DRAFT REPORT

ASSESSMENT OF WATER QUALITY IMPAIRMENTS IN ADAMS BAYOU TIDAL (SEGMENT 0508), COW BAYOU TIDAL (SEGMENT 0511) AND THEIR TRIBUTARIES

ORANGE COUNTY TOTAL MAXIMUM DAILY LOADS PROJECT

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ACRONYMS AND ABBREVIATIONS

7Q2	7-day, 2-year low flow, the lowest 7-day average flow over 2 years
BOD	Biochemical oxygen demand
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfu	Colony forming units
DO	Dissolved oxygen
FC	Fecal coliform bacteria
FS	Fecal streptococci bacteria
ft	Feet
IH	Interstate highway
km	Kilometers
L	Liter
lbs	Pounds
m	Meter
mg	Milligram
MGD	Million gallons per day
mL	Milliliter
NPDES	National Pollutant Discharge Elimination System
POC	Particulate organic carbon
SH	State highway
SOD	Sediment oxygen demand
SWQM	Surface water quality monitoring
TCEQ	Texas Commission on Environmental Quality (formerly TNRCC)
TDWR	Texas Department of Water Resources (a predecessor agency to TCEQ)
TMDL	Total maximum daily load
TNRCC	Texas Natural Resources Conservation Commission (now TCEQ)
TPWD	Texas Parks and Wildlife Department
TRACS	Texas Regulatory Activities and Compliance System
TSS	Total suspended solids
TWC	Texas Water Commission (a predecessor agency to TCEQ)
UAA	Use attainability analysis
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLE	Waste load evaluation
WWTP	Wastewater treatment plant

SECTION 1
INTRODUCTION

Section 303(d) of the Federal Clean Water Act and U.S. Environmental Protection Agency (USEPA) regulation 40 Code of Federal Regulations (CFR) 130.7 require states to identify water bodies that do no meet, or are not expected to meet, applicable water quality standards. The compilation of these "impaired" water bodies is known as the §303(d) list. Each state must assign priorities to water bodies on the list, in order to schedule development of total maximum daily loads (TMDL). The TMDL is an allocation of allowable point and nonpoint source pollutant loadings that will enable the water body to meet water quality standards.

The Texas Commission on Environmental Quality (TCEQ) is responsible for the monitoring and assessment of water quality to evaluate compliance with State water quality standards. Pursuant to the Clean Water Act, one of the areas of TCEQ responsibility is the development of the §303(d) list for Texas and subsequent development of TMDLs.

The subject of the present evaluation is the analysis of nine water bodies that have been included on the §303(d) list due to elevated levels of bacterial indicators for pathogens, low dissolved oxygen, and low pH (TCEQ 2002). The list is a draft that it has been approved by the TCEQ but has not yet been approved by the USEPA.

1.1 PROJECT AREA

This assessment covers tidal and non-tidal portions of Adams Bayou and Cow Bayou, two adjacent tributaries of the lower Sabine River in the southeast corner of Texas (Figure 1.1). It also covers Gum Gully and Hudson Gully, which are tributaries of Adams Bayou, and Terry Gully, Coon Bayou, and Cole Creek, which are tributaries of Cow Bayou.

Adams and Cow Bayous are sluggish streams that flow into the Sabine River just upstream of Sabine Lake in Orange County. Adams Bayou extends from its confluence with the Sabine River in a northerly direction across Orange County to near the Newton County Line. Adams Bayou previously extended into southern Newton County, but this flow has been redirected eastward through a ditch to the Sabine River. Cow Bayou extends from its confluence with the Sabine River in a northerly direction, roughly parallel to but west of Adams Bayou, across Orange County to Buna in southern Jasper County.

The lower portions of both bayous have been channelized, straightened, and dredged for navigation, creating numerous oxbows. Both bayous are under tidal influence below and a short distance above Interstate Highway (IH)-10. The tidal portions of Adams and Cow Bayous extend approximately 8 and 20 miles, respectively, above their confluences with the Sabine River.

There is no flow gaging station on Adams Bayou, but field surveys indicate that under low-flow conditions there is essentially no base flow (TWC 1986). Under these conditions, water movement occurs due to tidal ebb and flow, downstream water diversions, and

wastewater discharges to the bayou. Upper reaches of Adams Bayou and non-tidal tributaries are intermittent streams.

A U.S. Geological Survey (USGS) gaging station measured flow in Cow Bayou at the state highway (SH) 12 bridge near Mauriceville from 1952 to 1986, and was recently re-activated. The annual average, maximum, and 7-day, 2-year minimum flow (7Q2) at this site were 104.4 cubic feet per second (cfs), 4600 cfs, and 0.05 cfs, respectively, over the period of record.

The TCEQ has divided Adams and Cow Bayous and their tributaries into multiple segments for water quality management purposes. Figure 1.2 shows the locations of these segments, as well as ambient water quality monitoring stations on these segments. The segments are described as follows:

- Segment 0508 (Adams Bayou Tidal) - from the confluence with the Sabine River in Orange County to a point 1.1 kilometers (km) (0.7 miles) upstream of IH-10 in Orange County (a classified tidal stream of 8 miles in length).
- Segment 0508A (Adams Bayou above Tidal) - from a point 1.1 km (0.7 miles) upstream of IH-10 in Orange County to the upstream perennial portion of the stream northwest of Orange in Orange County (an unclassified freshwater stream of 8 miles in length).
- Segment 0508B (Gum Gully) - From the confluence of Adams Bayou to the upstream perennial portion of the stream northwest of Orange in Orange County (an unclassified freshwater stream of 3.5 miles in length).
- Segment 0508C (Hudson Gully) - From the confluence with Adams Bayou to the headwaters near US 890 in Pinehurst in Orange County (an unclassified tidal stream of 0.5 miles in length).
- Segment 0511 (Cow Bayou Tidal) - from the confluence with the Sabine River in Orange County to a point 4.8 km (3.0 miles) upstream of IH-10 in Orange County (a classified tidal stream of 20 miles in length).
- Segment 0511A (Cow Bayou above Tidal) – from a point 4.8 km (3.0 miles) upstream of IH-10 in Orange County to the upstream perennial portion of the stream northeast of Vidor in Orange County (an unclassified freshwater stream of 10.6 miles in length).
- Segment 0511B (Coon Bayou) – from the confluence with Cow Bayou up to the extent of tidal limit in Orange County (an unclassified tidal stream of 4.7 miles in length).
- Segment 0511C (Cole Creek) – from the confluence with Cow Bayou west of Orange in Orange County to the upstream perennial portion of the stream south of Mauriceville in Orange County (an unclassified tidal stream of 9.5 miles in length).

- Segment 0511E (Terry Gully) – from the confluence with Cow Bayou in Orange County to the headwaters northeast of Vidor in Orange County (an unclassified freshwater stream of 8.6 miles in length).

There are currently five permitted wastewater discharges to Adams Bayou and twenty permitted wastewater discharges to Cow Bayou. The locations of the discharge points are illustrated in Figure 1.3.

The Adams Bayou watershed of approximately 51 square miles lies entirely within Orange County, though it included a portion of southern Newton County before a drainage canal diverted the uppermost portions of Adams Bayou to the Sabine River. The Cow Bayou watershed comprises approximately 192 square miles covering substantial portions of Orange and Jasper Counties, as well as a corner of Newton County.

Portions of the cities of Orange, West Orange, Pinehurst and Mauriceville lie within the Adams Bayou watershed, while portions of Bridge City, Vidor, Mauriceville, Evadale, and Buna lie within the Cow Bayou watershed. The 1990 human populations of Adams and Cow Bayou watersheds were each close to 20,000. Figure 1.4 shows the 1990 population density within the study area at the census block level.

Overall, 13.6 percent of the Adams Bayou watershed and 5.6 percent of the Cow Bayou watershed are considered developed or built-up land (residential, commercial, industrial, or transportation) (Table 1.1). More than 60 percent of the Cow Bayou watershed, and 40 percent of Adams Bayou watershed, is covered by forest, primarily evergreen and mixed evergreen/deciduous forest. Approximately 16 percent of the Cow Bayou watershed and 24 percent of the Adams Bayou watershed is used for pasture or hay production for grazing animals. Wetlands comprise approximately 10 percent and 15 percent, respectively, of the Cow and Adams Bayou watersheds. Land use is illustrated in Figure 1.5, from the Multi-Resolution Land Cover Consortium's National Land Cover Database (USGS 2000). This land use classification is based on Landsat Thematic Mapper satellite imagery from the early 1990's.

Adams and Cow Bayou are located in the flat Gulf of Mexico coastal plain. The elevation of Adams Bayou varies from sea level at the Sabine River to 4.5 feet at its uppermost extent (TWC 1986), with an average slope of only 0.06 m/km. The elevation of Cow Bayou varies from sea level at the Sabine River to 7 feet at its uppermost extent (TWC 1986), with an average slope of 0.0586 m/km (TWC 1988). Rain is abundant in this corner of Texas, with average annual rainfall of approximately 56 inches.

Some photographs of the water bodies are presented in Figures 1.6 to 1.15.

1.2 OBJECTIVES AND SCOPE

The primary objective of this document is to compile and analyze available water quality data and information for the nine water bodies described above, in order to identify appropriate steps for the current TMDL project. If, based on the results of this assessment, the TCEQ concludes that current designated uses or criteria to support those uses may not be

appropriate for one or more of the water bodies, a Use Attainability Analysis (UAA) may be performed. If this assessment indicates substantial uncertainty in the determination of whether water quality criteria are met or exceeded in these waterbodies, additional water quality monitoring may be performed to determine if water quality standards are met with an acceptable level of confidence. If this assessment indicates that designated uses and water quality criteria are appropriate and achievable, but are not met, the project will proceed to develop a water quality model to determine the TMDL and load allocation.

A second objective of this assessment is to identify factors contributing to water quality problems, through review of existing reports and analysis of available data.

Table 1.1 Some Properties of Adams and Cow Bayous

	Adams Bayou	Cow Bayou
Size (square miles)	51.05	192.09
Population, 1990	19,436	21,533
Average Annual Rainfall	56”	56”
National Land Cover Data Land Use/ Land Cover, circa 1992		
Open Water	4.84%	1.25%
Low Intensity Residential	6.67%	2.53%
High Intensity Residential	2.72%	1.38%
Commercial/Industrial/Transportation	4.26%	1.70%
Bare Rock/Sand/Clay	0.11%	0.12%
Quarries/Strip Mines/Gravel Pits	0.00%	0.17%
Transitional	0.02%	1.98%
Deciduous Forest	8.74%	11.33%
Evergreen Forest	17.58%	21.09%
Mixed Forest	13.79%	31.51%
Grasslands/Herbaceous	0.53%	0.14%
Pasture/Hay	23.74%	15.98%
Row Crops	0.01%	0.02%
Small Grains	0.39%	0.37%
Urban/Recreational Grasses	1.67%	0.83%
Woody Wetlands	8.76%	6.17%
Emergent Herbaceous Wetlands	6.17%	3.43%

Source: Multi-Resolution Land Characterization National Land Cover Data (USGS 2000)

