# Watershed: Upper Colorado River Basin

**Water Bodies:** Champion Creek Reservoir, Colorado River, O.H. Ivie Reservoir, E.V. Spence Reservoir, Lake L.B. Thomas, Oak Creek Reservoir, Lake Colorado City

**Population Centers:** Ballinger, Colorado City, Big Spring, Snyder, Robert Lee, Winters, Bronte

**Counties:** Lynn, Dawson, Borden, Garza, Scurry, Howard, Mitchell, Sterling, Nolan, Coke, Taylor, Runnels, Coleman, Concho

**Ecoregion:** Western High Plains; Central Great Plains

**Ecoregion Description:**

- The Western High Plains are higher and drier than the Central Great Plains to the east, and in contrast to the irregular, mostly grassland or grazing land of the Northwestern Great Plains to the north, much of the Western High Plains comprises smooth to slightly irregular plains having a high percentage of cropland. Grama-buffalo grass is the potential natural vegetation in this region as compared to mostly wheatgrass-needlegrass to the north, Trans-Pecos shrub savanna to the south and taller grasses to the east. The northern boundary of this ecological region is also the approximate northern limit of winter wheat and sorghum and the southern limit of spring wheat.
- The Central Great Plains are slightly lower, receive more precipitation and are somewhat more irregular than the Western High Plains to the west. Once a grassland, with scattered low trees and shrubs in the south, much of this ecological region is now cropland, the eastern boundary of the region marking the eastern limits of the major winter wheat growing area of the United States.

**Climate:**

- The Western High Plains have high winds, dry winters, and low annual rainfall.
- The Central Great Plains have low humidity, wide ranges of temperature and precipitation, and frequent windstorms. Annual average precipitation is about 20 inches with May the wettest month. Although a substantial portion of this precipitation falls during the growing season, the amount and distribution is usually inadequate to ensure good crop yields.

**Land Use:**

- The Western High Plains have cropland, cropland with grazing land and irrigated agriculture.
- The Central Great Plains have cropland, cropland with grazing land and some vegetated agriculture.

**Soils:**

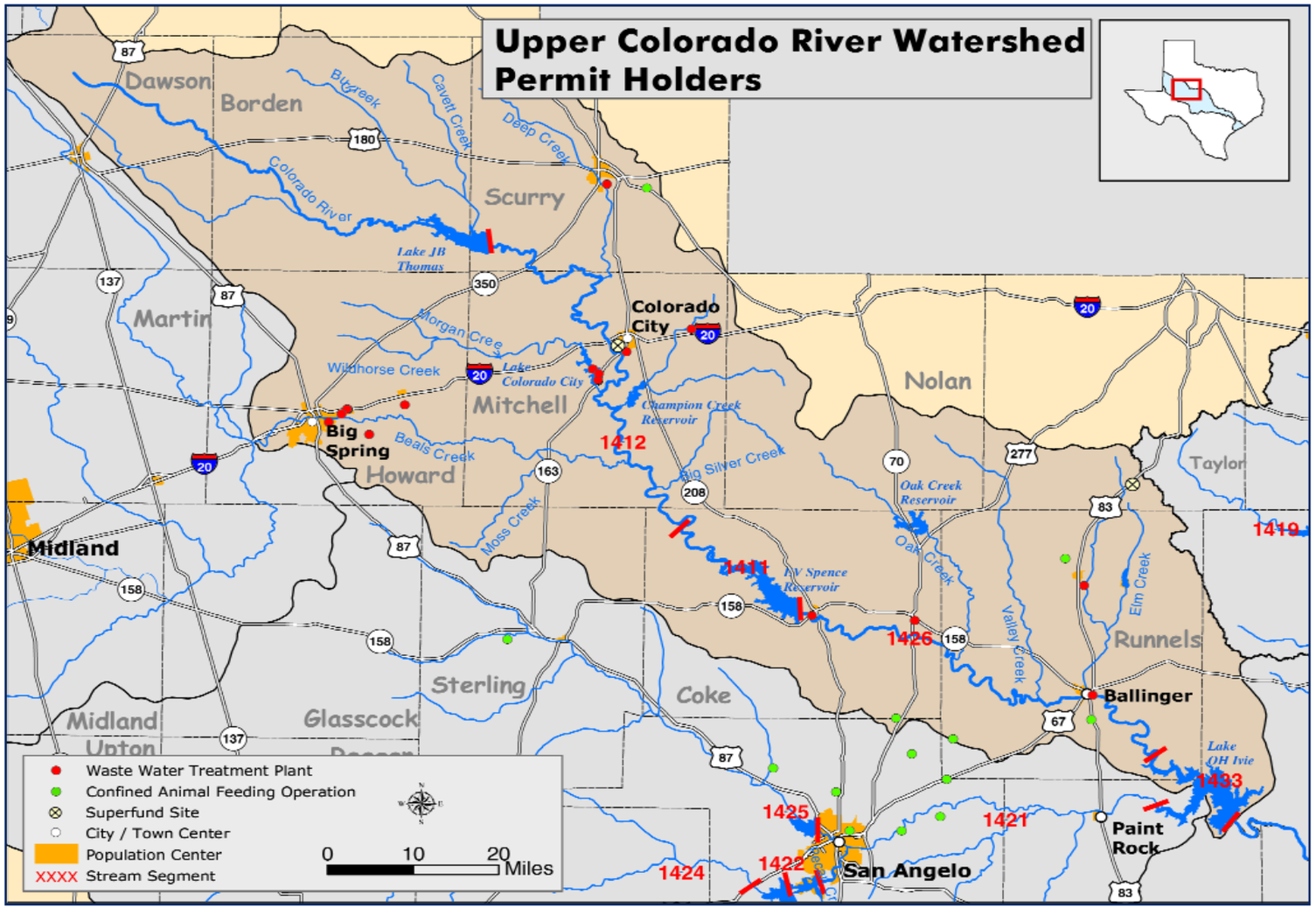
- The Western High Plains have dry mollisols. Upland soils are dark brown to reddish brown, mostly deep, neutral to calcareous clay and clay loams in the north to sandy loams and sands in the south. Caliche is present under many soils at various depths, especially on the Potter series.
- Central Great Plains have dry mollisols that are sandy, generally developed from unconsolidated beds of sands and clays under grasses with large quantities of organic matter deposited in the soil structure. However, due to the loose structure and coarse texture of many of the soils, the organic matter has largely leached out.

