gulf of Mexico

Water Quality Review by Watershed

Fayette County
Fort Bend County
Wharton County
Matagorda County
Calhoun County
Jackson County
Brazoria County
Manvel
East Bernard
Matagorda Bay
10
1402
1305

Brazoria Bay
Alvin
Ganado
Sweeny
Manvel
Wallis
Weimar
Seadrift
Bay City
El Campo
Angleton
Pearland
Richmond
Columbus
Needville
Rosenberg
Eagle Lake
Port Lavaca
Schulenburg
East Bernard
East Bernard
Fort Bend
Richmond
Rosenberg

Map Scale:
- 0
- 9.5
- 19

Coastal Watershed

Map Extent:
- Fayette County
- Fort Bend County
- Wharton County
- Matagorda County
- Calhoun County
- Jackson County
- Brazoria County
- Manvel
- East Bernard
- Manvel
- East Bernard
- Brazoria Bay
- Alvin
- Ganado
- Sweeny
- Manvel
- Wallis
- Weimar
- Seadrift
- Bay City
- El Campo
- Angleton
- Pearland
- Richmond
- Columbus
- Needville
- Rosenberg
- Eagle Lake
- Port Lavaca
- Schulenburg
- East Bernard
- East Bernard
- Fort Bend
- Richmond
- Rosenberg

Legend:
- Water Quality Monitoring Site
- Cities
- Counties
- Stream Segments
  - Stream Segment Boundaries
- Upper Colorado River Watershed
- Roads
- Lakes
- Rivers & Streams

Map Directions:
- North
- 0
- 9.5
- 19

Coastal Watershed

Map Scale:
- 0
- 9.5
- 19

Coastal Watershed

Map Extent:
- Fayette County
- Fort Bend County
- Wharton County
- Matagorda County
- Calhoun County
- Jackson County
- Brazoria County
- Manvel
- East Bernard
- Manvel
- East Bernard
- Brazoria Bay
- Alvin
- Ganado
- Sweeny
- Manvel
- Wallis
- Weimar
- Seadrift
- Bay City
- El Campo
- Angleton
- Pearland
- Richmond
- Columbus
- Needville
- Rosenberg
- Eagle Lake
- Port Lavaca
- Schulenburg
- East Bernard
- East Bernard
- Fort Bend
- Richmond
- Rosenberg

Legend:
- Water Quality Monitoring Site
- Cities
- Counties
- Stream Segments
  - Stream Segment Boundaries
- Upper Colorado River Watershed
- Roads
- Lakes
- Rivers & Streams

Map Directions:
- North
- 0
- 9.5
- 19
The coastal watershed of the Colorado River basin begins downstream of Columbus in Colorado County. From Columbus, the Colorado River flows to the east through Wharton and Bay City before entering Matagorda Bay where brackish waters create a productive spawning ground for estuarine species. In 2013, LCRA and TCEQ routinely monitored nine sites in the following segments:

Segment 1401 — Tidally influenced portion of the Colorado River
Segment 1402 — Colorado River downstream of Columbus
Segment 1402H — Skull Creek
Segment 1501 — Tidally influenced portion of the Tres Palacios River
Segment 1502 — Tres Palacios River downstream of El Campo

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<tr>
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Table 10. Impairments to the Coastal Watershed.
**Segment 1401 — Colorado River (tidal)**

The tidal portion of the Colorado River begins downstream of Bay City and ends where it flows into Matagorda Bay. Monitoring data collected about 12 miles upstream of the Intracoastal Waterway indicate elevated levels of bacteria. TCEQ placed the segment on the 303(d) List in 2006. Potential sources of bacteria include failing septic systems from a small subdivision located near the monitoring site or runoff from livestock and wildlife. Another potential cause of the impairment is the use of *Enterococcus* as an indicator or an incorrect criterion. Prior to 2006, fecal coliform was the primary bacterial indicator in tidal water bodies. In 2006, TCEQ began to use *Enterococcus* to measure attainment of contact recreation in the surface water quality standards. The result was an increase in bacteria listings along the Texas Coast, including segments 1401 and 1501.

![Matagorda Bay is a productive estuary at the mouth of the Colorado River.](image)

Matagorda Bay depends on freshwater from the Colorado River to help maintain a productive environment. At times during the current drought, the amount of freshwater flowing into the system has been extremely low. LCRA is required by the state-approved water management plan to ensure a certain amount of freshwater flows to the bay. The requirements are based on the amount of water flowing into the Highland Lakes and the amount of water flowing into Matagorda Bay. Flow requirements are lower during drought, but critical flows must be maintained to provide a low salinity area near the mouth of the Colorado River for oysters and other important estuarine species.