Figure 1.1 Study Area

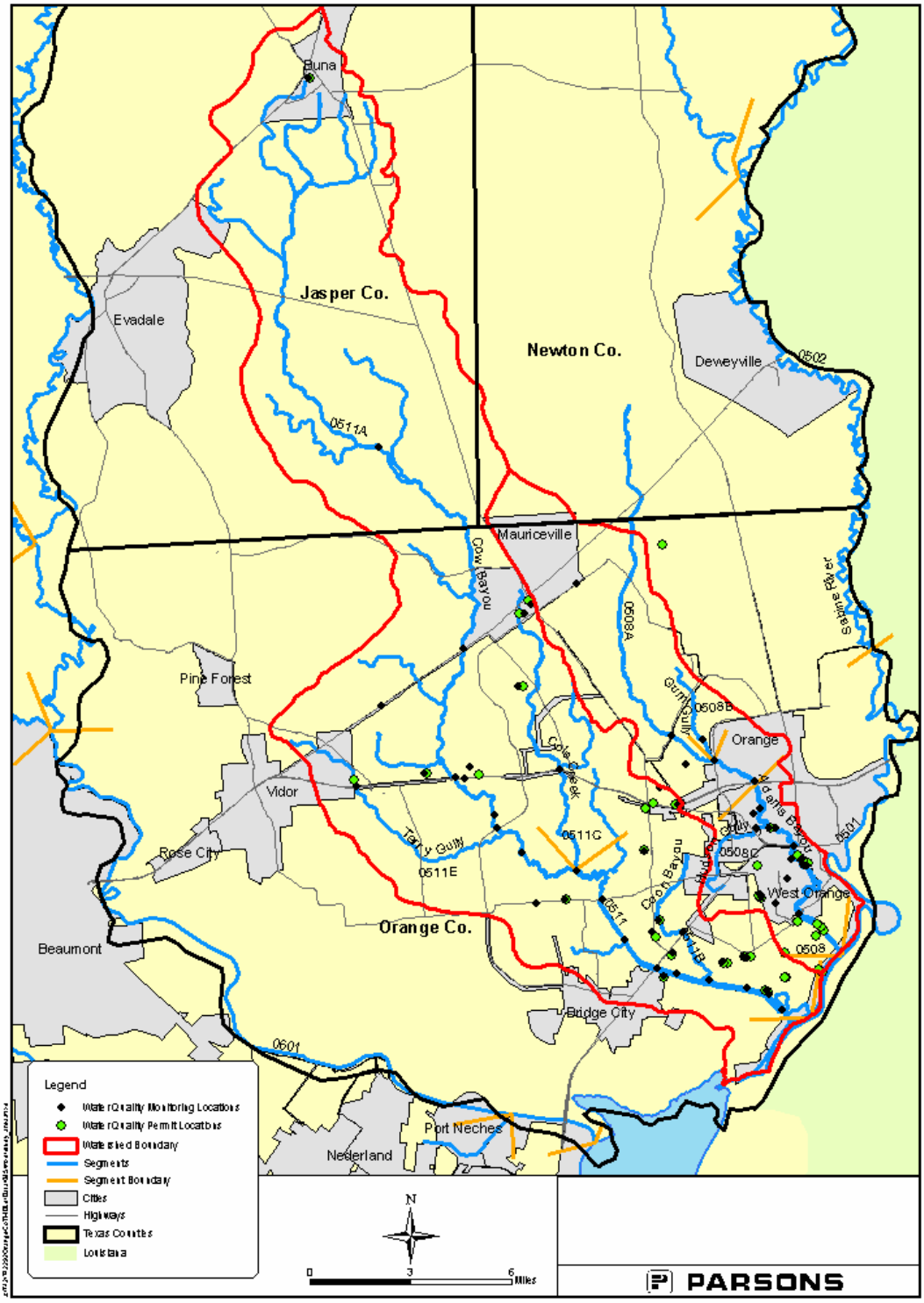


Figure 1.2 Hydrology and Ambient Monitoring Sites of Adams and Cow Bayous

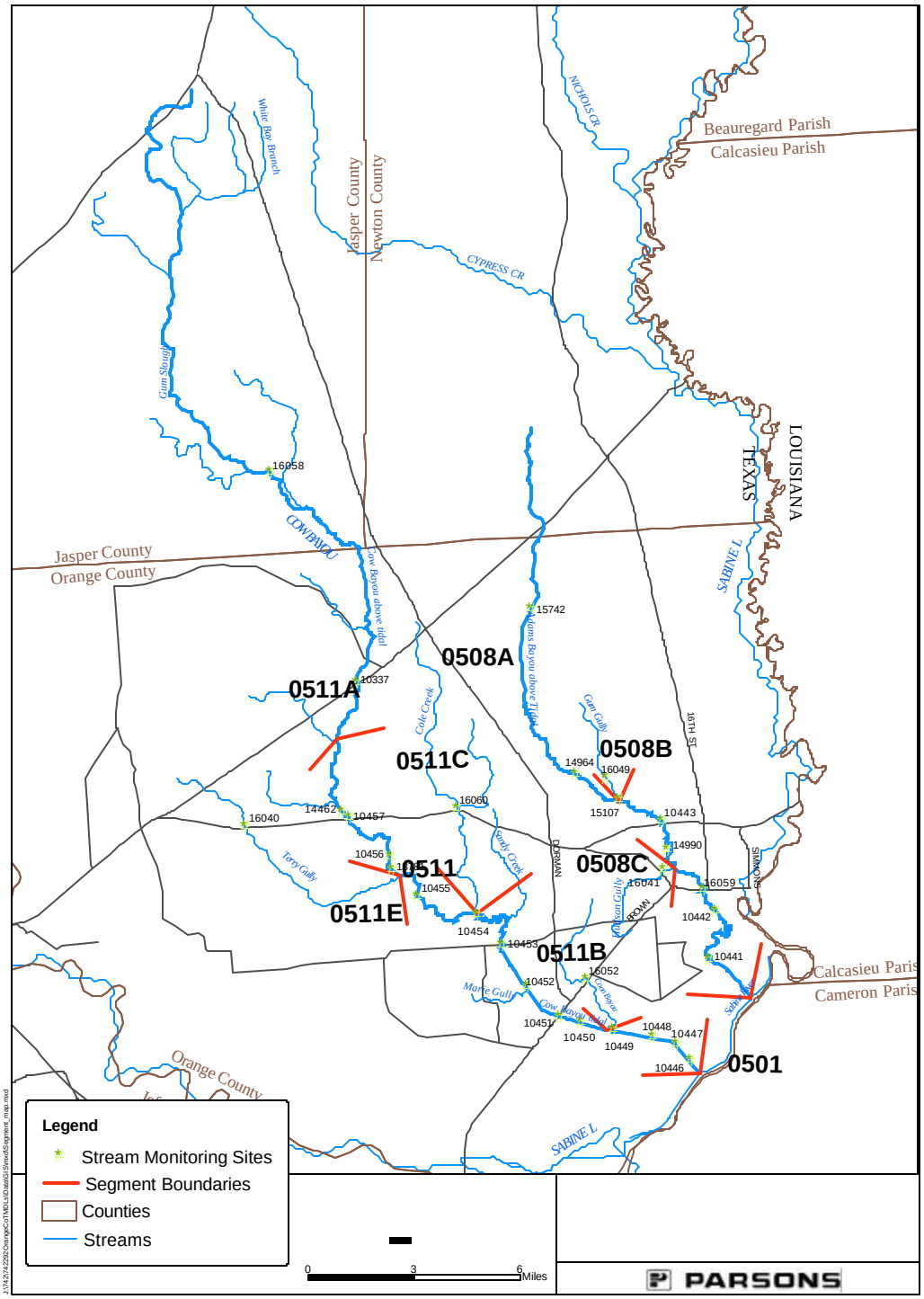


Figure 1.3 Permitted Wastewater Discharges to Adams and Cow Bayous

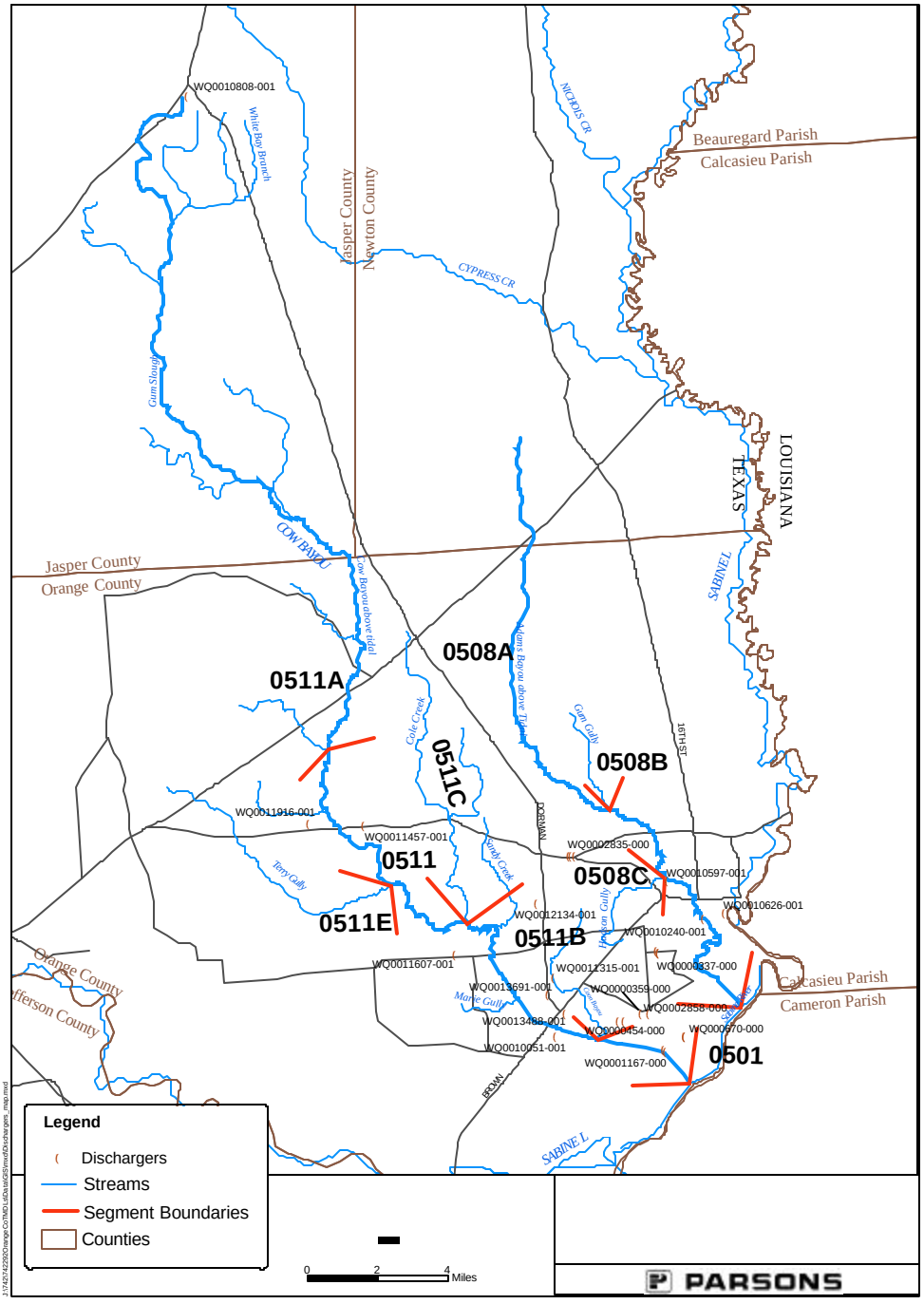


Figure 1.4 Population Density in the Study Area

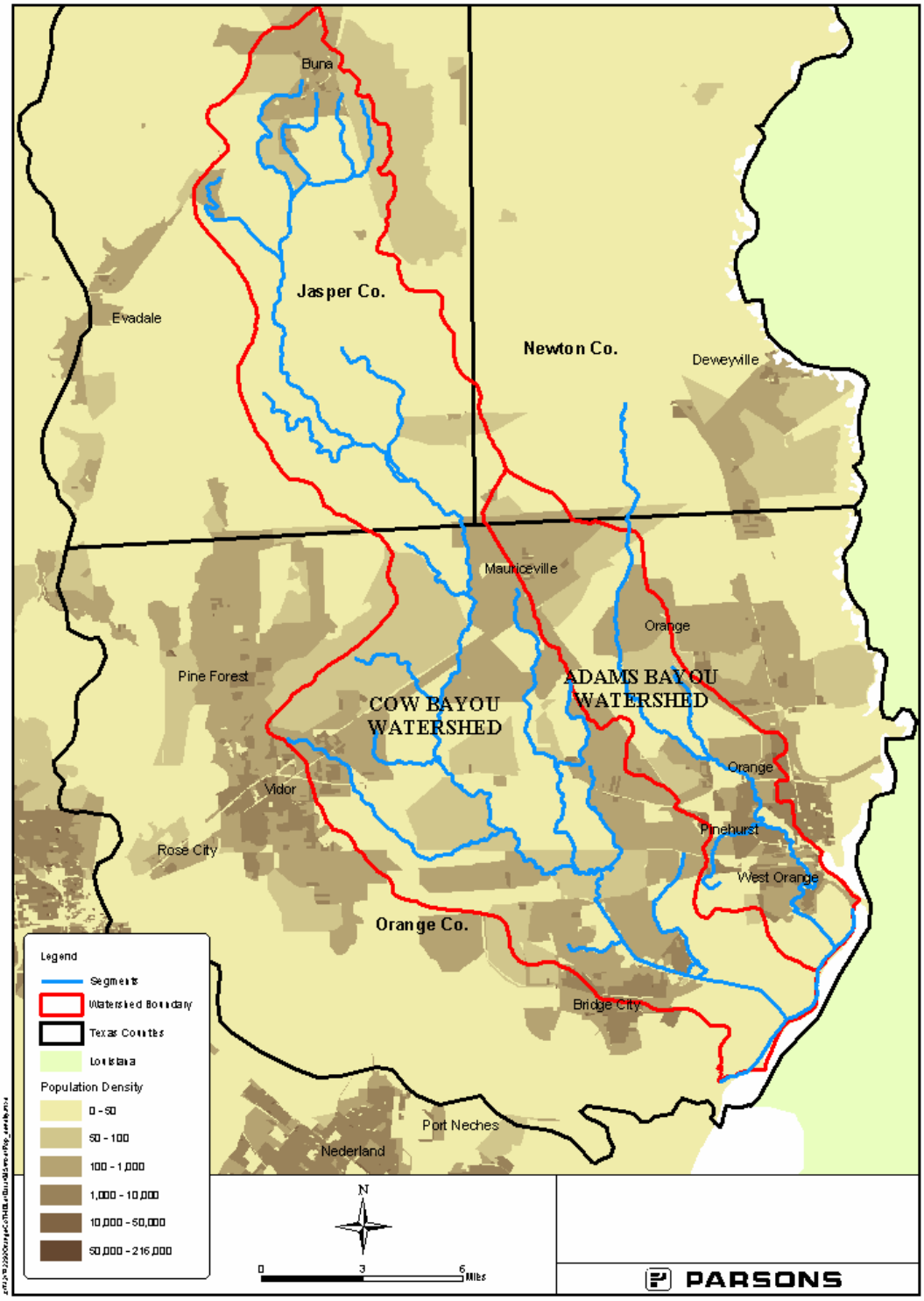


Figure 1.5 Land Use in the Watersheds of Adams and Cow Bayous

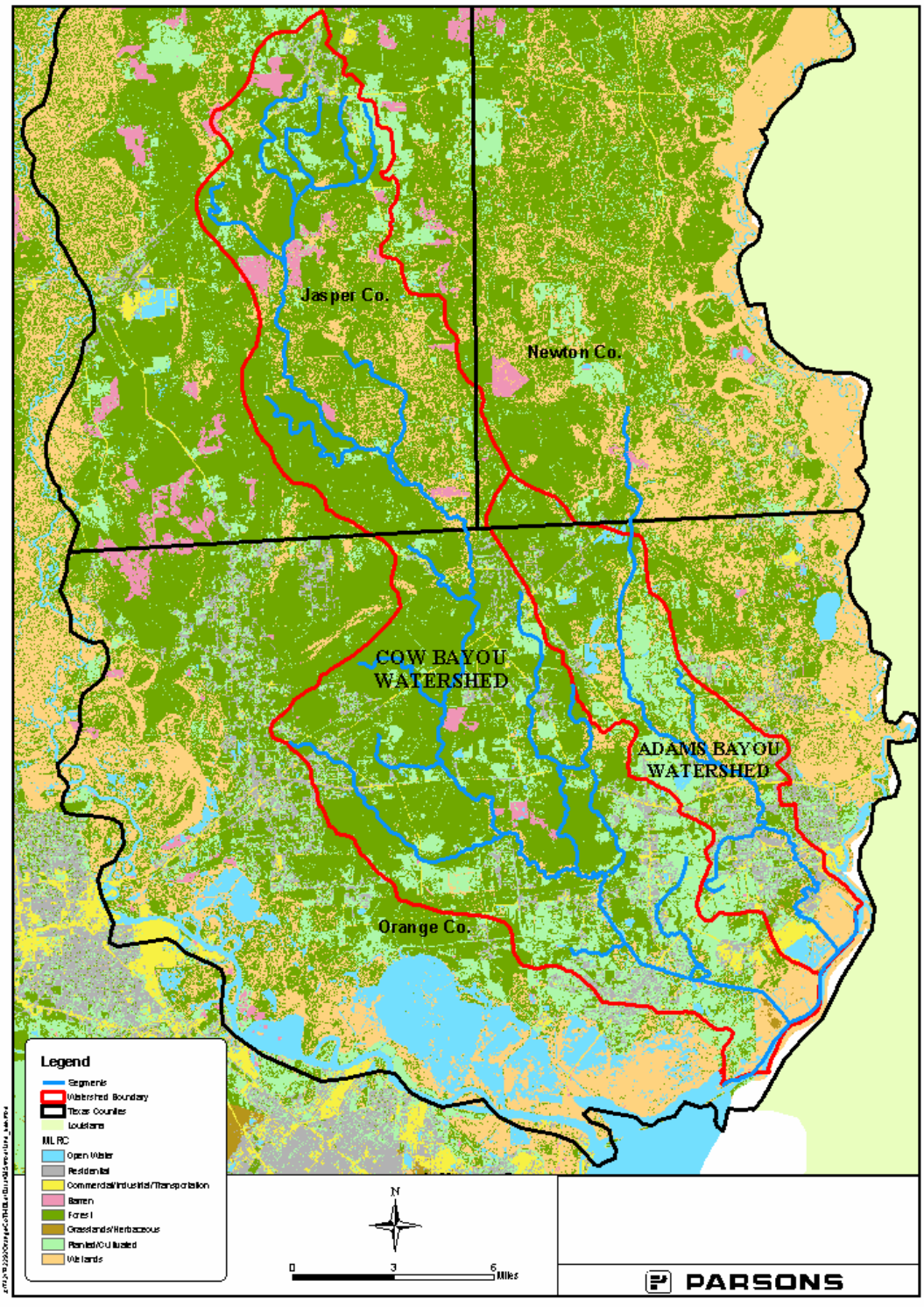


Figure 1.6 Adams Bayou Tidal @ FM 1006, Looking Downstream

Figure 1.7 Adams Bayou Tidal @ West Main Street, Looking Upstream

Figure 1.8 Adams Bayou Tidal @ IH 10, Looking Upstream

Figure 1.9 Adams Bayou Above Tidal @ FM 3247, Looking Downstream

Figure 1.10 Cow Bayou Tidal @ SH 87, Looking Downstream

Figure 1.11 Cow Bayou Tidal @ SH 87, Looking Upstream

Figure 1.12 Cow Bayou Tidal @ FM 105, Looking Downstream

Figure 1.13 Cow Bayou Tidal @ IH 10, Looking Downstream

Figure 1.14 Coon Bayou @ SH 87, Looking Upstream

Figure 1.15 Cole Creek @ IH 10, Looking Downstream

SECTION 2
WATER QUALITY STANDARDS

2.1 BACKGROUND

The federal Clean Water Act requires that States designate for each water body desirable and appropriate uses to be achieved and protected. These designated uses of water bodies include recreation in and on the water, public water supply, navigation, agricultural and industrial water supply, and protection and propagation of fish, shellfish and wildlife. In designating appropriate uses for a water body, States must consider the actual uses being achieved; downstream uses of the water body; the physical, chemical, and biological characteristics of the water body; its geographical setting; and economic considerations.

States must then set water quality criteria necessary to protect those designated uses. Criteria are expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use (40 CFR 131.3). Together, the designated uses and water quality criteria to protect those uses comprise the water quality standards. Water quality standards serve the dual purposes of establishing the water quality goals for a specific water body and serve as the regulatory basis for the establishment of water-quality-based treatment controls and strategies (40 CFR 131.10).

States must establish and implement appropriate water quality monitoring necessary to compile and analyze data on the quality of waters, and determine whether water quality criteria are met. The State's water monitoring program must include collection and analysis of physical, chemical and biological data and quality assurance and control programs to assure scientifically valid data. Other uses of these data include determining abatement and control priorities; developing and reviewing water quality standards, developing total maximum daily loads, waste load allocations and load allocations; assessing compliance with National Pollutant Discharge Elimination System (NPDES) permits by dischargers; and reporting information to the public through the section 305(b) report (40 CFR 130.4).

When water quality criteria to protect the designated uses of a water body are not met, or not expected to be met, the use is considered to be "impaired" or "water quality limited". The State is then required to develop a total maximum daily load for pollutants contributing to the impairment.

2.2 DESIGNATED USES OF ADAMS BAYOU, COW BAYOU, AND THEIR TRIBUTARIES

Adams Bayou Tidal (Segment 0508) and Cow Bayou Tidal (Segment 0511) are classified tidal segments described in Texas Surface Water Quality Standards. Adams Bayou above Tidal, Cow Bayou above Tidal, Hudson Gully, Gum Gully, Cole Creek, Terry Gully, and Coon Bayou are unclassified water bodies. Unclassified water bodies are those smaller water bodies that are not designated as segments with specific uses and criteria in Texas Surface Water Quality Standards. Cole Creek, Hudson Gully, and Coon Bayou are

considered tidal water bodies. Adams Bayou above Tidal, Gum Gully, and Cow Bayou above Tidal are considered intermittent streams with perennial pools. Intermittent streams are defined as having a period of zero flow for at least one week during most years. Where flow records are available, a stream with a 7Q2 of less than 0.1 cfs is considered intermittent. In their recent 2002 water quality assessment, Terry Gully was considered by the TCEQ to be a perennial freshwater stream. However, flow data available to us cast doubt on this assumption. On ten of thirty-three dates when flow observations have been made on Terry Gully at IH-10, all since May of 1998, observed flow was either non-existent or less than 0.1 cfs. It is apparent based on this data Terry Gully is not a perennial stream, but an intermittent stream or an intermittent stream with perennial pools.

The designated uses assigned to Adams and Cow Bayou and their tributaries by the TCEQ are shown in Table 2.1. Aquatic life criteria are of particular note. Texas Surface Water Quality Standards include several different subcategories of aquatic life use: exceptional, high, intermediate, and limited. The aquatic life uses are assigned based on the characteristics of the water bodies (Table 2.2). Perennial water bodies and tidal streams are assumed to have a high aquatic life use and corresponding dissolved oxygen criteria. Intermittent streams not specifically assigned an aquatic life use are considered to have no significant aquatic life use. When water is present in intermittent streams, a 24-hour dissolved oxygen (DO) mean/minimum criterion of 2.0/1.5 mg/L applies. Intermittent streams with perennial pools are assigned a limited aquatic life use.

The contact recreation use is applied to all water bodies, except where contact recreation is considered unsafe for reasons unrelated to water quality, such as ship traffic, or if elevated bacterial concentrations occur due to sources of pollution which cannot be reasonably controlled by existing regulations, as in portions of the Rio Grande due to discharge of untreated sewage from Mexico.

General uses are applied to all classified water bodies, but not to unclassified water bodies.

2.3 DISSOLVED OXYGEN CRITERIA

As shown in Table 2.3, the dissolved oxygen average/minimum criteria are 4.0/3.0 mg/L for Adams Bayou Tidal, Cow Bayou Tidal, Hudson Gully, Coon Bayou, and Cole Creek. If Terry Gully is assumed to be perennial, the dissolved oxygen average/minimum criteria are 5.0/3.0 mg/L, and 5.5/4.5 mg/L in the springtime. For Adams Bayou above Tidal, Cow Bayou above Tidal, Gum Gully, and Terry Gully (if it assumed to be intermittent with perennial pools) the dissolved oxygen average/minimum criteria are 3.0/2.0 mg/L, and 4.0/3.0 mg/L in the springtime.

Dissolved oxygen means are applied as a minimum average over a 24-hour period. Daily minima are not to extend beyond 8 hours per 24-hour day. Spring criteria to protect fish during spawning periods are applied during that portion of the first half of the year when water temperatures are 63.0 ºF to 73.0 ºF. It should also be noted that for unclassified freshwater streams, the dissolved oxygen standards do not apply at low flows below the 7Q2.

In addition to dissolved oxygen, other criteria for metals and organic toxicants, ambient toxicity, and biological criteria also protect the aquatic life use.

2.4 CONTACT RECREATION CRITERIA

Contact recreation criteria are designed to protect public health from harmful gut-carried pathogens that may be transmitted through fecal waste in water. Until recently, the fecal coliform group served as the sole bacterial indicator for contact recreation in Texas. With recent revisions to water quality standards (TNRCC 2000b), *E. coli* and *enterococcus* were designated the preferred bacterial indicator organism in freshwater saltwater, respectively. However, fecal coliform data may be used in water quality assessments until sufficient data using the new indicators is available. For tidal streams, which are intermediate between freshwater and saltwater, Texas Surface Water Quality Standards indicate that *E. coli* is the appropriate indicator (TNRCC 2000b). The contact recreation criteria include geometric mean and maximum criteria. For *E. coli*, the geometric mean is not to exceed 126 colony forming units (cfu)/100 mL, and single samples are not to exceed 394 cfu/100 mL. For fecal coliform, the geometric mean is not to exceed 200 cfu/100 mL, and single samples are not to exceed 400 cfu/100 mL.

2.5 GENERAL USE CRITERIA

Texas Surface Water Quality Standards include a minimum pH criterion of 6.0 and a maximum pH criterion of 8.5 for Adams and Cow Bayous. These pH criteria are typical for the Sabine River Basin, and the basis for their derivation by the TCEQ is not known. Nearby Big Cow Creek (Segment 0513) in Newton County has a minimum pH criterion of 5.5.

Other general use criteria include a temperature limit of 95 ºF.