**Permitted Discharges:** 17

**Permitted CAFOs:** 5

Upper Colorado River Basin

Fig. 27 - Upper Colorado River Basin Watershed:




## Trend Analyses for the Upper Colorado River Basin

Trend analyses were conducted using regression analysis for sites within water bodies listed on the 1999 303(d) list of impaired water bodies. The purpose of these analyses was to evaluate the relationship of the parameters in question to flow and time.

Because the parameters of concern were generally conservative, the trend analysis was simplified. For stream sites, data was processed to remove the effects attributable to flow. The resulting residuals were then regressed against time. In reservoirs, only time-based regression analysis was performed. For the purpose of this document, data sets of less than 10 samples over five years are excluded and significance is defined as a < 0.05.

## Trend Analysis for Segment 1420 – Upper Pecan Bayou

This segment is listed for low dissolved oxygen. Only one site (Pecan Bayou at S.H. 279) in this segment produced enough data for evaluation. A plot of dissolved oxygen deficit showed what appeared to be an increasing trend over time. Analysis also revealed a significant relationship to discharge, but once the effects of flow were removed, no significant temporal trend was observed.

## Trend Analyses for Segment 1411 – E.V. Spence Reservoir

E.V. Spence Reservoir is listed for not meeting sulfate and total dissolved solids (TDS) standards. Two sites on the reservoir (12359 and 12360) had adequate datasets for sulphate analysis. Neither site showed a significant trend over time. Only site 12460 had enough data to examine TDS. There was a significant relationship to TDS over time.

Intermittent Stream Lined with Salts

## Trend Analyses for Segment 1426 – Colorado River below E.V. Spence

This segment was listed for violating TDS and chloride standards. Five sites were analyzed for TDS standards violations (12207, 12430, 12432, 13561 and 15167). All sites except 15167 showed a significant relationship between TDS and flow. No site, however, showed any temporal trend once the effects of flow were removed from the data sets.

These same sites were also analyzed for chloride. No site showed a relationship to flow. There were positive relationships when chloride was regressed against time at sites 12207, 12430 and 13651. Because chloride is conservative and a major component of TDS, one would expect them to be related to stream flow (dilution at higher flow rates), but this pattern was not seen.