![Figure 4. Data from 2013 showing how freshwater inflows to the bay influence salinity levels.](chart)

Matagorda Bay
Segment 1402 –
(Colorado River below La Grange)

Segment 1402 of the Colorado River begins in La Grange and ends 150 miles downstream near Bay City. The segment traverses two watersheds: the lower Colorado River watershed and the coastal watershed. The upper portion of the segment is discussed above in the Lower Colorado River watershed section.

The lower portion of the river flows sluggishly over the flat landscape. Most of the land is used for agriculture. Sediment deposition and episodic floods created a floodplain rich with nutrients and earth materials. Gravel mining is a major industry in the region. Data collected from sites near Columbus, Wharton and La Grange indicate that the segment fully supports its designated uses.

![Colorado River at Wharton, September 2013.](image)

Figure 5. The volume of water flowing through the Colorado River in Wharton from 2011-2013 as compared to the average.
Segment 1402H — Skull Creek

The Skull Creek watershed is located downstream of Columbus on the south side of the Colorado River. It is approximately 112 square miles. Much of the riparian area in the upper watershed has been cleared and is used for grazing pastures. Several gravel operations are located in the lower part of the watershed.

Data collected near the confluence with the Colorado River indicate impairments for low levels of dissolved oxygen. Potential causes of low dissolved oxygen include decomposition of organic matter and sluggish flow regimes. TCEQ completed an aquatic life monitoring project that concluded the creek supports a diverse aquatic community despite chronic low dissolved oxygen levels. Fish, macroinvertebrate and habitat samples indicate a high aquatic life use. TCEQ plans to review the surface water quality standards for aquatic life use in Skull Creek.

Skull Creek is impaired due to low levels of dissolved oxygen.
Segment 1501 — Tres Palacios River (tidal)

Segment 1501 is the tidally influenced portion of the Tres Palacios River. It begins below State Highway 35 and ends approximately eight miles downstream where the river flows into Tres Palacios Bay. Monitoring data collected near the confluence of Tres Palacios Bay indicate impairment for bacteria and dissolved oxygen. In an effort to determine if the bacteria was coming from a local source(s), LCRA added a monitoring site upstream of the historical site in 2010. Two years of monitoring showed high bacteria levels were common at both sites, but did not help determine causes.

Potential sources include failing septic systems in a nearby subdivision, stormwater runoff, livestock, wildlife or the application of *Enterococcus* as an indicator organism as discussed in Segment 1401. Dissolved oxygen levels are likely a function of tidal influence (salt water does not retain dissolved oxygen as well as fresh water) and sluggish flows. A 2007 Texas Parks and Wildlife study of the Tres Palacios River and other tidally influenced streams found biological composition was primarily dependent on salt gradient. This presents a quandary because TCEQ’s assessment of aquatic life – in fresh water and saltwater habitats - is based primarily on dissolved oxygen levels. More study is necessary to understand the complex relationships between salt gradient, dissolved oxygen, water chemistry and biological functions in tidal streams. TCEQ currently plans a Water Quality Standard review of the segment.

Segment 1502 — Tres Palacios River

The headwaters of the Tres Palacios River are located near El Campo. The upper end of Segment 1502 is narrow with steep banks, more reminiscent of a small creek than a river. A narrow riparian area is maintained as the stream winds through cultivated farmland. The segment meets all applicable surface water quality standards.
Public participation is a cornerstone of the Clean Rivers Program. Since the early 1990s, LCRA and its Clean Rivers Program partners have held annual steering committee meetings in the basin. These meetings provided a venue for local stakeholders to learn about water in their region and provide input on projects in their communities.

Historically, three steering committees represented the upper, middle and lower regions of the basin. In 2013, LCRA divided the basin into four regions: upper, Hill Country, mid-central and lower. LCRA also created a Water Quality Advisory Committee (WQAC) in each region in lieu of steering committees. Similar to the steering committees, advisory committee members will provide insight into local water quality issues. However, communication will be more consistent because LCRA and UCRA will host annual meetings in each region. The meetings are open to the public. If you or someone you know is interested in getting involved with an advisory committee, we welcome land owners, recreationists, civic leaders and the regulatory community. Contact information and minutes from past meetings can be found on the LCRA Clean Rivers web page at lcra.org/water/quality/texas-clean-rivers-program.

Figure 6. Water Quality Advisory Committee Regions.
Help protect water quality in the Colorado River!

The Clean Rivers Program depends on stakeholders like you to identify water quality issues that may otherwise be overlooked. Join the effort to protect water quality by participating in the Clean Rivers Program Water Quality Advisory Committee. Your participation will enable us to have a more comprehensive understanding of the waterways in your area, and will give you a chance to help characterize and improve water quality.