Table 2.1 Stream Types and Designated Uses

Segment	Description	Location	Type	Aquatic life use subcategory	Designated Uses
0508	Adams Bayou Tidal	Entire tidal segment	Tidal	High	aquatic life use; contact recreation; general use; fish consumption
0508A	Adams Bayou above Tidal	Entire bayou above tidal	Intermittent with pools freshwater	Limited	aquatic life use; contact recreation; fish consumption
0508B	Gum Gully	Entire creek	Intermittent with pools freshwater	Limited	aquatic life use; contact recreation; fish consumption
0508C	Hudson Gully	Entire creek	Tidal	High	aquatic life use; contact recreation; fish consumption
0511	Cow Bayou Tidal	Entire tidal segment	Tidal	High	aquatic life use; contact recreation; general use; fish consumption
0511A	Cow Bayou above Tidal	Entire bayou above tidal	Intermittent with pools freshwater	Limited	aquatic life use; contact recreation; fish consumption
0511B	Coon Bayou	Entire tidal reach	Tidal	High	aquatic life use; contact recreation; fish consumption
0511C	Cole Creek	Entire tidal reach	Tidal	High	aquatic life use; contact recreation; fish consumption
0511E	Terry Gully	Entire creek	Perennial freshwater*	High*	aquatic life use; contact recreation; fish consumption

* Terry Gully may be an intermittent stream with perennial pools, for which a "limited" aquatic life use is assumed

Table 2.2 Aquatic Life Sub-Categories and Dissolved Oxygen Criteria

Aquatic Life Use Category	Aquatic Life Attributes						Dissolved Oxygen Criteria		
	Habitat Character-istics	Species Assemblage	Sensitive Species	Diversity	Species Richness	Trophic Structure	Freshwater mean/ minimum	Freshwater in spring mean/ minimum	Saltwater mean/ minimum
Exceptional	Outstanding natural variability	Exceptional or unusual	Abundant	Excep-tionally high	Excep-tionally high	Balanced	6.0/4.0	6.0/5.0	5.0/4.0
High	Highly diverse	Usual asso-ciation of regionally expected species	Present	High	High	Balanced to slightly imbalanced	5.0/3.0	5.5/4.5	4.0/3.0
Intermediate	Moderately diverse	Some expected species	Very low in abundance	Moderate	Moderate	Moderately imbalanced	4.0/3.0	5.0/4.0	3.0/2.0
Limited	Uniform	Most regionally expected species absent	Absent	Low	Low	Severely imbalanced	3.0/2.0	4.0/3.0	

Lower dissolved oxygen minima may apply on a site-specific basis, when natural daily fluctuations below the mean are greater than the difference between the mean and the minima of the appropriate criteria.

Table 2.3 Relevant Applicable Water Quality Criteria

Segment	Description	Applicable Criteria				
		Aquatic Life		Contact Recreation*		Other Criteria
		Dissolved Oxygen Avg/Min (mg/L)		Interim	Primary	pH
		Year-round	Springtime	Fecal coliform	*E. coli*	
0508	Adams Bayou Tidal	4.0/3.0		200/400	126/394	6.0-8.5
0508A	Adams Bayou above Tidal	3.0/2.0	4.0/3.0	200/400	126/394	
0508B	Gum Gully	3.0/2.0	4.0/3.0	200/400	126/394	
0508C	Hudson Gully	4.0/3.0		200/400	126/394	
0511	Cow Bayou Tidal	4.0/3.0		200/400	126/394	6.0-8.5
0511A	Cow Bayou above Tidal	3.0/2.0	4.0/3.0	200/400	126/394	
0511B	Coon Bayou	4.0/3.0		200/400	126/394	
0511C	Cole Creek	4.0/3.0		200/400	126/394	
0511E	Terry Gully	5.0/4.0 *3.0/2.0	5.5/4.5 *4.0/3.0	200/400	126/394	

Note: *E. coli* is the current water quality indicator organism for contact recreation. The fecal coliform criterion may continue to be used until sufficient *E. coli* data is available for assessment purposes.

* if Terry Gully is actually an intermittent stream with perennial pools, with a limited aquatic life use

SECTION 3
PRIOR WATER QUALITY ASSESSMENTS OF ADAMS AND COW BAYOUS

Numerous studies of water quality in Adams and Cow Bayous have been performed. In this section, we will briefly review the objectives, methodology, and results of those studies in chronological order by bayou. We will also review the §305(b) assessments of water quality performed by the TCEQ, focusing particularly on the 2002 assessment and draft §303(d) list.

3.1 1980-81 SOUTH EAST TEXAS NONPOINT SOURCE STUDY

Alan Plummer and Associates, together with the Sabine River Authority, studied nonpoint source pollution to Adams Bayou as part of the 1980-81 South East Texas Nonpoint Source Study for the South East Texas Regional Planning Commission (Alan Plummer and Associates 1982). The stated purpose of the study was to develop information about nonpoint sources of pollution relevant to the high levels of fecal coliform bacteria and depressed dissolved oxygen in Adams Bayou, as well as Hillebrandt Bayou in Beaumont.

The water quality monitoring program consisted of wet and dry weather components. The wet weather component included monitoring of runoff from urban, agricultural, and rural lands and their effects on instream water quality at six stations. The dry weather component included monitoring of drainage from septic tank areas, irrigation return flows, sediment quality, and eutrophication.

The geometric mean of fecal coliform concentrations in wet weather in Adams Bayou ranged from 2500 to 5300 colonies/100 mL. For the four domestic wastewater treatment plants monitored, geometric mean fecal coliform concentrations in effluents in wet weather ranged from 540 to 8,100. Geometric mean fecal coliform concentrations in wet weather bypasses from two of these same facilities ranged from 158,000 to 200,000 colonies/100 mL. Geometric mean fecal coliform concentrations in sewer overflows ranged from 2,200,000 to 8,400,000 colonies/100 mL. In Adams Bayou during wet weather, the geometric mean of fecal coliform based on routine sampling was 738 colonies/100 mL at Dupont Drive and 236 colonies/100 mL at the confluence with the Sabine River. Fecal coliform to fecal streptococcus ratios were typically less than one, which may indicate that animals were more significant sources. However, because fecal coliform tend to die more quickly, especially in saltwater, this result cannot be trusted. In dry weather routine monitoring, fecal coliform geometric mean levels of 79, 155, and 198 were measured, which met ambient water quality criteria. However, the levels exceeded the single sample maximum of 400 colonies/100 mL in 25 percent, 41 percent, and 47 percent of the samples for the lower, middle, and upper portions of the segment, respectively.

Dissolved oxygen concentrations were observed to frequently fall below the 4 mg/L criterion. In wet weather, dissolved oxygen levels were below 4 mg/L on 7 percent, 44 percent, and 52 percent of days for the upper, middle, and lower portions of the segment, respectively. In dry weather, dissolved oxygen levels were below 4 mg/L on 0 percent,

78 percent, and 41 percent of days for the upper, middle, and lower portions of the segment, respectively.

On an annual basis, the relative importance of fecal coliform loading sources were estimated to be (in order of declining importance) urban runoff, sewer overflows, wastewater treatment plant bypasses, agricultural and rural runoff, and wastewater treatment plant discharges. For oxygen demanding substances, the relative importance of sources was estimated to be wastewater treatment plant effluents, urban runoff, agricultural and rural runoff, and wastewater treatment plant bypasses and sewer overflows.

The study noted that planned improvements to sewer systems and treatment plants by the cities of Orange, West Orange, and Pinehurst were expected to improve water quality.

3.2 1982 INTENSIVE SURVEY OF ADAMS BAYOU

The Texas Department of Water Resources (TDWR) conducted an Intensive Survey of Adams Bayou in 1982 (Werkenthin 1984). This study followed up on an earlier 1974 intensive survey. The stated objectives of the intensive survey were 1) to determine quantitative cause and effect relationships of water quality; 2) to obtain data for updating water quality management plans, setting effluent limits, and where appropriate, verifying the classification of segments; 3) to set priorities for establishing or improving pollution controls; and 4) to determine any additional water quality management actions required. At this time, there were six permitted wastewater discharges to the bayou, with a total volume of 5.36 million gallons per day (MGD), and a total permitted biochemical oxygen demand (BOD) loading of 892 lbs/day. Samples were collected at 11 stations as shown in Table 3.1.

The results of this intensive survey for DO are shown in Figure 3.1, which shows that DO was below the criterion at Stations E, F, G, and H., in the middle of the segment. This result was similar to that found in the 1974 Intensive Survey. The measured BOD loading was 2029 lbs/day, more than twice the permitted loading, due to the discharge from Equitable Bag Co. The report noted that a lack of flow and high turbidity contributed to a low assimilative capacity in the bayou. The report also noted that four fish kills had been observed on Adams Bayou. To meet the dissolved oxygen criteria, the authors recommended that the BOD loading be reduced to the permitted levels, and recommended advanced wastewater treatment if water quality problems persisted.

3.3 1986 WASTE LOAD EVALUATION FOR ADAMS BAYOU

A waste load evaluation (WLE) was developed by the TWC in 1986 (Texas Water Commission 1986) using the data collected in the 1982 intensive survey, as well as the QUAL-TX model. The 4 mg/L dissolved oxygen criterion was determined to be attainable with effluent limitations of 10 mg/L BOD, 5 mg/L ammonia nitrogen, and 4 mg/L dissolved oxygen for domestic dischargers. The WLE also stated that if the Orange-Jackson Street Waste Water Treatment Plant (WWTP) was diverted from the segment, effluent limitations of 10 mg/L BOD, 15 mg/L ammonia nitrogen, and 2 mg/L dissolved oxygen for domestic dischargers should maintain the dissolved oxygen criterion if the City of Orange-Bancroft

received an effluent limit of 10 mg/L BOD, 10 mg/L ammonia nitrogen, and 4 mg/L dissolved oxygen. The WLE also recommended that industrial dischargers be limited to their existing final permit limits, and that any new industrial discharges should be limited to those limits recommended for domestic discharges.

Table 3.1 Station Locations Monitored During the 1982 Adams Bayou Intensive Survey

Station	Description
A	FM 1078 Bridge
B	IH-10 Bridge
C	Park Avenue Bridge
D	0.1 km Upstream from Pinehurst WWTP
E	Southern Pacific Railroad Bridge
F	0.3 km Upstream from City of Orange Jackson St. WWTP
G	0.4 km Downstream for City of Orange Jackson St. WWTP
H	FM 1006 Bridge
I	Near Dupont Intake
J	Sabine River at Adams Bayou Confluence

3.4 1998-1999 ADAMS BAYOU SPECIAL STUDY

The Sabine River Authority of Texas (SRA) conducted a special study on Adams Bayou between April 1998 and January 1999 in order to investigate and document the sources of fecal coliform, ammonia, and oxygen depleting materials, and to determine compliance with Texas Surface Water Quality Standards (Sabine River Authority of Texas 1999a).

Seven stations were sampled quarterly for BOD, total organic carbon, chemical oxygen demand, nutrients, and fecal coliform. Fecal coliform testing was also done weekly for five weeks of each quarter to determine compliance with the water quality standard in place at that time. Fecal streptococcus concentrations were also measured to assist in source differentiation. Finally, minimum daily dissolved oxygen measurements were collected within two hours of sunrise to verify noncompliance with the daily minimum dissolved oxygen criterion. The sample stations for this special study are shown in Table 3.2, and included stations on Adams Bayou, its tributaries, and wastewater outfalls. An additional station on Black Bayou in Louisiana was monitored for reference as a similar but sparsely populated bayou. Sampling was conducted during rainfall events as well as dry weather.

Table 3.2 Stations Monitored During the 1999 Adams Bayou Special Study

Station	Description
AB9	Adams Bayou at FM 1130
AB8	Adams Bayou at FM 1078
AB7	Adams Bayou at FM 3247
AB5	Adams Bayou at Park Avenue
AB4	Adams Bayou at Green Avenue
AB3	Adams Bayou at Western Avenue
AB2	Adams Bayou at FM 1006
AL8	Adams Bayou Lateral @ Bancroft Rd.
GG	Gum Gully at Halliburton Rd.
AL4B	Adams Bayou Lateral @ 31st St.
HG	Hudson Gully
SD1	Storm Drain to Adams Bayou
AL3	Adams Bayou Lateral #3 @ Dayton Rd.
AL2	Adams Bayou Lateral #2 @ Flint Rd.
AL1	Adams Bayou Lateral #1 @ FM 2177
AW3	City of Pinehurst WWTP
AW2	Orange County WCID #2 WWTP
AW1	A Schulman Inc. WWTP
AI2	Equitable Bag Company
AI1	A Schulman Inc.

Dissolved oxygen was low at Stations AB7, AB5, and AB4 as shown in Figure 3.2. These stations are located in Adams Bayou in the middle of the City of Orange. Fecal coliform was monitored during both dry weather as shown by Figure 3.3 and during rainfall as shown by Figure 3.4. During dry weather, fecal coliform problems were documented for all stations for October 1998. In addition, all Adams Bayou stations except AB2 exceeded the 5 sample in 30 day fecal coliform geometric mean criterion of 200 colonies/100 mL in at least two of the four quarters. A dramatic increase was observed in fecal coliform levels at all stations during rainfall. Particularly high fecal coliform levels were observed in Hudson Gully, and Adams Bayou Lateral 4B, which drain urban areas.

In contrast to Adams Bayou, dissolved oxygen fell below 4 mg/L and fecal coliform exceeded 400 cfu/100 mL only once out of 31 sampling events in Black Bayou.

The survey attributed the water quality problem to low assimilative capacity of this portion of Adams Bayou, wastewater treatment plant discharges, infiltration from leaking sewer pipes, and non-point sources of pollution, including leaky sewage collection system

pipes. No pH problems were noted during this survey. The special study report recommended a study to investigate the feasibility of a regional wastewater treatment plant, as well as constructed wetlands for discharge of effluents.

3.5 1982 INTENSIVE SURVEY OF COW BAYOU

An Intensive Survey of Cow Bayou was conducted by the TDWR from August 30 to September 1, 1982 (Kirkpatrick 1985). Samples were collected at 14 Cow Bayou stations and the five major wastewater discharge outfalls as listed in Table 3.3.

Table 3.3 Stations Monitored During the 1982 Intensive Survey of Cow Bayou

Station	Description
A	Cow Bayou at SH 12
B	Cow Bayou at IH 10
C	Cow Bayou halfway Between Stations B & D
D	Cow Bayou 50 yards Below SP Railroad Bridge
E	Cow Bayou 50 yards Below Cole Creek Confluence
F	Cow Bayou at FM 105
G	Cow Bayou halfway Between Stations F & H
H	Cow Bayou at SH 87
I	Cow Bayou 3500 feet Below SH 87
J	Cow Bayou at Round Bunch Road
K	Cow Bayou 6200 feet Below Round Bunch Road
L	Cow Bayou 600 feet Above Sabine River Confluence
M	Cow Bayou 2400 feet Above Sabine River Confluence
N	Sabine River at Cow Bayou Confluence
1	Chevron Chemical Company, Outfall 1
2	Firestone Synthetic Rubber and Latex, Outfall 1
3	Allied Chemical Corporation, Outfall 1
4	Polysar Gulf Coast, Inc., Outfall 1
5	Orange County WCID #3 (Bridge City)

The results of this intensive survey for DO and fecal coliform are shown in Figure 3.5. DO was below the criteria at Stations B, C, D, and E, and fecal coliform was high at Station B. This area between IH-10 and FM 105 is narrow, quiescent, removed from tidal influences, and receives no major point source discharges. The water quality problems in this area were attributed to low atmospheric re-aeration and dispersion rates, primary natural conditions, as well as malfunctioning septic tanks. No pH problems were noted during this survey.

3.6 1986 INTENSIVE SURVEY OF COW BAYOU

Another Intensive Survey of Cow Bayou was conducted by the Texas Water Commission (TWC) from September 9 to 11, 1986 (Kirkpatrick 1988). The stated objectives of the intensive survey were 1) to determine quantitative cause and effect relationships of water quality; 2) to obtain data for updating water quality management plans, setting effluent limits, and where appropriate, verifying the classification of segments; 3) to set priorities for establishing or improving pollution controls; and 4) to determine any additional water quality management actions required.

Samples were collected at 14 Cow Bayou stations and the five major wastewater discharge outfalls as described in Table 3.3. Sampling included diurnal field and water chemistry measurements, sediment oxygen demand measurements, primary productivity measurements, flow, cross-section, and time-of-travel measurements, tidal fluctuations, and fecal coliform measurements.

Some results of this intensive survey are shown in Figure 3.6. This figure shows that DO was below the criteria at Stations C, D, and E, and fecal coliform was high at Station C. No pH or temperature problems were noted. Proximate causes of the low dissolved oxygen were attributed to high sediment oxygen demand (SOD), a low atmospheric re-aeration rates because of the quiescent water, low oxygen production by autotrophs (algae) due to high turbidity, and high respiration by heterotrophs (such as bacteria). All of these causes were considered natural conditions.

3.7 1988 WASTE LOAD EVALUATION FOR COW BAYOU

A Waste Load Evaluation (WLE) for Cow Bayou was developed by the Texas Water Commission in 1988 (TWC 1988) using the QUAL-TX model, and calibrated using the data from the 1986 intensive survey, and verified using the data from the 1982 intensive survey. This WLE was never finalized and incorporated into the Water Quality Management Plan. The model found that the assimilative capacity of Cow Bayou was extremely low. The model was most sensitive to temperature, SOD, and re-aeration rate. A high sediment oxygen demand in portions of the bayou was observed in the Intensive Survey and required to calibrate the model. However, a reduced and constant SOD was used in predictive uses of the model. Even with the reduced SOD, the model predicted that a 4 mg/L dissolved oxygen criteria would not be met for any effluent scenario tested. Recommendations of the WLE included the following:

- a Use Attainability Analysis should be performed to determine if a 3 mg/L dissolved oxygen criterion would be more appropriate for low flow conditions in this segment.
- a study of the sources of the high sediment oxygen demand and mitigative measures should be performed
- domestic dischargers should be limited to those effluent limits in current permits and applications, except that Bridge City should be required to apply advanced

secondary treatment to meet effluent limits of 10 mg/L BOD, 15 mg/L ammonia nitrogen, and 4 mg/L DO.

- a 50 percent reduction of industrial BOD loading should be considered.
- regionalization of wastewater facilities was recommended.

3.8 1987 FISHERIES USE ATTAINABILITY STUDY FOR COW BAYOU

A Fisheries Analysis was completed by the Texas Parks and Wildlife Department (TPWD) in 1987 (Linam and Kleinsasser 1987) as part of a TWC Use Attainability Analysis. Fish were sampled at four stations corresponding to stations B, H, J and N in the intensive surveys. The uppermost station, at IH 10, received a fish community rating of good. The next station, at Highway 87, received a rating of fair. The two lower stations, received a rating of fair to good. Overall, the fish communities indicated the potential for a diverse and healthy fish community.

3.9 1988 USE ATTAINABILITY STUDY FOR COW BAYOU

A use attainability analysis (UAA) was completed by the Texas Water Commission (TWC) in 1988 (Twidwell 1988). Evaluations were performed at two stations corresponding to Stations F and J in the intensive surveys. The evaluations included a physical habitat evaluation, chemical evaluation, and biological evaluation based on the TPWD study described above.

Physical habitat received an intermediate or high rating at the upper station (the text disagrees with the table), and a limited rating at the lower station. The chemical water quality evaluation noted the depressed dissolved oxygen and elevated fecal coliform measurements noted by other reports.

The UAA concluded that contact recreation should remain a designated use because it was suitable and currently used. The UAA noted that the fishery data indicated that a diverse and healthy fish community existed. However, it was also noted that natural conditions may prevent the attainment of the in the upper portion of the Segment between IH 10 and FM 105. The UAA recommended additional studies of the upper portions of the bayou to identify sources of nonpoint source pollution. It also recommended further biological study of the reach between IH 10 and FM 105 to document its existing and potential biological integrity. It noted that studies were underway to determine the potential for upstream transport of effluents from lower portions of the bayou. The UAA recommended maintaining the high aquatic life use until these studies were completed.