## Upper Colorado River Basin Special Projects

The Colorado River basin above O.H. Ivie Reservior lies in the Permian basin, an area rich in oil and gas deposits. Development and exploration of these deposits have created problems that have and will continue to have a long-term impact on surface water in the upper basin. Improper disposal and improperly plugged wells have generated brine water and created excessive amounts of chlorides in soil and groundwater in the upper basin.

The development of these petroleum resources is an ongoing activity and will continue in the foreseeable future.

### *O'Daniel Seep*

The O'Daniel Seep is a produced water (oil field) seep near Beals Creek in the Snyder Oil Field east of Big Spring. This problem originally started with the contamination of a drinking water well in the late 1970s, eventually killing vegetation, contaminating a livestock tank, and covering several hundred acres. The Railroad Commission (RRC) has contained the seep. However, its source is still unknown. The current producer, Saga Petroleum, has agreed to work with Anadarko Petroleum Corporation in planning and constructing a cutoff trench near the Snyder Field Road. This cutoff trench, when completed, should stop the movement of the produced water and contain it for subsequent transport to an injection well at another location. Both oil companies will continue to search for the origin of the seep.

### *Lake J.B. Thomas Seep*

Another produced seep in the upper basin is located at Lake Thomas. The seep was first identified in the mid-1980s. Because of very low lake levels, the seep does not pose a serious threat to the water supply. In 2001, RRC staff began working with Apache Oil Company, the current lease owner, to construct a cut-off trench with French drain and three monitor wells to abate the seep.

### *Well Plugging Project*

Routine monitoring in the upper basin documented elevated salinity levels in the upper Colorado River watershed. Abandoned and improperly plugged oil wells in the E. V. Spence watershed have been identified as a source of high concentrations of TDS and chlorides coming from produced (brine) water. As part of an effort to address the issue of "rogue" oil wells, the TCEQ (formerly TNRCC) Nonpoint-Source Pollution Program and the Railroad Commission (RRC) embarked on a joint agency effort to plug 171 problem oil wells, which were known to the RRC. This ongoing, three-year project, which began in 1999 between the TCEQ (formerly TNRCC) and the RRC, was designed to target problem oil wells in the E.V. Spence Reservoir watershed. By the end of 2001, the RRC plugged 107 wells at a cost of $865,000. The project is ongoing and is an integral part of the E.V. Spence Reservoir TMDL project.

### *Col-Tex Superfund Site*

The Col-Tex site is an abandoned refinery and tank farm located along the south bank of the Colorado River in Colorado City. The refinery was constructed in 1924 and expanded in 1927. Ownership of the facility changed hands several times since 1924, ending with American Petrofina's acquisition in 1957. The plant operated for 10 more years, followed by a period of dismantling and abandonment. By 1971, most of the refinery equipment had been removed and only one tank remained in operation in 1991.

In 1990, after designation as a Superfund site, work by American Petrofina, the Texas Water Commission (now the TCEQ) and the Environmental Protection Agency (EPA) began to clean up the refinery, the tank farm and a waste pit area at the site.

CRMWD has monitored the cleanup activities at the site from planning through remediation to ensure the best possible outcome for the immediate health of the river and for the protection of the district's downstream reservoirs. Activities completed in 2000 by Atofina and Chevron Oil Company, under TCEQ (formerly TNRCC) supervision, included ecological risk assessment, real estate purchase, quarterly sampling events, continued remedial investigations, remediation systems operation and maintenance. Remediation activities continue at the site.

### *Magnesium Plant Cleanup*

The magnesium plant is located approximately seven miles southwest of the city of Snyder at the intersection of FM 1606 and FM 1607. The site contains buildings in various states of disrepair, a tank farm and several ponds for storage and catchment. The facility began operation in 1973 under American Magnesium Company (AMC) and has had several owners since. From 1969 to 1983 the facility used an electrolytic process to purify magnesium metal from magnesium chloride brine solutions. From 1983 to 1987, World Wide Refining, Inc. used the site for oil reclamation and/or refining. The plant used storage ponds and underground injection to dispose of the wastes from the site. The TCEQ (formerly TNRCC) regional office documented unauthorized discharges of high chloride water numerous times throughout the life of the plant. Operations were discontinued in 1987.

In January 1998, CRMWD staff collected water samples from a well near the property line and from a seep down-slope from the well. Chloride concentrations of the samples were 15,200 mg/L and 15,000 mg/L, respectively. Discharge from the seep was not measured, but was sufficient to cause a small flow across a nearby county road. An apparent kill zone was noted on both sides of the county road. The location of the site still presents a threat to the water quality of Bluff Creek and eventually to the Colorado River.