Member Opportunities:

• **Attend one committee meeting per year**

• **Provide occasional feedback via email**

• **Identify and prioritize water quality issues**

• **Provide input on the LCRA Clean Rivers Program work plan**

• **Review water quality reports**

• **Learn about and share your knowledge about water quality within your community**

Email crp@lcra.org to join an advisory committee or request information about the committee in your region.
Texas Surface Water Quality: What Is It, and How Is It Measured?

In order to protect water quality, we must define and measure it. The state of Texas has established standards that protect the purposes for which the streams, lakes, and estuaries in the state will be used, and defined measurements that determine whether the water quality is good enough to attain those uses.

Based on the standards, the Texas Commission on Environmental Quality (TCEQ), in concert with other federal, regional, and local organizations, carries out a regular program of monitoring and assessment to determine which water bodies are meeting the standards set for their use, and which are not. The state produces a periodic report, the Texas Water Quality Integrated Report for Clean Water Act Sections 305(b) and 303(d), which compares water quality conditions to established standards, as required by the federal Clean Water Act (CWA).

Texas Surface Water Quality Standards

- designate the uses, or purposes, for which the state’s waterways should be suitable;
- establish numerical and narrative criteria for water quality throughout the state;
- provide a basis on which TCEQ regulatory programs can establish reasonable methods to implement and attain the state’s goals (criteria) for water quality.

Water quality criteria are designed to be protective of uses. Substantial deviations from criteria indicate that related uses might be impaired. For example, the concentration of dissolved oxygen is one criterion for determining the attainment of the aquatic life use. Where oxygen concentrations are low, the use of the water body to support aquatic life might be impaired. However, since other factors affect the health of an aquatic environment, additional data, such as the presence of a high number and variety of species, may show that the use is fully attained, even if oxygen concentrations are lower than the criterion.

Four major categories for water use are defined in the Texas Surface Water Quality Standards:

- aquatic life use
- contact recreation (swimming)
- public water supply
- fish and shellfish (oyster) consumption

A variety of other general uses are also considered, such as navigation, water supply for agriculture and industry, seagrass propagation, and wetland functions.
Aquatic Life Use
The standards associated with this use are designed to protect aquatic species, and to protect the propagation of both aquatic and terrestrial species. They establish optimal conditions for the support of aquatic life and define indicators used to measure whether these conditions are met. Some pollutants or conditions that may violate this standard include low levels of dissolved oxygen, or high concentrations of toxics such as metals or pesticides dissolved in water.

Contact Recreation
The standard associated with this use measures the level of certain bacteria in water that indicate the relative risk of swimming or other water sports involving direct contact with the water. It is possible to swim in water that does not meet this standard without becoming ill; however, the probability of becoming ill is higher than it would be if bacteria levels were lower.

Public Water Supply
Standards associated with this use indicate whether water from a lake or river is suitable for use as a source for a public water supply system. Source water is treated before it is delivered to the tap. A separate set of standards governs treated drinking water.

Indicators used to measure the safety or usability of surface water bodies as a source for drinking water include the presence or absence of substances such as metals or pesticides. Concentrations of salts, such as sulfate or chloride, are also measured, since treatment to remove high levels of salts from drinking water may be expensive.

Fish Consumption
The standards associated with this use are designed to protect the public from consuming fish or shellfish that may be contaminated by pollutants in the water. The standards identify levels at which there is a significant risk that certain toxic substances dissolved in water may accumulate in the tissue of aquatic species.

Because toxic substances in water may exceed these levels while no accumulation in fish tissue is observable, the state conducts tests on fish and shellfish tissue to determine if there is a risk to the public from consuming fish caught in state waters. The standards also specify bacterial levels in marine waters to assure that oysters or other shellfish subject to commercial harvest and marketing are safe for public sale and consumption.

Indicators of water quality that are not tied to specific uses—such as dissolved solids, nutrients, and toxic substances in sediment—are also described in the standards. Indicators of water quality are discussed in more detail later in this document. A complete copy of the Texas Surface Water Quality Standards is available from the TCEQ Publications Library at 512/239-0028, or on the TCEQ website at <www.tceq.texas.gov/permitting/water_quality/wq_assessment/standards/>.
Texas Water Quality Integrated Report

The Texas Water Quality Integrated Report for Clean Water Act Sections 305(b) and 303(d) is an overview of the status of surface waters of the state, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources. More than 700 water bodies are assessed in Texas.