3.10 1998-1999 COW BAYOU SPECIAL STUDY

The Sabine River Authority (SRA) conducted a special study on Adams Bayou between May 1998 and February 1999 in order to investigate and document the sources of fecal coliform, ammonia, and oxygen depleting materials, and to determine compliance with Texas Surface Water Quality Standards (Sabine River Authority 1999b).

Seven stations were sampled quarterly for BOD, total organic carbon, chemical oxygen demand, nutrients, and fecal coliform. Fecal coliform testing was also done weekly for five weeks of each quarter to determine compliance with the water quality standard in place at that time. Fecal streptococcus concentrations were also measured to assist in source differentiation. Finally, minimum daily dissolved oxygen measurements were collected within two hours of sunrise to verify noncompliance with the daily minimum dissolved oxygen criterion. The sample stations for this special study are shown in Table 3.4, and included stations on Cow Bayou, its tributaries, and wastewater outfalls. An additional station on Black Bayou in Louisiana was monitored for reference as a similar but sparsely populated bayou. Sampling was conducted during rainfall events as well as dry weather. Rapid bioassessments were performed to determine the health of aquatic life at selected sites. Samples were collected at a single site for ambient toxicity testing.

Table 3.4 Stations Monitored During the 1999 Cow Bayou Special Study

Station	Description
CB7	Cow Bayou at Jasper CR 826
CB6	Cow Bayou at SH 12
CB5	Cow Bayou at IH-10
CB4	Cow Bayou at FM 1442 (north crossing)
TG	Terry Gully at IH-10
CC	Cole Creek at IH-10
CB3	Cow Bayou at FM 105
CNB	Coons Bayou at SH 87
CB1	Cow Bayou at Round Bunch Rd
CW13	Jasper Co. WCID Outfall 001
CW8	PCS Development Co. Outfall 001
CW7	TXDOT Outfall 001
CW12	David K Moore Crawdads Outfall 001
CW11	Mauriceville Junior High Outfall 002
CW10	Oak Terrace Mobile Home Park Outfall 001
CW9	Oakleaf Park (non-discharge)
CW6	Sabine River Authority Outfall 001
CW5	Orangefield ISD Outfall
CW1	City of Bridge City Outfall 001
CW2	Sunrise East Apartments Outfall 001
CW4	Bayou Pines Outfall 001
CW3	Blacksher Development Corp Outfall 001
CI6	TX Polymer Outfall 001
CI2	Print Pak Inc. Outfall

BOD levels were low at most stream sites in dry weather, and increased somewhat in wet weather. The largest increases in wet weather BOD were reported to be in areas utilizing on-site septic systems. Higher BOD levels were observed in wastewater discharges from stations CW13, CW12, CW10, CW9, and CW4, though it was not reported whether these levels represented permit limit exceedances.

Dissolved oxygen was low at all sample stations except CB6 and CB1 in August 1998 as shown in Figure 3.7. Problems with DO were persistent between IH-10 and FM 1442 at Stations CB5 and CB4, and in Cole Creek at Station CNB. The early morning dissolved oxygen measurements were below the 3.0 mg/L daily minimum criterion at all sites except CB6 and CB3. Low dissolved oxygen levels observed in some effluents were reported to be below the minimum permit requirements.

All Cow Bayou stations exceeded the 5 sample in 30 day fecal coliform geometric mean criterion of 200 colonies/100 mL in at least one of the four quarters. Stations CNB, TG, CC, CB1, and CB5 exceeded the criterion for two or more of the four quarterly events. Most of the wastewater discharges also exceeded the ambient fecal coliform geometric mean criterion in one or more quarters. Stations CW10, CW8, and CW4A exhibited particularly high fecal coliform concentrations, though they are minor dischargers. As expected, an increase was observed in fecal coliform levels at all stations during rainfall. Fecal coliform to fecal streptococcus ratios were variable at all sites, providing no strong indication of the relative contributions of humans versus animals.

The bioassessments indicated an intermediate level of biological integrity at CB6 and Cole Creek. A limited/intermediate integrity was measured at Terry Gully. The integrity ratings for Cole Creek and Terry Gully are consistent with what is expected for intermittent streams with pools, but less than that expected for tidal or perennial freshwater streams.

In contrast to Cow Bayou, dissolved oxygen fell below 4 mg/L and fecal coliform exceeded 400 cfu/100 mL only once out of 31 sampling events in Black Bayou.

Ambient toxicity was not found to be a problem in Cow Bayou in this survey.

The study authors noted that the present wastewater systems are not adequately preventing water quality degradation in the stream, and recommended investigation of the feasibility of a large regional treatment plant to eliminate the stress on the natural system.

3.11 1996 TNRCC §305(b) ASSESSMENT AND §303(d) LIST

The 1996 §305(b) Water Quality Assessment by the TNRCC showed that Adams Bayou Tidal did not support the aquatic life or contact recreation uses. The single-sample fecal coliform criterion of 400 cfu/100 mL was exceeded in 29 percent of samples. The 4.0 mg/L daily average dissolved oxygen criterion was not met in 37 percent of samples. It also noted water quality concerns over ortho-phosphorus levels in water, and arsenic, barium, copper, lead, and selenium in sediments.

Cow Bayou Tidal did not support the aquatic life use, as 38 percent of samples did not meet the 4.0 mg/L criterion. The lower five miles of Cow Bayou partially supported the contact recreation use, with 10 percent of samples exceeding the single sample criterion. Water quality concerns were noted for arsenic, barium, and copper in sediments.

Adams Bayou Tidal was on the 1996 §303(d) List of impaired waters, but Cow Bayou Tidal was not, for unknown reasons.

3.12 1998 TNRCC §305(b) ASSESSMENT AND §303(d) LIST

As in 1996, Adams Bayou Tidal was on the 1998 §303(d) List for non-support of aquatic life uses, due to low dissolved oxygen, and for non-support of contact recreation, due to elevated fecal coliform concentrations. All other uses were fully supported or not assessed due to insufficient data.

3.13 2000 TNRCC §305(b) ASSESSMENT AND §303(d) LIST

The data collected by the Sabine River Authority in their 1999 Special Studies of Adams and Cow Bayous were utilized by the TNRCC in its 2000 water quality assessment. Based on this assessment, Adams Bayou Tidal (Segment 0508) was again found to not support contact recreation and aquatic life uses. General uses were supported, based on water temperature and pH. Adams Bayou above Tidal (Segment 0508A) and Gum Gully (Segment 0508B) were added to the §303(d) List for non-support of contact recreation and aquatic life uses (dissolved oxygen). Cow Bayou Tidal (Segment 0511) was added to the §303(d) List for non-support of contact recreation and aquatic life uses (dissolved oxygen), as well as partial support of general uses for low pH. Cow Bayou above Tidal (Segment 0511A) and Coon Bayou (Segment 0511B) were also added to the §303(d) List for non-support of the contact recreation and aquatic life uses (dissolved oxygen). Cole Creek (Segment 0511C) was added to the §303(d) List for non-support of the contact recreation use and partial support of the aquatic life use (dissolved oxygen).

Water quality concerns were also identified for sediment quality and for chlorophyll A in Adams Bayou Tidal. The contaminants of concern in sediments included nickel, copper, lead, chromium, and selenium. These concerns were based on exceedance of screening levels calculated as either the 85^{th} percentile of statewide measurements in tidal streams or other screening levels based on expected ecological effects.

3.14 2002 TCEQ §305(b) WATER QUALITY ASSESSMENT AND §303(d) LIST OF IMPAIRED WATERS

For 2002, the TCEQ combined the §305(b) Assessment and the §303(d) List into a single report. This report is still considered draft because, though the TCEQ has submitted it to USEPA, it has not yet been approved by the USEPA. It should be noted that the USEPA has not yet approved the previous §303(d) List for 2000.

3.14.1 2002 Water Quality Assessment Methodology

The most recent TCEQ assessment methodology is described in the document "Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data, 2002" (TNRCC 2002). This most recent guidance document was based upon the Texas Surface Water Quality Standards that were adopted by the TCEQ in July 2000, but have not yet been approved by the USEPA. This assessment methodology includes substantial changes from previous guidance. The evaluation conducted in the present study was based upon application of this most recent guidance. The following is a concise summary of the features of the Year

2002 assessment guidance that pertain to the analysis of data for dissolved oxygen, pH, and bacterial indicators of contact recreation suitability.

3.14.1.1 Applicable Criteria

The most recent Texas Surface Water Quality Standards include criteria for *E. coli* and fecal coliform bacteria for each classified stream segment in the State (TNRCC 2000). The preferred indicator is *E. coli*, but fecal coliform can still be used as an alternative indicator during the transition period to the new indicator. For saltwater, the new indicator is *enterococci* bacteria. These bacteria all serve as indicators of the potential presence of pathogenic organisms. Classified segments are designated as either contact recreation or noncontact recreation waters.

For contact recreation waters, the *E. coli* counts should not exceed 126 colonies/100 mL, or, alternately, the fecal coliform content should not exceed 200 colonies per 100 mL, both expressed as geometric means. In addition, the *E. coli* concentration should not equal or exceed 394 colonies/100 mL, or, alternately, the fecal coliform content should not equal or exceed 400 colonies per 100 mL, in a single sample.

For noncontact recreation waters, the *E. coli* content should not exceed 605 colonies/100 mL, or, the fecal coliform content should not exceed 2,000 colonies per 100 mL, expressed as a geometric mean. In addition, the fecal coliform content should not equal or exceed 4,000 colonies per 100 mL in a single sample.

3.14.1.2 Sources of Data

Data to be assessed must be quality-assured and collected using methods consistent with TCEQ guidance in "Surface Water Quality Monitoring Procedures Manual" (TNRCC 1999). Data collected by the TCEQ, other state and federal agencies, river authorities, and other groups can be employed. In general, the surface water quality monitoring (SWQM) data used in the assessment resides in the Texas Regulatory Activities and Compliance System (TRACS) database of the TCEQ.

3.14.1.3 Waters Covered in Assessments

All water bodies are evaluated if sufficient data are present, including classified and unclassified water bodies. General criteria for aquatic life, contact recreation, and fish consumption uses are applied to classified and unclassified water bodies, unless site-specific criteria are available. Narrative criteria should be applied to unclassified water bodies, as site-specific criteria developed for classified segments (temperature, pH, chloride, sulfate, and total dissolved solids) do not apply to unclassified waters.

3.14.1.4 Period of Record

The TCEQ employs water quality data collected during the most recent five-year period when conducting an assessment. The objective is to use data that is spatially and temporally representative of existing conditions at a site. In some cases where water quality has

dramatically improved or declined recently, the assessment may be based solely on the more representative data. In other cases, data older than five years may be used, subject to the discretion of the TCEQ. The minimum requirement for assessment data is that samples must be available for at least two seasons and over two years, to include inter-seasonal and inter-year variation, and some samples must be collected during an index period, defined as 15 March - 15 October. Using routinely scheduled data collection, no more than two-thirds of the samples should be collected in one of the two assessment years.

For intensive 24-hour dissolved oxygen sampling, all sampling events must be spaced over the warm weather index period, with between one-half to two-thirds of the events occurring during the critical period (July 1 – September 30). A period of about one month must separate each event.

3.14.1.5 Minimum Number of Samples

The TCEQ assessment protocol requires that a minimum of ten samples be available for the most recent five-year period at each site used in the assessment. There are exceptions for streams 25 miles or less in length where water quality conditions are similar, for reservoirs or estuaries, or for sampling sets of three measurements that all exceed the criterion. For streams less than 25 miles in length (and reservoirs or estuaries) samples collected at multiple sites can be aggregated to meet the minimum requirement. An assessment is generally not conducted for impairment of recreational use when three or fewer samples are available at each site. When four to nine samples are available at each site, and one exceedance is found, a primary water quality concern is identified.

3.14.1.6 Use of the Binomial Method for Establishing the Required Number of Exceedances to Determine Partial Support and Non-Support of Uses

The TCEQ has devised a procedure based upon the binomial method to reduce errors in making use support decisions to acceptable levels. An acceptable Type I error rate of 20 percent was identified for all criteria except acute aquatic life criteria, for which an acceptable error rate of 50 percent. With this method, the minimum number of required exceedances has been calculated for different sample sizes to determine if uses are supported, partially supported, or not supported. For example, with a sample size of 10 samples, three exceedances are required to classify a segment as partially supporting, and 5 exceedances are required to classify a segment as not supporting. The number of exceedances varies with sample size, as described in tabular form in the guidance document.

There are also exceedance requirements established to determine if there are "primary concerns." For example, with a sample size of 10 samples, three exceedances are required.

3.14.1.7 Flow Conditions

Samples in freshwater streams should be included in the assessment only when stream flow is equal to or greater than critical conditions, typically the seven-day, two-year low flow (7Q2) condition. The data may include samples under high-flow runoff conditions.

The TCEQ has also developed guidance for appropriate flow conditions in small unclassified streams. For freshwater perennial streams, the dissolved oxygen and contact recreation use is evaluated using data collected when the flow is equal to or greater than the 7Q2 flow or 0.1 cfs. For intermittent streams, the bacterial indicator and dissolved oxygen criteria apply at all times when water is present, keeping in mind that the dissolved oxygen criteria that apply to intermittent streams and intermittent streams with perennial pools are different and lower than those for perennial streams.

3.14.1.8 Values Below Limits of Detection

The TCEQ assessment procedure includes results measured as below the analytical reporting limit at one-half of the analytical reporting limit when calculating summary statistics such as averages. Values less than a reporting limit are never counted as an exceedance, however.

3.14.1.9 Spatial Coverage

A station by station analysis of water quality data is conducted under TCEQ assessment procedures for classified and unclassified stream segments in order to determine the spatial extent of support for designated uses and criteria. A single monitoring site in a flowing stream should not be considered to be representative of more than 25 miles of a segment. However, the spatial extent of the assessment for any single station should also consider hydrologic features such as tributary confluences or dams. Any areas of a stream that are not covered by a single site should be reported as "not assessed."

3.14.1.10 Depth of Measurements

Samples collected for use in assessment of bacterial indicators are typically surface samples, collected at a depth of one foot below the water surface, though depth-integrated composite samples collected by the USGS may also be used in the assessment. In deep freshwater streams, pH and dissolved oxygen measurements made in profile over the entire mixed surface layer are assessed. All of the dissolved oxygen measurements made in the mixed surface layer portion of the profile are averaged and compared to the criterion. Individual pH measurements made in the mixed surface layer are compared to the max/min criteria, but only one exceedance is counted per profile if more than one measurement is outside the criteria.

The mixed surface layer in tidal water bodies is defined as the water column from the surface down to the depth at which specific conductance equals 6,000 µmhos/cm greater than that at the surface. As with freshwater, the dissolved oxygen criteria apply to the entire mixed surface layer.

For intensive 24-hour dissolved oxygen sampling using an automated recording probe, measurements near the surface are considered representative of the mixed surface layer.

3.14.1.11 Determination of Tidal Influence

A water body is considered tidally influenced when there is observed tidal activity, total dissolved solids exceed 2,000 mg/L, salinity exceeds 2 parts per thousand, or specific conductance exceeds 3,077 µmhos/cm. In the absence of monitored data, the tidal limit is approximated as the point where the 5-foot contour line on a USGS topographic map crosses the stream.

3.14.1.12 Assessment for Use Support

Contact recreation use support is evaluated based upon analysis of fecal coliform, *E. coli*, or enterococci (in saltwater) data. The typical available data base consists of samples collected at routine biannual, quarterly, or monthly frequencies. For this type of routine data, assessment screening levels for single samples are set as 400 colonies/100 mL for fecal coliform, 394 colonies/100 mL for *E. coli,* and 89 colonies/100 mL for enterococci. Geometric means are also included in the assessment protocol as follows: fecal coliform 200 colonies/100 mL, *E. coli* 126 colonies/100 mL, and enterococci 35 colonies/100 mL. According to the TCEQ guidance document, the preferred indicator is *E. coli* in freshwater, and data for this indicator should be used when data for fecal coliform is also available.

For 10 are more samples, support of the contact recreation use is defined as "fully supporting" where the geometric mean is less than the criterion and 25 percent of the time, or less, concentrations exceed the single sample criterion at a frequency commensurate with the binomial method. The assessment is defined as "not supporting" where the geometric average exceeds the criterion and greater than 25 percent of all samples collected exceed the single sample criterion, with the required number of exceedances described by the binomial method. A "primary concern" can also be identified for the bacterial indicator data. A "Tier 2 primary concern" is designated where greater than 25 percent of all samples exceed the single sample criterion, at a frequency in accordance with the binomial method.

Procedures are modified for data sets of 4 to 9 samples. The contact recreation use is not assessed as either "fully supporting" or "not supporting" for small sample sizes. However, a "Tier 1 primary concern" is assigned where the long-term geometric mean exceeds the criterion, or, greater than 25 percent of the time, concentrations exceed the single sample criterion at a frequency determined by the binomial method.

Unlike the year 2000 guidance document, the pending TCEQ guidance does not express a preference for use of intensive monitoring event data for proper assessment of contact recreation use where problems are suspected.

Noncontact recreation use support is assessed for routinely collected samples, analogous to the procedure for contact recreation use.

Dissolved oxygen criteria depend on the aquatic life use sub-category assigned to the water body in Texas Surface Water Quality standards: exceptional, high, intermediate, limited, or no significant aquatic life use. The dissolved oxygen daily average criteria for

these sub-categories are 6.0, 5.0, 4.0, 3.0, and 2,0, respectively. The criteria are 1 mg/L lower in tidally-influenced water bodies for exceptional, high, and intermediate sub-categories due to differences in oxygen solubility in saltwater. Absolute minimum dissolved oxygen criteria in freshwater for these sub-categories are 4.0, 3.0, 3.0, 2.0, and 1.5 mg/L, respectively. In tidal waters, these minimum criteria are 4.0, 3.0, 2.0, 2.0, and 1.5 mg/L, respectively.

3.14.2 Results of the 2002 TCEQ §305(b) Assessment and §303(d) List of Impaired Water Bodies

The 2002 §305(b)Assessment utilized data from the five-year period March 1, 1996 through February 28, 2001. For the water bodies addressed by this study, the results of the §305(b) Assessment and the §303(d) List are summarized in Tables 3.5 and 3.6, respectively.

Hudson Gully (Segment 0508C) and Terry Gully (Segment 0511E) were added to the §303(d) List for not supporting contact recreation. Hudson Gully was also listed for depressed dissolved oxygen. Cow Bayou Tidal was not found to not support contact recreation use, based on the new assessment methodology, with 6 of 21 samples exceeding applicable criteria. Thus, Cow Bayou Tidal was removed from the §303(d) List for contact recreation and assigned a Tier II primary concern. Other use impairments were the same as in the 2000 assessment. The complete draft 2002 TCEQ §305(b) Assessment for the water bodies addressed by this report are included as Appendix A.

It should be noted that insufficient *E. coli* and intensive 24-hour dissolved oxygen measurements were available to allow direct comparison with the new water quality standards or assessment procedures. Also, the decision of the TCEQ to treat Terry Gully as a perennial freshwater stream, with a 5 mg/L DO criterion, does not appear to be correct; however, based on data available to us. However, it is apparent that given the magnitude and widespread nature of criteria exceedances for contact recreation and dissolved oxygen, the criteria are not met in much of Adams and Cow Bayous and their tributaries.