### *CRMWD Water Diversion System*

The circumstances that provided the Permian Basin with a rich supply of valuable oil reserves also left an abundance of chlorides and minerals to be picked up by runoff and carried into the Colorado River and the reservoirs it fills. From its earliest engineering studies, the district has been forced to modify its plans and build facilities to keep salt and other minerals out of the reservoirs. In the mid-1980s, isolated heavy rainfall caused a near catastrophe at Natural Dam Lake, just northwest of Big Spring, threatening to inundate the city with water from the lake that ranks as one of the saltiest bodies of water in the world. To save the dam and the city, excessive amounts of the highly mineralized water was allowed to pass through an emergency spillway, where it traveled down Beals Creek and ended up in the E.V. Spence Reservoir. After the event, CRMWD spent about $3 million upgrading and building new diversion facilities in the area.

CRMWD has spent more than $22 million constructing water quality-enhancement projects, including Natural Dam, the Beals Creek project and others. The normal low flows of the Colorado River above Spence, as well as those from Beals Creek, are diverted along with their load of salt into side-storage reservoirs with a total capacity of 100,867 acre-feet.

The system permits only flood flows, with chloride contents of less than 500 ppm, to pass over the low dams and enter the lake. The diverted water from the side storage reservoirs is sold to oil companies or allowed to evaporate. With West Texas oil drilling operations cycling up and down, demand and sales of secondary recovery non-potable water fluctuate significantly from year to year.

During this basin summary period (September 1996 through August 2001), the diversion works above Lake Spence (Barber Reservoir, Mitchell County Reservoir, Beals Creek Diversion, and the Three and Four Mile Lakes diversions) to removed significant levels of poor quality water from Beals Creek and the Colorado River.

Table 30 displays the amount of chlorides removed by the diversion works from 1997-2001.

Tabel 30 - Chlorides Removed via the Diversion System

| Year | Water | Chlorides |
|---|---|---|
| 1997 | 3,710 million gallons | 45,442 tons of chlorides |
| 1998 | 2,292 million gallons | 18,631 tons of chlorides |
| 1999 | 2,058 million gallons | 18,430 tons of chlorides |
| 2000 | 1,997 million gallons | 18,326 tons of chlorides |
| 2001 | 2,834 million gallons | 46,667 tons of chlorides |
| Total | 12,891 million gallons | 147,496 tons of chlorides |

### *E.V. Spence Reservoir TMDL Project*

The E.V. Spence Reservoir is located on the Colorado River just north of San Angelo and southeast of Big Spring in Coke County. The reservoir's watershed includes a large area of Texas and New Mexico and covers 15,278 square miles. A majority of this drainage area, 10,260 square miles, is part of the High Plains Region and does not normally contribute runoff or pollution to the main stem of the Colorado River above the reservoir.

The reservoir was placed on the 1998 Clean Water Act Section 303(d) list because sulfate and TDS concentrations exceeded the segment standards criteria of 450 mg/L and 1,500 mg/L, respectively. In April 1999, the TCEQ (formerly TNRCC) and the CRMWD agreed to develop TMDL for sulfate and TDS in the reservoir.

Stakeholders participated throughout the TMDL project through a 14-member watershed Steering Committee. Members of the Steering Committee represented the general public, environmental interests, municipalities, industry, agriculture, water districts, river authorities and state and federal agencies. A technical subcommittee was formed to address technical issues such as modeling, and to provide recommendations to the Steering Committee.

Monthly chloride, sulfate and TDS loading capacities over the 28-year period of record were estimated using an updated reservoir water quality model. Once the series of loading capacities was established, the loading capacity values were ranked in order of magnitude. In recognition of the climatological limitations associated with this portion of Texas, the 80th percentile loading capacity, the loading capacity that would be present in the reservoir 80 percent of the time, was selected as the target loading capacity.

Monthly estimates of the point-source loads in the watershed were derived from each facility's full-permitted flows and monitoring data collected by CRMWD just downstream of the discharge outfalls. For each parameter, the difference between the target loading capacity and the point source load represents the allowable loading contribution from nonpoint sources, with 44 percent of that remainder assigned to manmade nonpoint sources and 56 percent assigned to natural sources. This distribution was suggested by a U.S. Geological Survey study completed in 1994.