The 303(d) List, a subset of the report, identifies:

- water bodies that do not attain one or more of the standards set for their use, or are expected not to meet one or more uses in the near future;
- which pollutants or conditions are responsible for the failure of a water body to attain standards;

Common limitations in water quality include:

- bacteria levels that exceed the criterion established to assure the safety of contact recreation
- dissolved oxygen levels that are lower than the criterion established to assure optimum conditions for aquatic life
- total dissolved solids, sulfate, and chloride that exceed the criteria established to safeguard general water quality uses
- contaminants in fish tissue that pose a risk to consumers

Some water bodies also have:

- toxic substances in water that exceed the criterion to protect aquatic life
- conditions of acidity (measured as pH) and high temperature that exceed the criteria to safeguard general water quality uses


Indicators of Water Quality

Several different parameters are measured to determine whether a water body meets the standards for its use. Some of the most common are listed here, with an explanation of why they are important to the health of a water body.

Bacteria

E. coli and Enterococci bacteria are measured to determine the relative risk of swimming (contact recreation), depending on whether the water body is fresh or marine. These bacteria originate from the wastes of warm-blooded animals. The presence of these bacteria indicates that associated pathogens from these wastes may be reaching a body of water. Sources may include inadequately treated sewage, improperly managed animal waste from livestock, pets in urban areas, aquatic birds and mammals, or failing septic systems.
Dissolved Oxygen
The concentration of dissolved oxygen is a single, easy-to-measure characteristic of water that correlates with the occurrence and diversity of aquatic life in a water body. A water body that can support diverse, abundant aquatic life is a good indication of high water quality. A problem frequently related to dissolved oxygen concentrations is an excess of nutrients in water. Large quantities of nutrients in water can cause excessive growth of vegetation. This excessive vegetation, in turn, can cause low dissolved oxygen.

Dissolved Solids
High levels of dissolved solids such as chloride and sulfate can cause water to be unusable, or simply too costly to treat for drinking water uses. Changes in dissolved solids concentrations also affect the quality of habitat for aquatic life.

Metals
High concentrations of metals such as cadmium, mercury, and lead pose a threat to drinking water supplies and human health. Eating fish contaminated with metals can cause these toxic substances to accumulate in human tissue, posing a long-term, but significant health threat. Metals also pose a threat to livestock and aquatic life. Potentially dangerous levels of metals and other toxic substances are identified through chemical analysis of water, sediment, and fish tissue.

Organics
Toxic substances from pesticides and industrial chemicals, called organics, pose the same concerns as metals. Polychlorinated biphenyls (PCBs), for example, are industrial chemicals that are toxic and probably carcinogenic. Although banned in the United States in 1977, PCBs remain in the environment, and they accumulate in fish and human tissues when consumed.

Fish Consumption Advisories and Closures
The Texas Department of State Health Services (DSHS) conducts chemical testing of fish tissue to determine whether there is a risk to human health from consuming fish or shellfish caught in Texas streams, lakes, and bays. Fish seldom contain levels of contaminants high enough to cause an imminent threat to human health, even to someone who eats fish regularly. However, risk increases for people who regularly consume larger fish and predatory fish from the same area of contaminated water over a long period of time. To reduce health risks in areas of contamination, people should eat smaller fish from a variety of water bodies. When a fish consumption advisory is issued, a person may legally take fish or shellfish from the water body under advisory, but it is not recommended. When a fish consumption closure is issued for a water body, the taking of fish or shellfish is legally prohibited.

Fish Consumption Advisories
Fish advisories may warn against the consumption of particular fish or shellfish species from the affected water body, or may recommend the amount of fish that
may be consumed over certain periods of time by specific segments of the population. For example, an advisory may read:

“Consumption Advice: The advisory includes all species of fish and recommends limiting consumption to the following:

- Adults should consume no more than one meal, not to exceed 8 ounces of fish per serving, each week.
- Children seven years of age and older should consume no more than one meal, not to exceed 4 ounces of fish per serving, each week.
- Children 6 and under, pregnant women, or women who may soon become pregnant should not consume fish from this reservoir.
- Persons consuming fish from this reservoir should not consume mineral dietary supplements with selenium exceeding 50 micrograms per day.”

**Fish Consumption Closures**

Fish consumption closures identify a specific water body, or portion of a water body, where the taking of fish is prohibited because the human health risk from fish consumption is very high. The closure notice will also identify the contaminant of concern, such as mercury or fecal coliform bacteria, and will list any (or all) species of fish or shellfish which people are prohibited from taking from the area of closure.
Prepared by the Lower Colorado River Authority and the Upper Colorado River Authority in cooperation with the Texas Commission on Environmental Quality under the authorization of the Texas Clean Rivers Act.

Cover photo was taken over Lake Travis on March 10, 2014.