Table 3.5 Summary of Draft 2002 Texas §305(b) Statewide Water Quality Assessment for the Study Area

Segment	Sequence	Description	Aquatic Life Use	Contact Recreation Use	General Use	Fish Consumption Use	Public Water Supply Use	Overall Use	2002 Impairment	Category
0508	01	Lower 3 miles of Adams Bayou Tidal	Partially supporting	Fully supporting	Fully supporting	Not assessed	Fully supporting	Partially supporting	Dissolved oxygen	4e
0508	02	2 mile reach of Adams Bayou Tidal near Western Ave.	Not supporting	Not supporting	Fully supporting	Not assessed	N/A	Not supporting	Bacteria Dissolved oxygen	5 4e
0508	03	1-mile reach of Adams Bayou Tidal near Green Avenue	Not supporting	Not supporting	Fully supporting	Not assessed	N/A	Not supporting	Bacteria Dissolved oxygen	5 4e
0508A	01	Entire Adams Bayou Above Tidal	Fully supporting	Not supporting	N/A	Not assessed	N/A	Not supporting	Bacteria	4e
0508B	01	Entire Gum Gully Creek	Not assessed	Not assessed	N/A	Not assessed	N/A	Not assessed	Bacteria Dissolved oxygen	4e 4e
0508C	01	Entire Hudson Gully Creek	Not supporting	Not supporting	N/A	Not assessed	N/A	Not supporting	Bacteria	5
0511	01	Lower 5 miles of Cow Bayou Tidal	Fully supporting	Not supporting	Fully supporting	Not assessed	N/A	Not supporting	Bacteria	4e
0511	02	6-mile reach of Cow Bayou Tidal near FM 105	Not supporting	Fully supporting	Fully supporting	Not assessed	N/A	Not supporting	Dissolved oxygen	4d

Segment	Sequence	Description	Aquatic Life Use	Contact Recreation Use	General Use	Fish Consumption Use	Public Water Supply Use	Overall Use	2002 Impairment	Category
0511	03	5-mile reach of Cow Bayou Tidal near 1442	Not supporting	Fully supporting	Fully supporting	Not assessed	N/A	Not supporting	Dissolved oxygen	4d
0511	04	Upper 4 miles of Cow Bayou Tidal	Partially supporting	Not supporting	Partially supporting	Not assessed	N/A	Not supporting	Bacteria Dissolved oxygen Low pH	4e 4d 4d
0511A	01	Lower 5.3 mile reach of Cow Bayou Above Tidal	Fully supporting	Fully supporting	N/A	Not assessed	N/A	Fully supporting		4e
0511A	02	Upper 5.3 mile reach of Cow Bayou Above Tidal	Partially supporting	Fully supporting	N/A	Not assessed	N/A	Partially supporting	Dissolved oxygen	4e
0511B	01	Entire Coon Bayou Tidal Reach	Partially supporting	Not supporting	N/A	Not assessed	N/A	Not supporting	Bacteria Dissolved oxygen	4e 4e
0511C	01	Entire Cole Creek Tidal Reach	Fully supporting	Not supporting	N/A	Not assessed	N/A	Not supporting	Bacteria	4e
0511E	01	Entire Terry Gully Creek	Fully supporting	Not supporting	N/A	Not assessed	N/A	Not supporting	Bacteria	4e

N/A = not applicable

Table 3.6 Summary of Draft 2002 Texas §303(d) List of Impaired Water Bodies for the Study Area

Segment	Description	Area	Parameter	Category	Rank
0508	**Adams Bayou Tidal**	1 mile reach near Green Ave.	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5c	D – requires additional data collection
		2 mile reach near Western Ave.	Bacteria	5a	L – TMDL scheduled
			Dissolved oxygen	5c	D – requires additional data collection
		Lower 3 miles of segment	Dissolved oxygen	5c	D – requires additional data collection
		Upper 2 miles of segment	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5c	D – requires additional data collection
0508A	**Adams Bayou Above Tidal**	Entire bayou above tidal	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5b	S – Review of water quality standards
0508B	**Gum Gully**	Entire creek	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5c	D – requires additional data collection
0508C	**Hudson Gully**	Entire creek	Bacteria	5a	H – TMDL
			Dissolved oxygen	5c	D – requires additional data collection
0511	**Cow Bayou Tidal**	5 mile reach near FM 1442	Dissolved oxygen	5b	S – Review of water quality standards
		6 mile reach near FM 105	Dissolved oxygen	5b	S – Review of water quality standards
		Lower 5 miles	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5b	S – Review of water quality standards
0511	**Cow Bayou Tidal**	Upper 4 miles	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5b	S – Review of water quality standards
			Low pH	5b	S – Review of water quality standards

Segment	Description	Area	Parameter	Category	Rank
0511A	**Cow Bayou Above Tidal**	Upper 5.3 miles	Dissolved oxygen	5c	D – requires additional data collection
0511B	**Coon Bayou**	Entire tidal reach	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5c	D – requires additional data collection
0511C	**Cole Creek**	Entire tidal reach	Bacteria	5c	D – requires additional data collection
			Dissolved oxygen	5c	D – requires additional data collection
0511E	**Terry Gully**	Entire creek	Bacteria	5c	D – requires additional data collection

Figure 3.1 Dissolved Oxygen in the 1982 Adams Bayou Intensive Survey

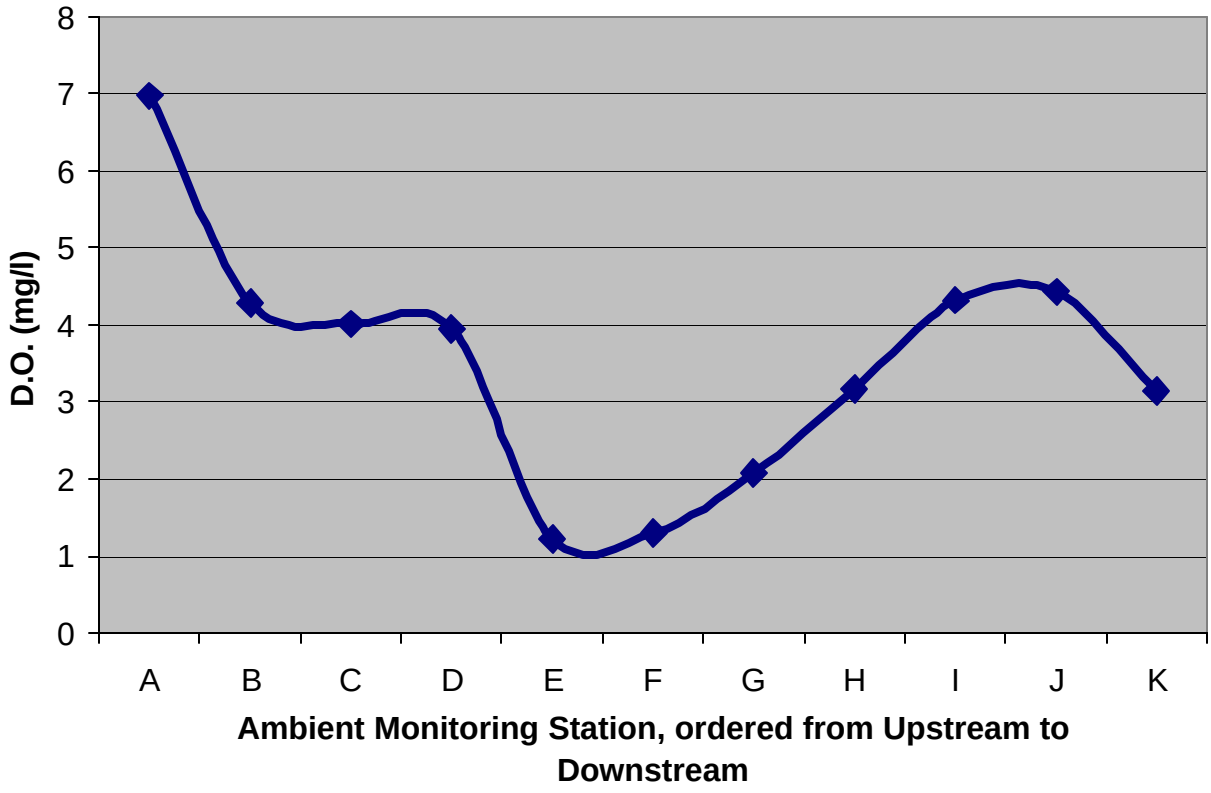


Figure 3.2 Dissolved Oxygen in the 1998-1999 Adams Bayou Special Study

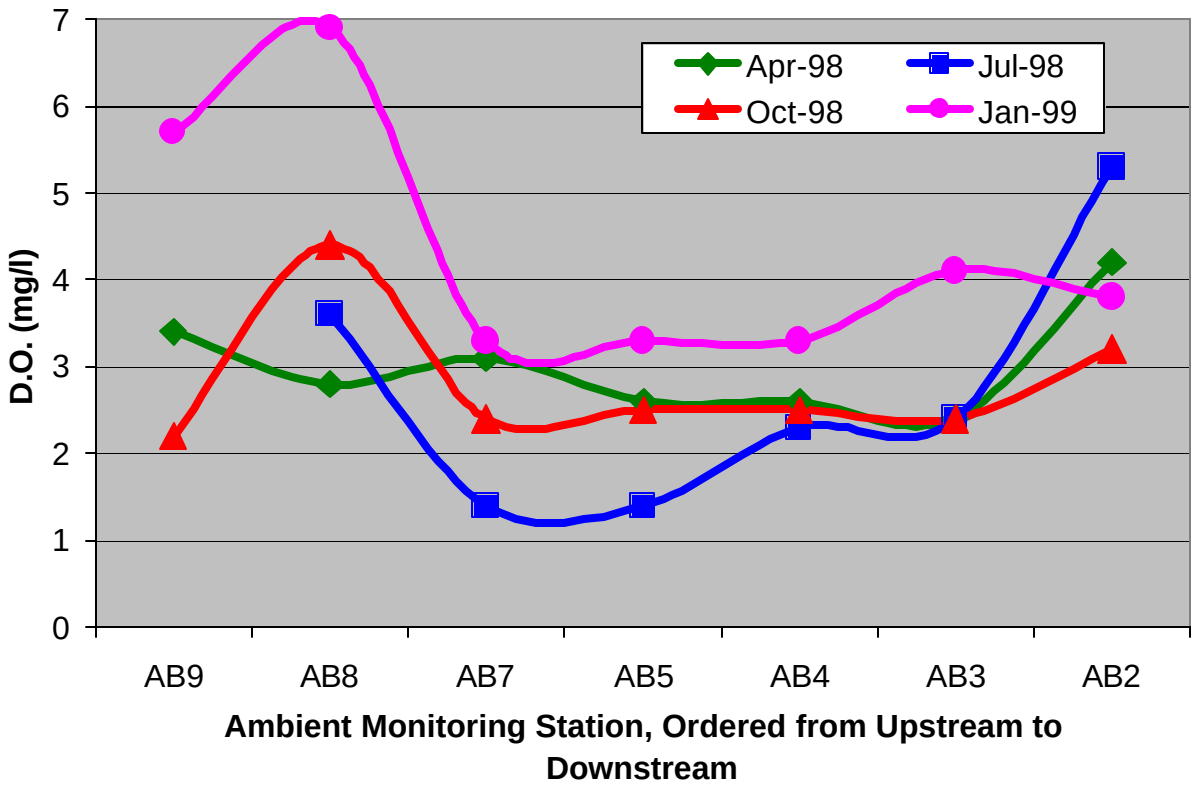


Figure 3.3 Fecal Coliform in Dry Weather in the Adams Bayou Special Study 1998-1999

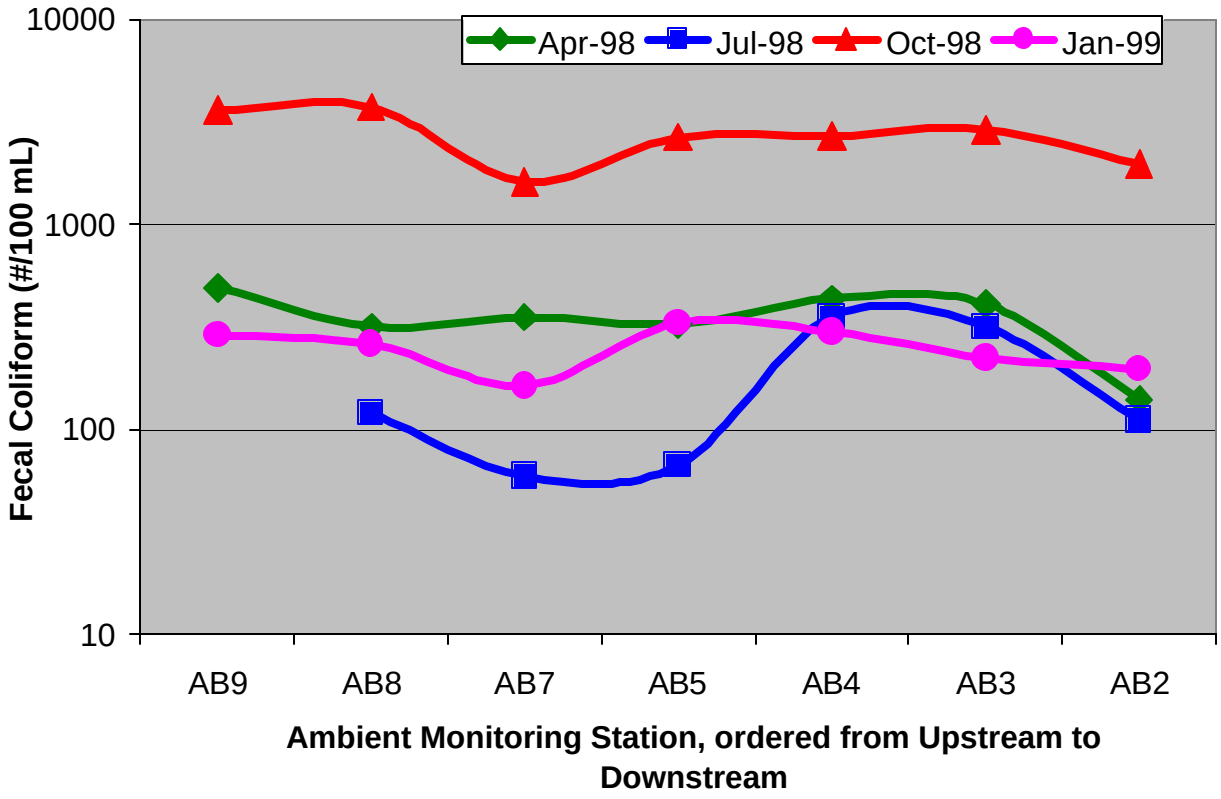


Figure 3.4 Fecal Coliform in Wet Weather in the Adams Bayou Special Study 1998-1999

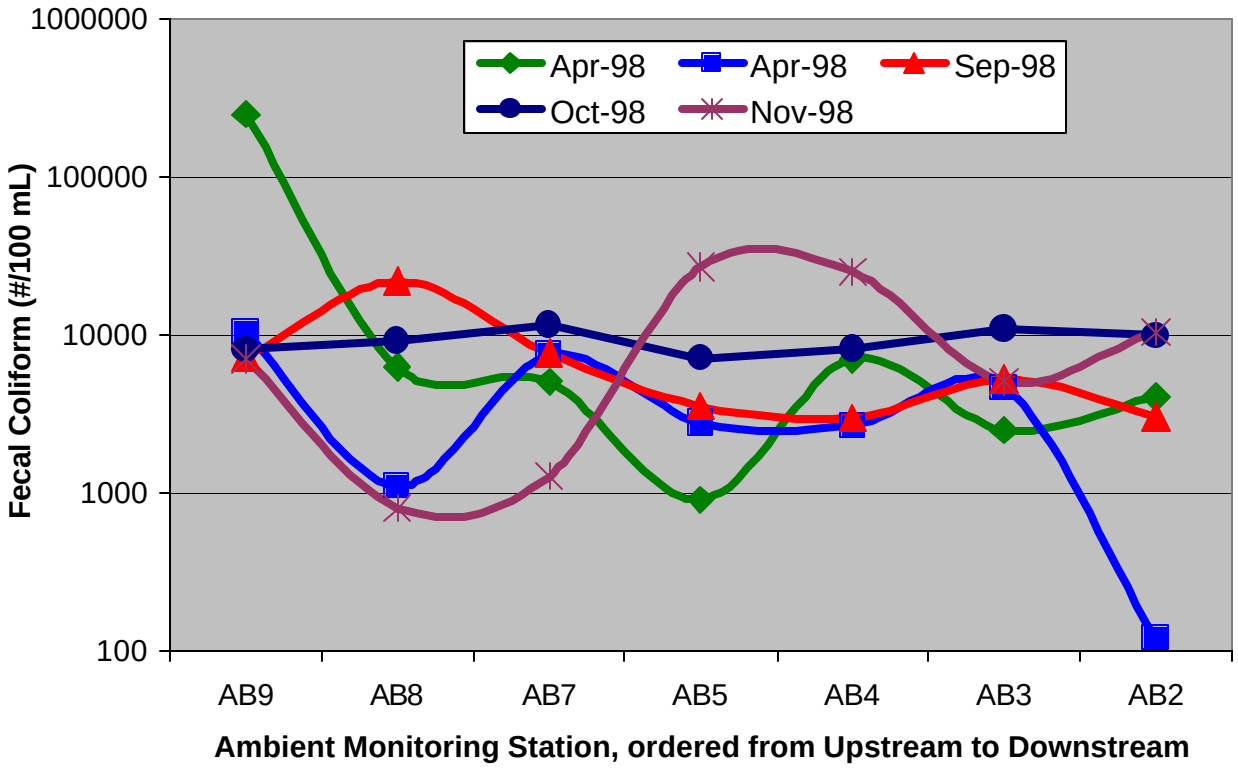


Figure 3.5 Fecal Coliform and Dissolved Oxygen in the Cow Bayou 1982 Intensive Survey