The total maximum daily loads were adopted by the TCEQ (formerly TNRCC) in November of 2000 and submitted to the EPA for approval. The TMDL implementation plan was completed in April of 2001. It was designed to achieve the reductions in the annual average concentration and total-annual loading of sulfate and total dissolved solids in the reservoir's watershed. This implementation plan was prepared by the TCEQ (formerly TNRCC) with technical assistance provided by CRMWD.

### *Segment 1426 TMDL Project*

The 2000 303(d) List reported segment 1426, the Colorado River between E.V. Spence Reservoir and O.H. Ivie Reservoir as exceeding state standards for TDS stream segment criteria. The Texas Water Commission which preceded TCEQ (formerly TNRCC) established criteria of 2,000 ppm for TDS in 1978. TDS, chlorides (610 ppm) and sulfates (980 ppm) have been exceeded on a routine basis since the spill of Natural Dam Lake (1986) in the Beals Creek watershed above Big Spring. This catastrophic spill brought brine water down the Colorado River into Spence Reservoir, causing it to exceed segment standards and placing it on the 1998 303(d) List. CRMWD and TCEQ (formerly TNRCC) collaborated on the completion of the Spence TMDL for sulfates and total dissolved solids in October 2000.

In an effort to ameliorate the effect of the brine water on the reservoir, the district released large quantities of reservoir water downstream into Segment 1426. This release strategy was continued during the summary period and was included in the Spence TMDL implementation.

In February 2001, TCEQ (formerly TNRCC) published a notice requesting an invitation for bid for completion of a suite of statewide TMDLs. Segment 1426 was grouped with several other river basins' TMDLs for TDS. The consulting firm of EA Engineering was awarded the bid to complete the Segment 1426 TMDL. CRMWD will participate in the process as a stakeholder and act as a member of the TMDL Steering Committee. EA Engineering is presently gathering water quality data and putting together the steering committee. The initial work on this TMDL is scheduled to begin in mid-2002.

It should be noted that as of March 2002, TCEQ (formerly TNRCC) has not received EPA approval of the E.V. Spence Reservoir TMDL and the implementation plan has not been enacted.

### *Salt Cedar Eradication Project*

Salt cedar, *Tamarix spp.*, is a naturally occurring shrub from southern Europe, northern Africa and eastern Asia. It was first introduced to the United States in the early 1800s as an ornamental shrub. But because of its ability to reproduce and grow in moist, saline soils, it has spread throughout the upper Colorado River basin from the headwaters of the Colorado River in Borden County to the mouth of Lake Buchanan. It is impacting both water quality and water quantity in the upper Colorado River basin.

In 1987, the plant was noted along the Colorado River in isolated and small numbers down to and near Ballinger. By 1996 the plant was observed at sites near Rockwood in Coleman County. It now occurs in dense stands throughout the shoreline of O.H. Ivie Reservoir (inundated in 1992), and there is an estimated 6,000 acres of the plant in the E.V. Spence Reservoir basin.

Preliminary results of a research project by Texas A&M University and the Texas Cooperative Extension (San Angelo) estimated that one acre of salt cedar will transpire three acre-feet of water during one growing season. Using Spence Reservoir as an example where there may be as many as 6,000 acres of salt cedar (a conservative estimate), that would equal 18,000 acre feet of water per year. At the current elevation for Spence, that is more than one-third of its current capacity.

The State of Texas is beginning to recognize the benefits of controlling brush (mesquite and juniper) on rangelands. The Texas Department of Agriculture has formed a statewide task force to begin an effort to address the invasion of exotic aquatic species that are threatening our reservoirs and river resources. The CRMWD is planning to begin an eradication program for salt cedar in the headwater reaches of the Colorado River above Lake Thomas. CRMWD will work in a cooperative effort with the Texas Department of Agriculture, the Texas Cooperative Extension and the Natural Resource Conservation Service in the initial phase of this project.

It should be noted that this effort to eradicate salt cedar is a costly project. The only effective means of control of the plant is through aerial application of a herbicide. Within the riparian reaches of the river, a helicopter will have to be employed. This facilitates pinpoint application of the chemical on only the salt cedar and protects against spray drift and herbicide contact with other desirable, native vegetation. Based on a salt cedar eradication project currently under way on the Pecos River, costs have ranged from $170 to $200 per acre. Although the total acreage of salt cedar in the upper Colorado River basin has yet to be determined, preliminary estimates indicate there may be as many as 10,000 to 15,000 acres of salt cedar from the headwaters downstream to the upper end of Lake Buchanan.

CRMWD plans to sponsor the initial phase of an eradication project in the upper Colorado River basin in 2002. This project will be a cooperative effort with the Texas Extension Cooperative, the USDA Natural Resource Conservation Service, the Texas Department of Agriculture, and the Texas State Soil and Water Conservation Board through the local districts (Upper Colorado SWCD, Howard SWCD, and Mitchell SWCD). Key to the CRMWD's success will be the close cooperation of all these agencies plus the cooperation of all landowners of riparian habitat in the upper basin. Without 100 percent landowner consent to spray the salt cedar, there will remain a residual "seed bank" that will continue to replenish the plant in downstream riparian habitat.

Salt Cedar grows along the Colorado River.

Table 25 - Data Summary for Upper Colorado River Basin (continued on p. 72)

| | Year | Temperature (°C) | Dissolved Oxygen (mg/L) | pH (S.U.) | Ammonia (mg/L) | Nitrate + Nitrite (mg/L) | Total Phosphorus (mg/L) | Ortho Phosphorus (mg/L) | Chloride (mg/L) | Sulfate (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **E.V. Spence Reservoir** | 1996 | - | - | - | - | - | - | - | - | - |
| Segment 1411 | 1997 | 9.64 | 8.93 | - | - | - | - | - | 6572.0 | 1458.3 |
| 2 Sites on Segment | 1998 | 17.65 | 9.18 | 8.10 | 0.010 | 0.050 | 0.020 | 0.010 | 4254.4 | 1404.9 |
| | 1999 | 17.53 | 9.17 | - | 0.050 | - | 0.020 | - | 1458.5 | 1183.1 |
| | 2000 | 19.36 | 8.67 | 8.13 | - | 0.210 | - | - | 1584.5 | 1208.3 |
| | Mean | 16.99 | 9.09 | 8.12 | 0.030 | 0.157 | 0.020 | 0.010 | 3035.7 | 1291.1 |
| | Benchmark | 32.78 | 5.00 | 6.5 - 9.0 | 0.106 | 0.320 | 0.180 | 0.050 | 950.0 | 450.0 |
| | Violation Rate | 0.00 | 0.00 | 0.00 | 0.000 | 33.333 | 0.000 | 0.000 | 84.6 | 92.0 |
| **CR below Lake J.B. Thomas** | 1996 | 18.32 | 8.48 | 7.74 | 0.068 | 0.098 | 0.170 | 0.025 | 3644.2 | 1292.7 |
| Segment 1412 | 1997 | 15.51 | 8.63 | 7.80 | 0.063 | 0.097 | 1.999 | 0.014 | 2976.5 | 1080.9 |
| 5 Sites on Segment | 1998 | 16.30 | 7.91 | 7.83 | - | - | - | 0.017 | 4092.0 | 1366.8 |
| | 1999 | 17.25 | 9.73 | 7.88 | - | - | 1.380 | 0.430 | 3819.4 | 1225.7 |
| | 2000 | 19.72 | 8.89 | 7.88 | 0.185 | 0.279 | 0.310 | 0.016 | 2580.8 | 1162.0 |
| | **Mean** | **17.74** | **8.87** | **7.83** | **0.092** | **0.231** | **1.124** | **0.130** | **3391.1** | **1219.5** |
| | **Benchmark** | **33.88** | **5.00** | **6.5 - 9.0** | **0.170** | **2.760** | **0.800** | **0.500** | **11000.0** | **2500.0** |
| | **Violation Rate** | **0.54** | **7.69** | **0.00** | **11.111** | **3.704** | **18.182** | **10.811** | **6.6** | **4.4** |
| **Lake Brownwood** | 1996 | - | - | - | - | - | - | - | - | - |
| Segment 1418 | 1997 | 12.46 | 8.93 | 8.22 | 0.048 | - | 0.022 | - | 65.9 | 36.8 |
| 3 Sites on Segment | 1998 | - | - | - | 0.060 | 0.010 | 0.090 | 0.010 | 96.1 | 102.8 |
| | 1999 | 12.07 | 9.44 | 8.15 | 0.098 | - | 0.055 | - | 67.0 | 38.7 |
| | 2000 | 18.88 | 8.64 | 8.13 | 0.065 | - | 0.080 | - | 54.3 | 34.7 |
| | **Mean** | **16.20** | **8.91** | **8.14** | **0.068** | **0.010** | **0.063** | **0.010** | **71.8** | **55.2** |
| | **Benchmark** | **32.22** | **5.00** | **6.5 - 9.0** | **0.106** | **0.320** | **0.180** | **0.050** | **150.0** | **100.0** |
| | **Violation Rate** | **0.00** | **0.00** | **0.00** | **0.000** | **0.000** | **4.000** | **0.000** | **4.0** | **4.0** |
| **Lake Coleman** | 1996 | - | - | - | - | - | - | - | - | - |
| Segment 1419 | 1997 | - | - | - | - | - | - | - | - | - |
| 2 Sites on Segment | 1998 | - | - | - | 0.050 | - | 0.016 | - | 57.4 | 38.3 |
| | 1999 | 9.82 | 10.58 | 8.23 | 0.058 | - | 0.065 | - | 79.5 | 51.5 |
| | 2000 | 27.43 | 6.57 | 8.23 | 0.050 | - | 0.050 | - | 92.0 | 60.0 |
| | **Mean** | **18.62** | **8.58** | **8.23** | **0.054** | **-** | **0.038** | **-** | **71.3** | **46.9** |
| | **Benchmark** | **33.88** | **5.00** | **6.5 - 9.0** | **0.106** | **0.320** | **0.180** | **0.050** | **150.0** | **100.0** |
| | **Violation Rate** | **0.00** | **0.00** | **0.00** | **0.000** | **0.000** | **0.000** | **0.000** | **0.0** | **0.0** |