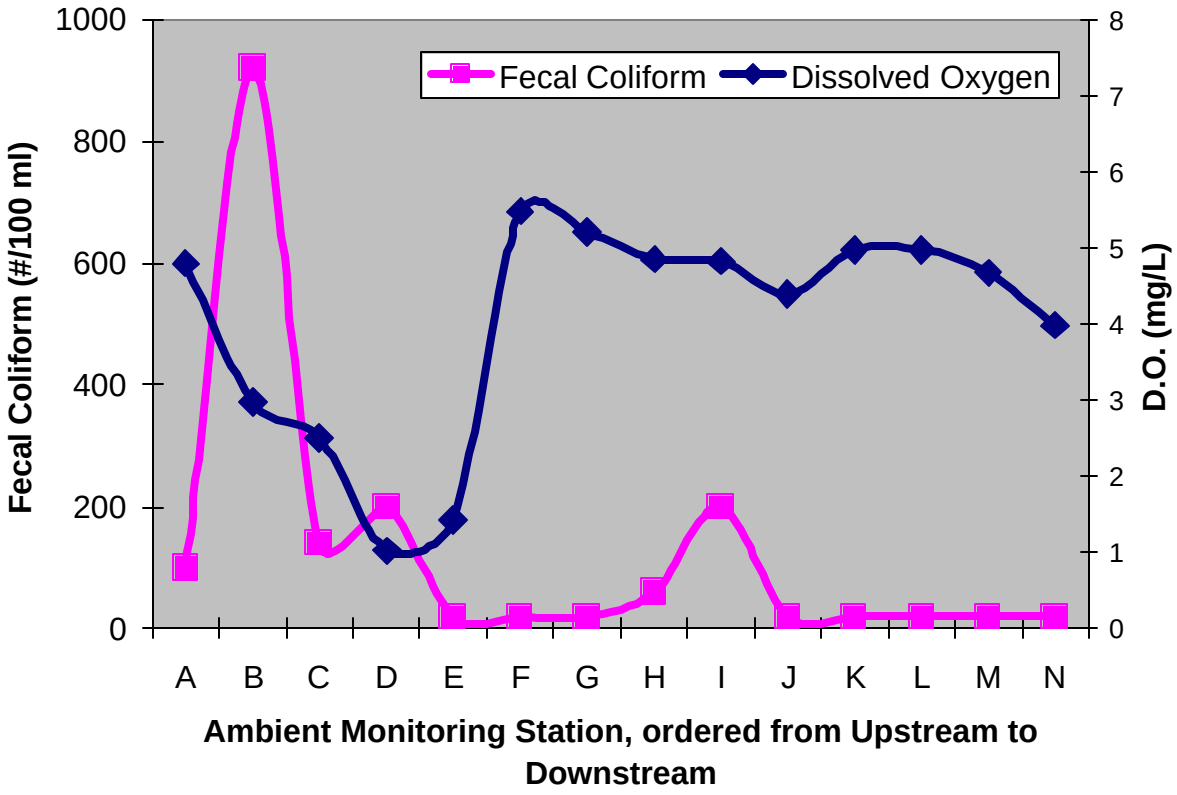


Figure 3.6 Fecal Coliform and Dissolved Oxygen in the Cow Bayou 1986 Intensive Survey

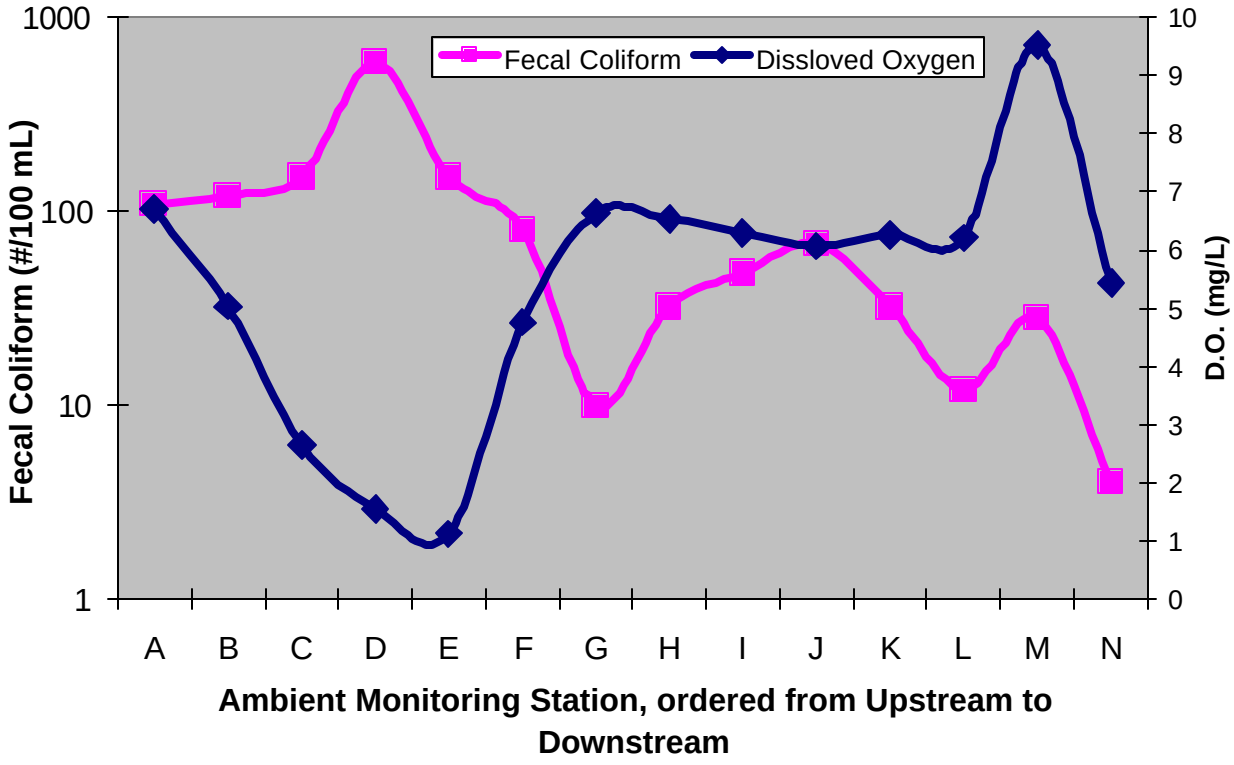


Figure 3.7 Dissolved Oxygen in the 1998-1999 Cow Bayou Special Study

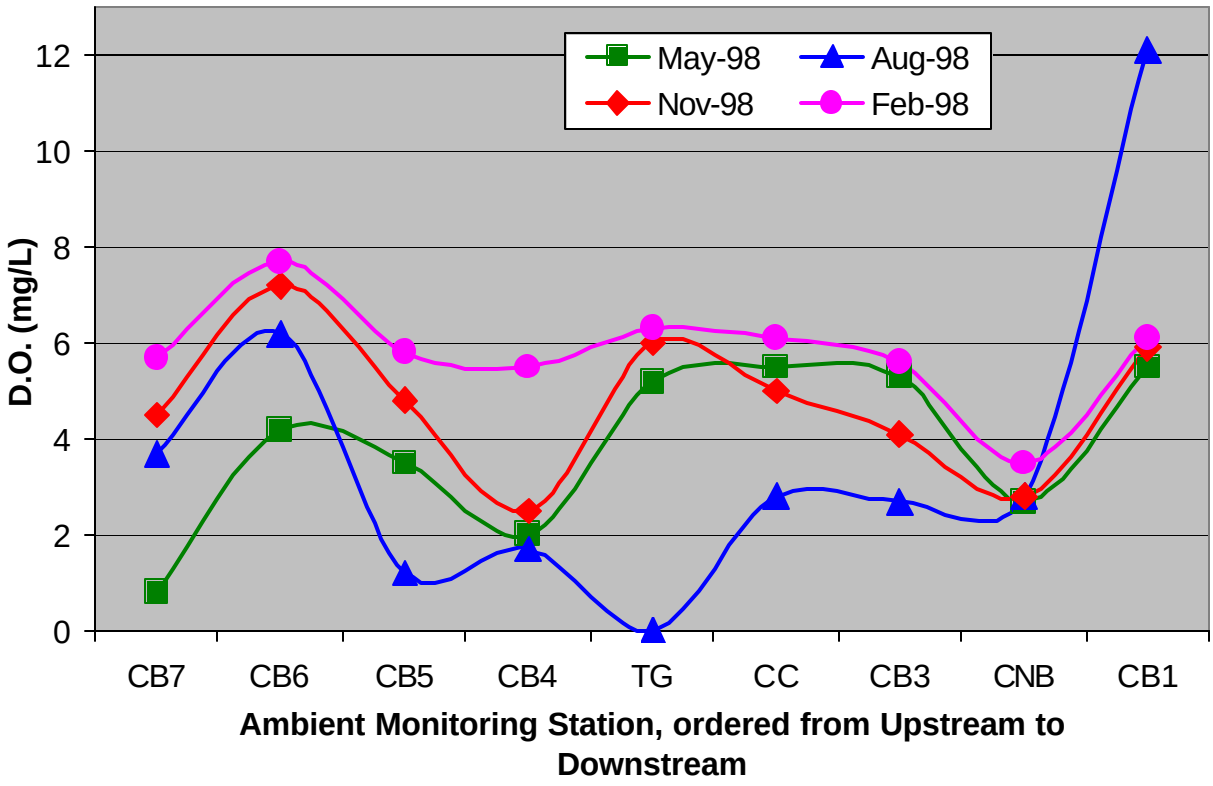


Figure 3.8 Fecal Coliform in Dry Weather in the Cow Bayou Special Study 1998-1999

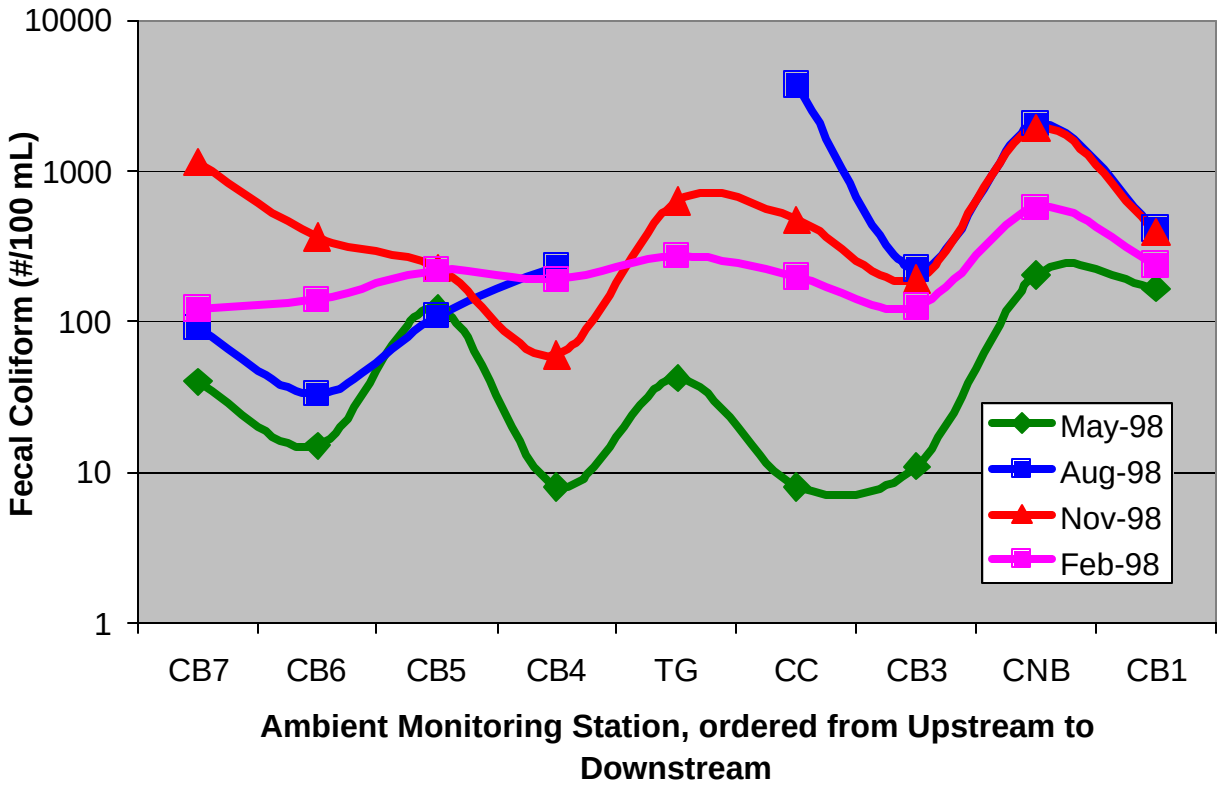
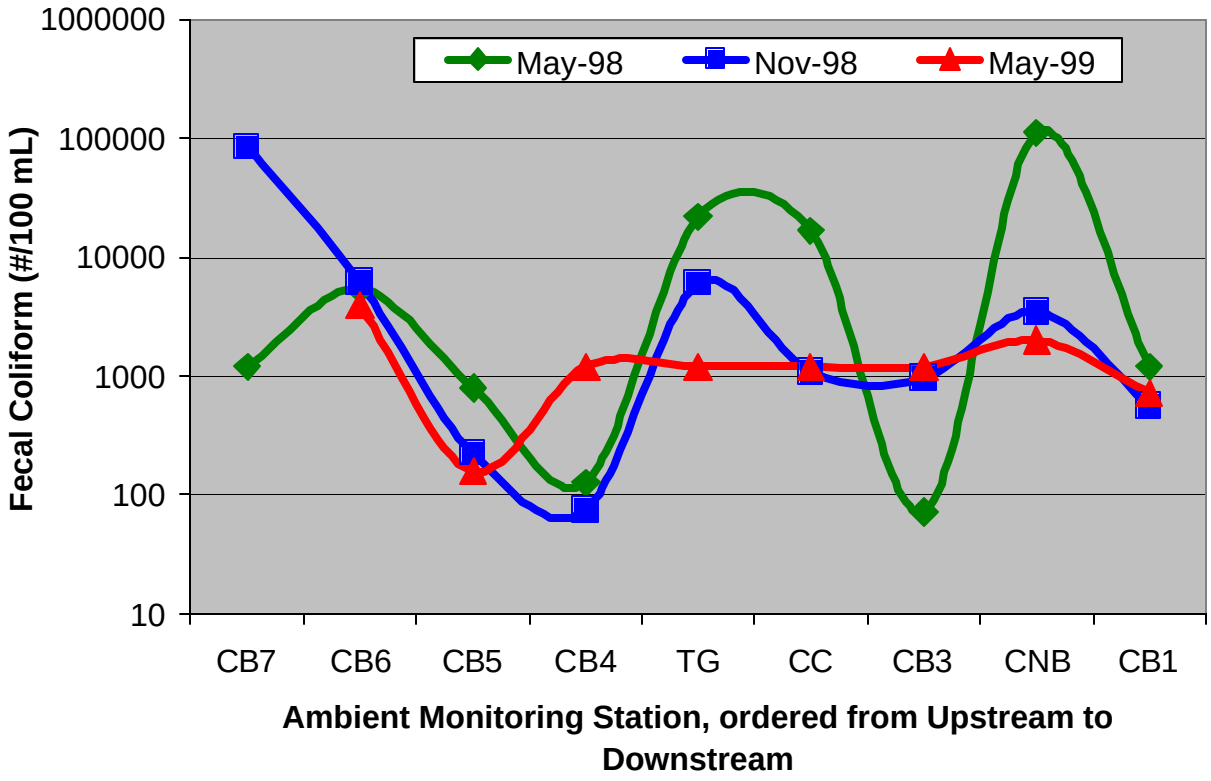


Figure 3.9 Fecal Coliform in Wet Weather in the Cow Bayou Special Study 1998-1999



SECTION 4
UPDATE OF WATER QUALITY IMPAIRMENT ASSESSMENTS

We have performed additional assessments of water quality data from Adams and Cow Bayous using a more recent five year period of data, as well as the entire dataset for each site. Because the TCEQ assessment of use support was performed recently, there is little utility in repeating it. Instead, the primary purpose of this assessment was identification of spatial and temporal patterns that may suggest the effects of particular sources, or declining or improving water quality trends with time.

4.1 DATA SOURCES

Data was retrieved from several sources: 1) The Texas Regulatory and Compliance System (TRACS) of the TCEQ, which serves as the primary repository of surface water quality monitoring data in Texas; 2) the Sabine River Authority, who had additional data not reported to TRACS, or not yet loaded into TRACS; 3) The USGS, who had additional flow data for Cow Bayou; 4) the Texas Watch Program, who also had additional data not resident in TRACS. The data retrieval was not limited to a specific time period. Some data were not available in electronic format, but only on printed page or summarized in reports. Because of the substantial effort to convert these to appropriate formats, and due to quality concerns with the data, this data was not compiled into the database but analyzed separately.

After combining data from all these sources into a common database, a substantial effort was made to apply uniform fields and field descriptions, standardize site names, and eliminate duplicate observations.

Table 4.1 lists the monitoring stations in Adams Bayou and its tributaries, while Table 4.2 lists the monitoring stations in Cow Bayou and its tributaries. These stations are graphically illustrated in Figures 1.2.

For spatial trend analyses and standards attainment analyses, only the most recent five years of data was used in order to get a more current analysis as well as to keep the data sets consistent between sites. These five years of data covered the period between May 9, 1997 and May 8, 2002. For analyses of water quality parameter relationships with flow and seasonality, and for temporal trend analyses, all available data were used, covering the period between 1969 and May 2002.

Temporal trend analyses were typically performed using only two monitoring stations, one in Adams Bayou (10441) and one in Cow Bayou (10449), that have been consistently monitored for over 30 years. Other stations have only been monitored intermittently. These stations are in the lower tidal sections of these bayous, and may not represent changes in upper portions of the bayous or tributaries.

To determine the likelihood that the criteria are met, we applied the bionomial probability method. In this method, we calculate the probability that the observed frequency of criteria exceedances (e.g., 10 of 20 observations) could happen by chance if the true

frequency of exceedances was equal to the criterion (*e.g.*, 5 of 20 for non-support or 2 of 20 for partial support). This is similar to counting the number of times that one gets six or more "heads" when flipping a coin ten times. The TCEQ incorporated this approach in their water quality assessment procedures for the 2002 year (TNRCC, 2002) in order to limit the probability of errors to no more than 20% in determinations that criteria are not met.