*Mean - annual average value* *Benchmark - state standard or threshold* *Violation Rate - percent of sample exceeded benchmark*

| | Year | Temperature (°C) | Dissolved Oxygen (mg/L) | pH (S.U.) | Ammonia (mg/L) | Nitrate + Nitrite (mg/L) | Total Phosphorus (mg/L) | Ortho Phosphorus (mg/L) | Chloride (mg/L) | Sulfate (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pecan Bayou above Lake Brownwood** | 1996 | 19.42 | 8.05 | 7.87 | 0.033 | 0.145 | 0.063 | 0.045 | 165.5 | 108.5 |
| Segment 1420 | 1997 | 18.67 | 8.74 | 7.92 | 0.045 | 0.390 | 0.063 | 0.070 | 227.3 | 202.3 |
| 2 Sites on Segment | 1998 | 15.58 | 7.17 | 7.73 | 0.054 | - | 0.062 | - | 217.6 | 233.0 |
| | 1999 | 19.35 | 5.86 | 7.76 | 0.066 | - | 0.088 | - | 91.2 | 59.2 |
| | 2000 | 17.63 | 6.66 | 7.91 | 0.052 | - | 0.122 | - | 19.4 | 27.6 |
| | **Mean** | **18.05** | **7.20** | **7.83** | **0.051** | **0.227** | **0.081** | **0.053** | **139.7** | **123.6** |
| | **Benchmark** | **32.22** | **5.00** | **6.5 - 9.0** | **0.170** | **2.760** | **0.800** | **0.500** | **500.0** | **500.0** |
| | **Violation Rate** | **0.00** | **21.74** | **0.00** | **0.000** | **0.000** | **0.000** | **0.000** | **0.0** | **4.3** |
| **CR below E.V. Spence Reservoir** | 1996 | 16.99 | 10.41 | 7.96 | 0.030 | 1.315 | 0.055 | 0.038 | 735.3 | 670.5 |
| Segment 1426 | 1997 | 17.58 | 9.33 | 7.90 | 0.109 | 0.472 | 0.061 | 0.020 | 677.8 | 711.8 |
| 5 Sites on Segment | 1998 | 18.14 | 8.33 | 7.81 | 0.149 | 0.286 | 0.074 | 0.080 | 933.4 | 863.5 |
| | 1999 | 19.25 | 9.60 | 7.82 | 0.125 | - | 0.145 | - | 1051.5 | 1212.6 |
| | 2000 | 20.77 | 9.55 | 7.92 | 0.419 | 0.129 | 0.119 | 0.010 | 983.4 | 1013.7 |
| | **Mean** | **18.71** | **9.35** | **7.89** | **0.186** | **0.359** | **0.093** | **0.035** | **890.0** | **912.5** |
| | **Benchmark** | **32.78** | **5.00** | **6.5 - 9.0** | **0.170** | **2.760** | **0.800** | **0.500** | **610.0** | **980.0** |
| | **Violation Rate** | **0.50** | **2.53** | **0.00** | **23.529** | **0.000** | **0.000** | **0.000** | **69.3** | **38.5** |
| **Pecan Bayou** | 1996 | 19.34 | 8.28 | 7.58 | 0.084 | 5.422 | 1.113 | 1.002 | 134.2 | 79.3 |
| Segment 1431 | 1997 | 18.23 | 7.94 | 7.69 | 0.068 | 1.830 | 0.648 | 0.385 | 74.5 | 53.8 |
| 1 Site on Segment | 1998 | 18.55 | 8.07 | 7.71 | 0.053 | - | 1.178 | - | 125.5 | 100.0 |
| | 1999 | 18.57 | 8.82 | 7.80 | 0.060 | - | 2.087 | - | 132.8 | 85.8 |
| | 2000 | 19.39 | 10.16 | 7.89 | 0.050 | - | 2.330 | - | 139.3 | 84.0 |
| | **Mean** | **18.84** | **8.64** | **7.73** | **0.068** | **4.524** | **1.329** | **0.847** | **123.2** | **80.2** |
| | **Benchmark** | **32.22** | **2.00** | **6.5 - 9.0** | **0.170** | **2.760** | **0.800** | **0.500** | **410.0** | **120.0** |
| | **Violation Rate** | **0.00** | **0.00** | **0.00** | **4.348** | **75.000** | **78.261** | **75.000** | **0.0** | **0.0** |
| **Pecan Bayou** | 1996 | 20.77 | 8.43 | 7.88 | 0.048 | 0.140 | 0.050 | 0.060 | 99.1 | 77.3 |
| Segment 1432 | 1997 | 19.58 | 8.43 | 7.97 | 0.040 | - | 0.050 | - | 91.7 | 64.5 |
| 1 Site on Segment | 1998 | - | - | - | - | - | - | - | - | - |
| | 1999 | 16.53 | 5.62 | 7.29 | 0.050 | - | 0.060 | - | 119.0 | 70.0 |
| | 2000 | 22.20 | 7.34 | 7.77 | 0.053 | - | 0.160 | - | 102.7 | 61.3 |
| | **Mean** | **19.82** | **8.01** | **7.83** | **0.047** | **0.140** | **0.077** | **0.060** | **99.0** | **68.4** |
| | **Benchmark** | **32.22** | **5.00** | **6.5 - 9.0** | **0.170** | **2.760** | **0.800** | **0.500** | **200.0** | **150.0** |
| | **Violation Rate** | **0.00** | **0.00** | **0.00** | **0.000** | **0.000** | **0.000** | **0.000** | **0.0** | **0.0** |