Table 4.1 Water Quality Monitoring Stations of Adams Bayou and Tributaries

Station ID	Segment	Sequence	River Km	Type	Station Short Name (SRA ID)
10441	0508	1000	2.6	Ambient	Adams Bayou At FM 1006 (AB2)
10442	0508	1500	5.3	Ambient	Adams Bayou At Western (AB3)
16059	0508	1700	6.6	Ambient	Adams Bayou At Green Ave (AB4)
14990	0508	1800	10.0	Ambient	Adams Bayou At Park Ave (AB5)
10443	0508	2000	11.5	Ambient	Adams Bayou At IH 10 (AB6)
15107	0508A	2100	14.0	Ambient	Adams Bayou At FM 3247 (AB7)
14964	0508A	0	16.9	Ambient	Adams Bayou At FM 1078 (AB8)
15742	0508A	0	24.5	Ambient	Adams Bayou At FM 1130 (AB9)
16057	0508t	0	2.8t	Ambient	Adams Bayou Lateral #1 (AL1)
16053	0508t	0	3.8t	Ambient	Adams Bayou Lateral #2 (AL2)
16054	0508t	0	6.0t	Ambient	Adams Bayou Lateral #3 (AL3)
16039	0508t	0	9.8t	Ambient	Adams Bayou Lateral #4b (AL4b)
16056	0508At	0	15.0t	Ambient	Adams Bayou Lateral #8 (AL8)
16049	0508B	0	14.3t	Ambient	Gum Gully At Halliburton (GG)
16041	0508C	0	8.6t	Ambient	Hudson Gully At Lexington (HG)
16061	0508t		8.4t	Canal	Storm Drain To Adams Bayou (SD1)
16051	0508t		2.8t	Pipe	A. Schulman Inc 001 (AW1) (WQ0000337.001)
16048	0508t		2.8t	Pipe	A. Schulman WWTP 002 (AI1) (WQ0000337.002)
16044	0508t		5.5	Pipe	Orange Co. WCID #2 WWTP (AW2) (WQ0010240.001)
16046	0508t		5.7	Pipe	Equitable Bag Inc (AI2) (WQ0000727.001)
16043	0508t		8.5	Pipe	Pinehurst WWTP 001 (AW3) (WQ0010597.001)

Note: t indicates the point where the tributary enters Adams Bayou, not the point where the discharge to state waters occurs. River km are approximate

Table 4.2 Water Quality Monitoring Stations of Cow Bayou and Tributaries

Station ID	Segment	Sequence	River^{Km}	Type	Station Short Name (SRA ID)
10392	0501	1500	0	Ambient	Sabine River At Cow Bayou Confluence
10446	0511	500	0.7	Ambient	Cow Bayou 2400 Ft Upstream Of Sabine River
10447	0511	600	1.7	Ambient	Cow Bayou 6000 Ft Upstream Of Sabine River
10448	0511	750	2.8	Ambient	Cow Bayou 6200 Ft Downstream Of FM 1442
10449	0511	1000	4.7	Ambient	Cow Bayou At FM 1442 (CB1)
10450	0511	1300	6.3	Ambient	Cow Bayou 3500 Ft Downstream Of SH 87
10451	0511	1500	7.3	Ambient	Cow Bayou At SH 87
10452	0511	1700	9.3	Ambient	Cow Bayou Halfway Between FM 105 And SH 87
10453	0511	2000	11.5	Ambient	Cow Bayou At FM 105 (CB3)
10454	0511	2500	15.5	Ambient	Cow Bayou 50 Yds Downstream Of Cole Creek
10455	0511	3000	19.8	Ambient	Cow Bayou 50 Yds Downstream Of SP RR Bridge
13781	0511	3250	22.0	Ambient	Cow Bayou At FM 1442 North (CB4)
10456	0511	3500	22.7	Ambient	Cow Bayou Between IH 10 And SP RR Bridge
10457	0511	4000	26.0	Ambient	Cow Bayou At IH 10 (CB5)
14462	0511	4100	26.3	Ambient	Cow Bayou 300 M North Of IH 10
10337	0511A	0	33.5	Ambient	Cow Bayou At SH 12 (CB6) (USGS gage 08031000)
16058	0511A	0	45.7	Ambient	Cow Bayou At Jasper CR 826 (CB7)
16052	0511B	0	5.1t	Ambient	Coons Bayou At SH 87 (CNB)
16060	0511C	0	15.6t	Ambient	Cole Creek At IH 10 (CC)
16040	0511E	0	21.7t	Ambient	Terry Gully At IH 10 (TG)
16055	0511t	0	28.8t	Ambient	Cow Bayou Lateral #10 (CL10)
16068	0511t		6.7	Pipe	Bridge City WWTP 001 (CW1) (WQ0010051.001)
16071	0511t		6.6	Pipe	Sunrise East WWTP 001 (CW2) (WQ0013488.001)
16067	0511Bt		5.1t	Pipe	Blackshur Development Corp WWTP (CW3) (WQ0013691.001)
16070	0511t		5.1t	Pipe	Bayou Pines WWTP 001 (CW4) (WQ0011315.001)
16063	0511t		11.4t	Pipe	Orange Field ISD WWTP (CW5) (WQ0011607.001)
16042	0511t		15.6t	Pipe	SRA WWTP 001 (CW6) (WQ0012134.001)
16066	0511t		25.9	Pipe	TXDOT WWTP Outfall 001 (CW7) (WQ0011457.001)
16064	0511t		26.1t	Pipe	PCS Development Co WWTP (CW8) (WQ0011916.001)
16065	0511t		15.6t	Pipe	Oakleaf Park WWTP (CW9) (WQ0011316.001)

Station ID	Segment	Sequence	River Km	Type	Station Short Name (SRA ID)
16062	0511Ct		15.6t	Pipe	Oak Terrace WWTP 001 (CW10) (WQ0011357.001)
16069	0511Ct		15.6t	Pipe	Little Cypress-Mauriceville JH (CW11) (WQ0011094.002)
16050	0511Ct		15.6t	Pipe	Crawdad WWTP 001 (CW12) (WQ0013379.001)
16045	0511At		66.7t	Pipe	Jasper WCID WWTP 001 (CW13) (WQ0010808.001)
16047	0511t	90120	1.9	Pipe	Bayer Corp. (CI1) (WQ0001167.001)
16075	0511t		2.8	Pipe	Printpak Inc 001 (CI2) (WQ0002858.001)
16072	0511t		15.6t	Pipe	Texas Polymer Services 001 (CI6) (WQ0002835.001)
16073	0511t	90100	3.7	Pipe	Firestone Inc. Outfall 001 (WQ0000454.001)
16074	0511t	90090	2.9	Pipe	Chevron Chemical Co. Outfall (WQ0000359.001)

Note: t indicates the point where the tributary enters Adams Bayou, not the point where the discharge to state waters occurs. River km are approximate

4.2 CONTACT RECREATION AND INDICATOR BACTERIA

There is no pronounced variation in fecal coliform levels with distance in Adams Bayou figure 4.1). Most stations in Adams Bayou exceed the water quality criterion of 200 cfu/100 mL, as the geometric mean of measurements (Table 4.3). The highest levels of fecal coliform bacteria are found in tributaries to Adams Bayou rather than the Bayou itself. The laterals and other tributaries drain highly populated urban areas of Orange, West Orange, and Pinehurst. Adams Bayou Lateral #4b exhibited a particularly high geometric mean fecal coliform level, though this was based on only a few measurements. Based on this data, it can be concluded with a high degree of certainty that fecal coliform levels exceed criteria in at least parts of Segments 0508, 0508A, 0508B, and 0508C.

In Cow Bayou, only at the uppermost station of Segment 0511 (Cow Bayou Tidal) do fecal coliform geometric mean concentrations exceed the water quality criterion, and even at this site the confidence that criteria are not met is very low. It can be concluded with high confidence that fecal coliform levels exceed the criterion in the tributaries Coon Bayou, Terry Gully, Cow Bayou Lateral #10, and to a lesser extent, Cole Creek.

As might be expected, fecal coliform levels in Adams and Cow Bayous varied with flow conditions. Because flow measurements were rarely found in the database, we compared fecal coliform levels to flow severity, a subjective indicator with the categories none, low, normal, flood, and high flow. In general, fecal coliform levels tended to be positively related to stream flow conditions (Figures 4.3 and 4.4). This is not unexpected because recent runoff, which tends to be rich in fecal coliform, would lead to flood or high flow. Intestinal indicator bacteria tend to die off in natural waters, and without a local or continuous upstream source, their levels are expected to decline in non-flowing or minimally-flowing waters.

Figure 4.5 shows seasonal variation in fecal coliform levels. There is a consistent springtime peak and summertime decline in fecal coliform levels at all stations. At some stations there was also a secondary autumn peak in fecal coliform. These peaks and declines may be related to stream flow, temperature, predation by other microorganisms, or other unknown factors. Interestingly, the figure also shows that, counter to expectations, normal monthly precipitation at Port Arthur peaks in summer, when stream flow and fecal coliform are lowest. It is commonly expected that the highest fecal coliform levels occur in the season with the most frequent rainfall, because runoff washes fecal matter built up on land into waterways, as well as contributing to sewer overflows and WWTP bypasses. It appears that the critical seasonal conditions for fecal coliform differ from those for dissolved oxygen, which tend to occur in late summer.

Fecal coliform levels have been measured for over thirty years at one monitoring site in each of Cow Bayou and Adams Bayou. These stations, 10449 and 10441, are in the lower tidal reaches of each bayou. Figure 4.6 shows the annual geometric mean fecal coliform concentration at these two sites. The variability in geometric mean concentrations is high in the 1970's and 1980's because fewer measurements were made in these years. Fecal coliform concentrations have not varied significantly in either bayou over the thirty year period examined. There is a suggestion in this figure of lower fecal coliform levels in the last few years; this may be simply due to natural inter-annual variability

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Table 4.3 Contact Recreation Indicator Bacteria Concentration Statistics for Adams Bayou by Station, 5/1997 – 5/2002

Station Short Description	Station ID	EC		EN		FC			FS		Probability Meet Criteria*
		GM	N	GM	N	GM	%>400	N	GM	N	
ADAMS BAYOU AT FM 1130 (AB9)	15742	928	2			916	63%	16	412	16	0.002
ADAMS BAYOU AT FM 1078 (AB8)	14964	704	2			528	48%	21	305	21	0.021
ADAMS BAYOU LATERAL #8 (AL8)	16056	2952	2			1351	76%	21	774	21	<0.001
GUM GULLY AT HALLIBURTON (GG)	16049	100	1			592	55%	20	576	20	0.004
ADAMS BAYOU AT FM 3247 (AB7)	15107	424	2	154	5	172	29%	62	186	46	0.274
ADAMS BAYOU AT PARK AVE (AB5)	14990	294	2			337	41%	29	190	23	0.039
ADAMS BAYOU LATERAL #4B (AL4B)	16039	22400	1			19635	100%	3	4574	3	0.016
HUDSON GULLY AT LEXINGTON (HG)	16041	2277	2			2047	85%	33	753	31	<0.001
ADAMS BAYOU AT GREEN AVE (AB4)	16059	502	2			641	57%	21	189	21	0.002
ADAMS BAYOU LATERAL #3 (AL3)	16054	1281	2			916	67%	21	387	21	<0.001
ADAMS BAYOU AT WESTERN (AB3)	10442	415	2			600	57%	21	164	21	0.002
ADAMS BAYOU LATERAL #2 (AL2)	16053	1543	2			885	62%	21	862	21	<0.001
ADAMS BAYOU LATERAL #1 (AL1)	16057	246	2			413	52%	21	422	21	0.006
ADAMS BAYOU AT FM 1006 (AB2)	10441	473	2	73	5	144	23%	62	117	44	0.933
PINEHURST WWTP 001 (AW3)	16043	22	2			167	33%	21	180	21	
STORM DRAIN TO ADAMS BAYOU (SD1)	16061	23200	1			13103	100%	2	2866	2	
ORANGE CO WCID WWTP (AW2)	16044	24	2			189	33%	21	50	21	
A SCHULMAN INC 001 (AW1)	16051		2			2	0%	5	2	5	

* probability that water quality criteria are met, based on the binomial distribution and making a decision that a station meets or does not meet water quality criteria
EC = *E. coli*
EN = enterococci
FC = fecal coliform
FS = fecal streptococcus
GM = geometric mean
N = count
%>400 = the percent of samples that exceeded the single-sample criterion of 400 colonies/mL

Table 4.4 Contact Recreation Indicator Bacteria Concentration Statistics for Adams Bayou by Station, 1969 - 2002

Station Short Description	Station ID	EC		EN		FC			FS	
		GM	N	GM	N	GM	%>400	N	GM	N
ADAMS BAYOU AT FM 1130 (AB9)	15742	928	2			916	63%	16	412	16
ADAMS BAYOU AT FM 1078 (AB8)	14964	704	2			523	50%	24	417	23
ADAMS BAYOU LATERAL #8 (AL8)	16056	2952	2			1351	76%	21	774	21
GUM GULLY AT HALLIBURTON (GG)	16049	100	1			592	55%	20	576	20
ADAMS BAYOU AT FM 3247 (AB7)	15107	424	2	154	5	195	32%	78	188	61
ADAMS BAYOU AT IH 10 (AB6)	10443					199	33%	58		
ADAMS BAYOU AT PARK AVE (AB5)	14990	294	2			428	49%	51	256	42
ADAMS BAYOU LATERAL #4B (AL4B)	16039	22400	1			19635	100%	3	4574	3
HUDSON GULLY AT LEXINGTON (HG)	16041	2277	2			2047	85%	33	753	31
ADAMS BAYOU AT GREEN AVE (AB4)	16059	502	2			641	57%	21	189	21
ADAMS BAYOU LATERAL #3 (AL3)	16054	1281	2			916	67%	21	387	21
ADAMS BAYOU AT WESTERN (AB3)	10442	415	2			600	57%	21	164	21
ADAMS BAYOU LATERAL #2 (AL2)	16053	1543	2			885	62%	21	862	21
ADAMS BAYOU LATERAL #1 (AL1)	16057	246	2			413	52%	21	422	21
ADAMS BAYOU AT FM 1006 (AB2)	10441	473	2	73	5	235	34%	235	153	101
PINEHURST WWTP 001 (AW3)	16043	22	2			185	33%	21	193	21
STORM DRAIN TO ADAMS BAYOU (SD1)	16061	23200	1			13103	100%	2	2866	2
ORANGE CO WCID WWTP (AW2)	16044	33	2			202	33%	21	61	21
A SCHULMAN INC 001 (AW1)	16051	3	2			3	0%	5	4	5

EC = *E. coli*

EN = enterococci

FC = fecal coliform

FS = fecal streptococcus

GM = geometric mean

N = count

%>400 = the percent of samples that exceeded the single-sample criterion of 400 colonies/mL

Table 4.5 Contact Recreation Indicator Bacteria Concentration Statistics for Cow Bayou by Station, 5/1997 – 5/2002

Station Short Description	Station ID	EC		EN		FC			FS		Probability Meet Criteria*
		GM	N	GM	N	GM	%>400	N	GM	N	
COW BAYOU AT JASPER CR 826 (CB7)	16058	230	1			174	20%	20	197	20	0.775
COW BAYOU AT SH 12 (CB6)	10337	96	1			183	29%	21	282	21	0.433
COW BAYOU LATERAL #10 (CL10)	16055	168	1			673	57%	14	509	14	0.010
COW BAYOU AT IH 10 (CB5)	10457	104	1			223	29%	21	182	21	0.433
COW BAYOU AT FM 1442 NORTH (CB4)	13781	23	1	60	5	86	16%	62	132	46	0.966
TERRY GULLY AT IH 10 (TG)	16040	26	1			383	54%	28	347	27	0.001
COLE CREEK AT IH 10 (CC)	16060	39	1			179	39%	33	181	31	0.048
COW BAYOU AT FM 105 (CB3)	10453	39	1			88	20%	30	160	23	0.797
COON BAYOU AT SH87 (CNB)	16052	1223	1			1002	76%	21	817	21	<0.001
COW BAYOU AT FM 1442 (CB1)	10449			62	5	184	27%	60	129	47	0.431
JASPER WCID WWTP 001 (CW13)	16045					94	30%	20	24	20	
PCS DEVELOPMENT CO WWTP OUTFL (CW8)	16064	7800	1			699	67%	21	169	21	
TX DOT WWTP OUTFALL 001 (CW7)	16066					7	10%	20	7	20	
LITTLE CYPRESS-MAURICEVILLE JH (CW11)	16069					14	15%	20	9	20	
OAK TERRACE WWTP 001 (CW10)	16062	2700	1			6342	100%	21	2962	21	
CRAWDAD WWTP 001 (CW12)	16050	2	1			88	35%	23	79	23	
TEXAS POLYMER SERVICES 001 (CI6)	16072	560	1			81	29%	21	44	21	
SRA WWTP 001 (CW6)	16042					3	0%	20	4	20	
BAYOU PINES WWTP 001 (CW4)	16070	10182	1			23850	100%	17	4090	17	
OAKLEAF PARK WWTP (CW9)	16065	9	1			46	10%	20	32	19	
ORANGE FIELD ISD WWTP (CW5)	16063	10	1			2	0%	20	2	20	
BLACKSHUR DEVELP CORP WWTP (CW3)	16067	9	1			63	29%	21	48	21	
BRIDGE CITY WWTP 001 (CW1)	16068	10	1			13	5%	20	13	20	
SUNRISE EAST WWTP 001 (CW2)	16071					3	0%	18	3	18	
PRINTPAK INC 001 (CI2)	16075					189	35%	20	445	20	

* probability that water quality criteria are met, based on the binomial distribution and making a decision that a station meets or does not meet water quality criteria

EC = *E. coli* EN = enterococci FC = fecal coliform

FS = fecal streptococcus GM = geometric mean

Table 4.6 Contact Recreation Indicator Bacteria Concentration Statistics for Cow Bayou by Station, 1969-2002

Station Short Description	Station ID	EC		EN		FC			FS	
		GM	N	GM	N	GM	%>400	N	GM	N
COW BAYOU AT JASPER CR 826 (CB7)	16058	230	1			180	20%	20	197	20
COW BAYOU AT SH 12 (CB6)	10337	96	1			184	27%	22	282	21
COW BAYOU LATERAL #10 (CL10)	16055	168	1			707	57%	14	509	14
COW BAYOU AT IH 10 (CB5)	10457	104	1			225	29%	24	197	23
COW BAYOU AT FM 1442 NORTH (CB4)	13781	23	1	60	5	115	22%	81	162	61
TERRY GULLY AT IH 10 (TG)	16040	26	1			383	54%	28	347	27
COLE CREEK AT IH 10 (CC)	16060	39	1			186	39%	33	181	31
COW BAYOU AT FM 105 (CB3)	10453	39	1			101	18%	96	156	43
COONS BAYOU AT SH87 (CNB)	16052	1223	1			1002	76%	21	817	21
COW BAYOU AT FM 1442 (CB1)	10449			62	5	271	32%	212	192	104
JASPER WCID WWTP 001 (CW13)	16045					101	30%	20	27	20
PCS DEVELOPMENT CO WWTP OUTFL (CW8)	16064	7800	1			825	67%	21	192	21
TX DOT WWTP OUTFALL 001 (CW7)	16066					14	10%	20	12	20
LITTLE CYPRESS-MAURICEVILLE JH (CW11)	16069					24	15%	20	15	20
OAK TERRACE WWTP 001 (CW10)	16062	2700	1			6342	100%	21	2962	21
CRAWDAD WWTP 001 (CW12)	16050	4	1			123	35%	23	98	23
TEXAS POLYMER SERVICES 001 (CI6)	16072	560	1			99	29%	21	54	21
SRA WWTP 001 (CW6)	16042					6	0%	20	7	20
BAYOU PINES WWTP 001 (CW4)	16070	10182	1			23850	100%	17	4090	17
OAKLEAF PARK WWTP (CW9)	16065	9	1			51	10%	20	35	19
ORANGE FIELD ISD WWTP (CW5)	16063	10	1			4	0%	20	4	20
BLACKSHUR DEVELP CORP WWTP (CW3)	16067	9	1			77	29%	21	60	21
BRIDGE CITY WWTP 001 (CW1)	16068	10	1			14	5%	20	17	20
SUNRISE EAST WWTP 001 (CW2)	16071					5	0%	18	5	18
PRINTPAK INC 001 (CI2)	16075					210	35%	20	477	20

EC = *E. coli*
EN = enterococci
FC = fecal coliform
FS = fecal streptococcus
GM = geometric mean
N = count
%>400 = the percent of samples that exceeded the single-sample criterion of 400 colonies/mL

4.3 DISSOLVED OXYGEN

Throughout most of Adams Bayou and in portions of Cow Bayou, DO frequently falls below the criteria set forth in Texas Water Quality Standards for the protection of aquatic life. Table 4.7 lists, for Adams Bayou in the most recent five-year period of available data (May 9, 1997 to May 8, 2002), the average measured dissolved concentration, the percent of measurements falling below daily average and daily minimum water quality criteria for that water body. These measurements include only those collected in the upper 1 meter of the water column, to ensure they are representative of the surface mixed layer. Table 4.8 is identical to 4.7 except that it includes data for the entire period of record, since 1969. Only the lowest Adams Bayou station, near the Sabine River, meets the criteria more than 75 percent of the time. The average dissolved oxygen concentrations is approximately 3 mg/L at the uppermost Adams Bayou station (FM 1130), increases to over 4 mg/L at FM 1078, then declines to less than 2 mg/L at Western Avenue in Orange before rising to greater than 5 mg/L near the confluence with the Sabine River (Figure 4.7). Dissolved oxygen levels are low in Gum Gully, Hudson Gully, and other tributaries. It can be concluded with a high level of confidence that the daily minimum DO criterion is not met throughout most of Adams Bayou Tidal, Gum Gully, Hudson Gully, and several laterals. The daily minimum DO criterion appears to be met in Adams Bayou above Tidal.