*Mean - annual average value* *Benchmark - state standard or threshold* *Violation Rate - percent of sample exceeded benchmark*

Table 25 - Data Summary for Upper Colorado River Basin (continued from p. 72)

| | Year | Temperature (°C) | Dissolved Oxygen (mg/L) | pH (S.U.) | Ammonia (mg/L) | Nitrate + Nitrite (mg/L) | Total Phosphorus (mg/L) | Ortho Phosphorus (mg/L) | Chloride (mg/L) | Sulfate (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **O.H. Ivie Reservoir** | 1996 | - | - | - | - | - | - | - | - | - |
| Segment 1433 | 1997 | 13.55 | 8.55 | 8.22 | 0.100 | - | 0.020 | - | 348.0 | 264.0 |
| 3 Sites on Segment | 1998 | 20.25 | 7.68 | 8.11 | 0.063 | 0.270 | 0.233 | 0.030 | 352.4 | 275.4 |
| | 1999 | 19.68 | 7.79 | 8.28 | 0.050 | - | 0.803 | - | 450.9 | 291.4 |
| | 2000 | 16.73 | 7.85 | 8.29 | 0.053 | 0.020 | 0.050 | - | 374.2 | 307.2 |
| | **Mean** | **18.78** | **7.80** | **8.24** | **0.058** | **0.083** | **0.423** | **0.030** | **389.1** | **291.5** |
| | **Benchmark** | **33.88** | **5.00** | **6.5 - 9.0** | **0.106** | **0.320** | **0.180** | **0.050** | **-** | **-** |
| | **Violation Rate** | **0.00** | **18.52** | **0.00** | **0.000** | **0.000** | **14.286** | **0.000** | **-** | **-** |

*Mean - annual average value* *Benchmark - state standard or threshold* *Violation Rate - percent of sample exceeded benchmark*