Dissolved oxygen concentrations tend to be higher in Cow Bayou than in Adams Bayou (Tables 4.9 and 4.10). Dissolved oxygen levels tend to be lowest in the uppermost above tidal station (16058), in the middle portion at the north crossing of FM 1442, and in the tributaries Coon Bayou and Cow Bayou Lateral #10 (Figure 4.8). At stations near to the Sabine River, and in Terry Gully and Cole Creek, dissolved oxygen levels tend to be higher. It can be concluded with a high level of confidence that current DO daily minimum criteria are not met in middle portions of Cow Bayou Tidal, upper reaches of Cow Bayou above Tidal, and Coon Bayou. In Terry Gully and Cole Creek, it is uncertain whether these DO criteria are met.

Dissolved oxygen levels in Adams and Cow Bayous appeared to be somewhat related to flow conditions, with lower dissolved oxygen levels typically found under no flow or low flow conditions (Figures 4.9-4.10). However, this relationship was not observed in all water bodies. While increased flow typically increases the aeration rate of the stream, high flows also occur under runoff conditions, when oxygen-consuming substances on land are washed into the stream or re-suspended from the sediments. The relationship between flow and dissolved oxygen levels was more apparent in Cow Bayou than in Adams Bayou, for unknown reasons.

Oxygen tends to be less soluble in water at higher temperatures. Thus, dissolved oxygen levels are expected to be lowest in the summertime. This expected pattern is in fact observed in Adams and Cow Bayous (Figure 4.11). Another factor contributing to the higher DO concentrations in cooler weather is that stream flow is higher in those seasons.

The annual average of dissolved oxygen measurements since 1969 is plotted in Figure 4.12 at the single long-term monitoring station in each of Adams and Cow Bayous. Average dissolved oxygen levels in the 1970's and early 1980's tend to be more variable because they

are based on fewer measurements. Average DO levels have been higher at the Cow Bayou site than the Adams Bayou site in all but three years. There was no statistically significant change in dissolved oxygen levels at the Cow Bayou monitoring station. However, DO levels have been slowly, but increasing at a very small but statistically significant ($p=0.0024$) rate at the Adams Bayou station. The change in Adams Bayou DO has averaged +0.036 mg/L per year over the 34-year period, with a 95 percent confidence interval of +0.013 to +0.060 mg/L per year.

4.4 pH

pH in Adams and Cow Bayous is affected by a plethora of factors, including loading of acidic natural organic matter, soil type, effluent discharges, temperature, algal photosynthesis, and respiration of organic matter. Algal photosynthesis consumes hydrogen ion, raising the pH. Respiration reverses this process, releasing hydrogen ion and lowering pH. Saltwater is somewhat pH buffered by its salts. The lower portions of both bayous are somewhat pH-buffered by salts introduced in the tidal ebb, and thus are unlikely to violate pH criteria.

Average pH levels fall entirely within the 6.0-8.5 range specified in water quality criteria throughout Adams and Cow bayous, though the percentages of samples not falling within that range was higher than 10 percent at some stations. This criterion applies only to the classified tidal portions of Adams and Cow Bayous. The stations in classified segments with more than 10 percent of samples outside the 6.0-8.5 criterion were Station 16059 (Adams Bayou at Green Avenue), in the middle of Segment 0508, and Stations 13781 (Cow Bayou at FM 1442 North Crossing) and 10457 (Cow Bayou at IH 10), in the upper to middle reaches of Cow Bayou. The spatial variation in pH in Adams and Cow Bayous is shown in Figures 4.13 and 4.14, respectively.

Based on the binomial probability method, it can be concluded that there is roughly a 95% chance that the 6.0 minimum pH criterion is violated in upper portions of Cow Bayou Tidal.

In the draft 2002 §303(d) List, Adams Bayou was not listed as impaired by pH due to the peculiarities of the TCEQ assessment methodology for pH, which states "Individual pH measurements made in the mixed surface layer are compared to the max/min criteria, but only one exceedance is counted per profile if more than one measurement is outside the criteria." For the assessment period, there were 44 total pH measurements made at Station 16059 in 21 sampling events. pH was measured at one to three depths in each event. Eight of these 44 pH measurements were exceedances (<6.0). Because they occurred in only four events, they were counted as only 4 exceedances, then divided by 44 observations to calculate an exceedance frequency of 9 percent, which is considered fully supporting the general uses. Based on the guidance document for assessing surface water quality data (TNRCC 2002), it is not clear if multiple observations should be counted per event. If so, the number of measurements in a given event would skew the calculation of criteria exceedances.

pH exhibits only minor variation with stream flow in Adams and Cow Bayous (Figures 4.15 and 1.6). pH tends to be slightly lower under high flow conditions, perhaps due

to a reduction of the saltwater influence. Seasonal variation in pH is also relatively minor, likely influenced by the freshwater inflows and algal photosynthesis, among other factors.

Surface (<1 meter) pH measurements at the long-term monitoring stations in Adams and Cow Bayous since 1969 are plotted in Figures 4.18 and 4.19. There was no statistically significant change in pH at the Cow Bayou monitoring station over this period. However, pH levels have been declining at a very slow but statistically significant ($p=0.001$) rate at the Adams Bayou station. The change in pH at this station has averaged -0.00524 units per year over the 34-year period, with a 95 percent confidence interval of -0.00837 to -0.00211 units per year.

Table 4.7 Dissolved Oxygen Concentration Summary Statistics for Adams Bayou and Tributary Stations, 5/1997 – 5/2002

Segment	Sequence	Station Short Description	Station ID	Average Conc.	% < Segment Daily Average Criterion	% < Segment Daily Minimum Criterion	N	Probability Fully Support Dly Min Criterion*
0508	1000	Adams Bayou At FM 1006 (AB2)	10441	5.35	22%	13%	63	0.293
0508	1500	Adams Bayou At Western (AB3)	10442	2.87	81%	62%	21	<0.001
0508	1700	Adams Bayou At Green Ave (AB4)	16059	2.78	90%	67%	21	<0.001
0508	1800	Adams Bayou At Park Ave (AB5)	14990	2.53	87%	70%	30	<0.001
0508	2000	Adams Bayou At IH 10 (AB6)	10443	1.50	100%	100%	2	0.010
0508A	2100	Adams Bayou At FM 3247 (AB7)	15107	3.35	67%	54%	63	<0.001
0508A	0	Adams Bayou At FM 1078 (AB8)	14964	4.33	33%	14%	21	0.352
0508A	0	Adams Bayou At FM 1130 (AB9)	15742	3.06	56%	13%	32	0.400
0508t	0	Adams Bayou Lateral #1 (AL1)	16057	2.08	100%	71%	21	<0.001
0508t	0	Adams Bayou Lateral #2 (AL2)	16053	1.69	100%	91%	22	<0.001
0508t	0	Adams Bayou Lateral #3 (AL3)	16054	2.47	86%	73%	22	<0.001
0508t	0	Adams Bayou Lateral #4b (AL4b)	16039	3.52	33%	33%	3	0.271
0508At	0	Adams Bayou Lateral #8 (AL8)	16056	4.45	29%	10%	21	0.635
0508B	0	Gum Gully At Halliburton (GG)	16049	3.74	40%	25%	20	0.043
0508C	0	Hudson Gully At Lexington (HG)	16041	3.02	69%	56%	32	<0.001
0508t		Storm Drain To Adams Bayou (SD1)	16061	3.56	50%	50%	2	0.190
0508t		A Schulman Inc 001 (AW1)	16051	6.98			4	
0508t		Orange Co WCID WWTP (AW2)	16044	6.05			20	
0508t		Pinehurst WWTP 001 (AW3)	16043	6.19			20	

* Probability that no more than 10% of instantaneous DO samples do not meet the daily minimum criterion

Table 4.8 Dissolved Oxygen Concentration Summary Statistics for Adams Bayou and Tributary Stations, 1969 - 2002

Segment	Sequence	Station Short Description	Station ID	Average Conc.	% < Segment Daily Average Criterion	% < Segment Daily Minimum Criterion	N
0508	1000	Adams Bayou At FM 1006 (AB2)	10441	4.99	35%	20%	312
0508	1500	Adams Bayou At Western (AB3)	10442	2.78	82%	64%	22
0508	1700	Adams Bayou At Green Ave (AB4)	16059	2.78	90%	67%	21
0508	1800	Adams Bayou At Park Ave (AB5)	14990	3.04	81%	66%	59
0508	2000	Adams Bayou At IH 10 (AB6)	10443	4.27	48%	34%	150
0508A	2100	Adams Bayou At FM 3247 (AB7)	15107	3.59	64%	49%	81
0508A	0	Adams Bayou At FM 1078 (AB8)	14964	4.54	31%	15%	26
0508A	0	Adams Bayou At FM 1130 (AB9)	15742	3.05	55%	12%	33
0508t	0	Adams Bayou Lateral #1 (AL1)	16057	2.08	100%	71%	21
0508t	0	Adams Bayou Lateral #2 (AL2)	16053	1.69	100%	91%	22
0508t	0	Adams Bayou Lateral #3 (AL3)	16054	2.47	86%	73%	22
0508t	0	Adams Bayou Lateral #4b (AL4b)	16039	3.52	33%	33%	3
0508At	0	Adams Bayou Lateral #8 (AL8)	16056	4.45	29%	10%	21
0508B	0	Gum Gully At Halliburton (GG)	16049	3.74	40%	25%	20
0508C	0	Hudson Gully At Lexington (HG)	16041	3.02	69%	56%	32
0508t		A Schulman Inc 001 (AW1)	16051	6.98			4
0508t		Orange Co WCID WWTP (AW2)	16044	6.05			20
0508t		Pinehurst WWTP 001 (AW3)	16043	6.19			20
0508t		Storm Drain To Adams Bayou (SD1)	16061	3.56			2

Table 4.9 Dissolved Oxygen Concentration Summary Statistics for Cow Bayou and Tributary Stations, 5/1997 – 5/2002

Segment	Sequence	Station Short Description	Station ID	Average Conc.	% < Segment Daily Average Criterion	% < Segment Daily Minimum Criterion	N	Probability Fully Support Dly Min Criterion*
0511	1000	Cow Bayou At FM 1442 (CB1)	10449	6.21	11%	5%	62	0.955
0511	2000	Cow Bayou At FM 105 (CB3)	10453	4.55	29%	23%	31	0.031
0511	3250	Cow Bayou At FM 1442 North (CB4)	13781	3.35	65%	52%	63	<0.001
0511	4000	Cow Bayou At IH 10 (CB5)	10457	4.03	50%	27%	22	0.018
0511	4100	Cow Bayou 300 M N of IH 10	14462	5.12	18%	0%	17	1
0511A	0	Cow Bayou At SH 12 (CB6)	10337	5.98	8%	0%	24	1
0511A	0	Cow Bayou At Jasper CR 826 (CB7)	16058	3.27	39%	35%	23	0.001
0511B	0	Coons Bayou At SH87 (CNB)	16052	2.83	79%	54%	24	<0.001
0511C	0	Cole Creek At IH 10 (CC)	16060	5.51	18%	9%	33	0.654
0511E	0	Terry Gully At IH 10 (TG)	16040	5.31	46%	14%	28	0.305
0511t	0	Cow Bayou Lateral #10 (CL10)	16055	3.12	57%	21%	14	0.158
0511t		Bridge City WWTP 001 (CW1)	16068	6.38			20	
0511t		Sunrise East WWTP 001 (CW2)	16071	7.31			19	
0511t		Blackshur Develp Corp WWTP (CW3)	16067	2.62			21	
0511t		Bayou Pines WWTP 001 (CW4)	16070	3.14			17	
0511t		Orange Field ISD WWTP (CW5)	16063	7.28			20	
0511t		Sra WWTP 001 (CW6)	16042	5.55			20	
0511t		TXDOT WWTP Outfall 001 (CW7)	16066	3.62			20	
0511t		PCS Development Co WWTP Outfl (CW8)	16064	6.86			20	
0511t		Oakleaf Park WWTP (CW9)	16065	6.08			20	

Segment	Sequence	Station Short Description	Station ID	Average Conc.	% < Segment Daily Average Criterion	% < Segment Daily Minimum Criterion	N	Probability Fully Support Dly Min Criterion*
0511t		Oak Terrace WWTP 001 (CW10)	16062	1.06			21	
0511At		Little Cypress-Mauriceville JH (CW11)	16069	5.11			20	
0511At		Crawdad WWTP 001 (CW12)	16050	2.20			23	
0511At		Jasper WCID WWTP 001 (CW13)	16045	5.59			20	
0511t		Printpak Inc 001 (CI2)	16075	7.61			20	
0511t		Texas Polymer Services 001 (CI6)	16072	6.92			21	

* Probability that no more than 10% of instantaneous DO samples do not meet the daily minimum criterion

Table 4.10 Dissolved Oxygen Concentration Summary Statistics for Cow Bayou and Tributary Stations, 1969 - 2002

Segment	Sequence	Station Short Description	Station ID	Average Conc.	% < Segment Daily Average Criterion	% < Segment Daily Minimum Criterion	N
0501	0	Sabine River at Cow Bayou confluence	10392	6.16	0%	0%	8
0511	500	Cow Bayou 2400 ft upstream of Sabine River	10446	6.46	0%	0%	8
0511	600	Cow Bayou 6000 ft upstream of Sabine River	10447	6.85	0%	0%	8
0511	750	Cow Bayou 6200 ft downstream of FM 1442	10448	6.74	0%	0%	8
0511	1000	Cow Bayou At FM 1442 (CB1)	10449	6.05	17%	5%	282
0511	1300	Cow Bayou 3500 ft downstream of SH 87	10450	6.63	0%	0%	8
0511	1500	Cow Bayou At SH 87	10451	6.84	0%	0%	8
0511	1700	Cow Bayou halfway between FM 105 and SH87	10452	7.16	0%	0%	8
0511	2000	Cow Bayou At FM 105 (CB3)	10453	5.52	25%	13%	132
0511	2500	Cow Bayou 50 yds downstream of Cole Creek	10454	1.86	100%	100%	7
0511	3000	Cow Bayou 50 yds downstream of SP RR bridge	10455	1.41	100%	100%	7
0511	3250	Cow Bayou At FM 1442 North (CB4)	13781	3.84	56%	45%	86
0511	3500	Cow Bayou between IH 10 and SP RR bridge	10456	2.93	90%	70%	10
0511	4000	Cow Bayou At IH 10 (CB5)	10457	4.18	45%	27%	33
0511	4100	Cow Bayou 300 M N of IH 10	14462	5.24	24%	8%	66
0511A	0	Cow Bayou At SH 12 (CB6)	10337	6.22	4%	0%	47
0511A	0	Cow Bayou At Jasper CR 826 (CB7)	16058	3.27	39%	35%	23
0511B	0	Coons Bayou At SH87 (CNB)	16052	2.83	79%	54%	24
0511C	0	Cole Creek At IH 10 (CC)	16060	5.51	18%	9%	33
0511E	0	Terry Gully At IH 10 (TG)	16040	5.31	46%	14%	28

Segment	Sequence	Station Short Description	Station ID	Average Conc.	% < Segment Daily Average Criterion	% < Segment Daily Minimum Criterion	N
0511t	0	Cow Bayou Lateral #10 (CL10)	16055	3.12	57%	21%	14
0511t		Bridge City WWTP 001 (CW1)	16068	6.38			20
0511t		Sunrise East WWTP 001 (CW2)	16071	7.31			19
0511t		Blackshur Develp Corp WWTP (CW3)	16067	2.62			21
0511t		Bayou Pines WWTP 001 (CW4)	16070	3.14			17
0511t		Orange Field ISD WWTP (CW5)	16063	7.28			20
0511t		Sra WWTP 001 (CW6)	16042	5.55			20
0511t		TXDOT WWTP Outfall 001 (CW7)	16066	3.62			20
0511t		PCS Development Co WWTP Outfl (CW8)	16064	6.86			20
0511t		Oakleaf Park WWTP (CW9)	16065	6.08			20
0511t		Oak Terrace WWTP 001 (CW10)	16062	1.06			21
0511At		Little Cypress-Mauriceville JH (CW11)	16069	5.11			20
0511At		Crawdad WWTP 001 (CW12)	16050	2.20			23
0511At		Jasper WCID WWTP 001 (CW13)	16045	5.59			20
0511t		Printpak Inc 001 (CI2)	16075	7.61			20
0511t		Texas Polymer Services 001 (CI6)	16072	6.92			21

Table 4.11 pH Concentrations in Adams Bayou and Tributaries, 1969 - 2002

Segment	Sequence	Station Short Description	Station ID	pH		
				Average	% outside 6.0-8.5	N
0508	1000	Adams Bayou At FM 1006 (AB2)	10441	6.94	1%	292
0508	1500	Adams Bayou At Western (AB3)	10442	6.71	5%	22
0508	1700	Adams Bayou At Green Ave (AB4)	16059	6.56	19%	21
0508	1800	Adams Bayou At Park Ave (AB5)	14990	6.62	10%	59
0508	2000	Adams Bayou At IH 10 (AB6)	10443	6.51	4%	150
0508A	2100	Adams Bayou At FM 3247 (AB7)	15107	6.67	4%	81
0508A	0	Adams Bayou At FM 1078 (AB8)	14964	6.58	12%	26
0508A	0	Adams Bayou At FM 1130 (AB9)	15742	6.29	15%	33
0508t	0	Adams Bayou Lateral #1 (AL1)	16057	6.60	0%	21
0508t	0	Adams Bayou Lateral #2 (AL2)	16053	6.74	0%	22
0508t	0	Adams Bayou Lateral #3 (AL3)	16054	6.83	0%	22
0508t	0	Adams Bayou Lateral #4b (AL4b)	16039	6.78	0%	3
0508At	0	Adams Bayou Lateral #8 (AL8)	16056	6.86	5%	21
0508B	0	Gum Gully At Halliburton (GG)	16049	6.92	5%	20
0508C	0	Hudson Gully At Lexington (HG)	16041	7.12	3%	32
0508t		A Schulman Inc 001 (AW1)	16051	7.36	0%	5
0508t		Orange Co WCID WWTP (AW2)	16044	7.23	0%	21
0508t		Pinehurst WWTP 001 (AW3)	16043	7.11	0%	21
0508t		Storm Drain To Adams Bayou (SD1)	16061	6.01	50%	2

Table 4.12 pH Concentrations in Adams Bayou and Tributaries, 5/1997 – 5/2002

Segment	Sequence	Station Short Description	Station ID	pH			Probability Fully Support Criterion*
				Average	% outside 6.0-8.5	N	
0508	1000	Adams Bayou At FM 1006 (AB2)	10441	6.89	3%	64	0.990
0508	1500	Adams Bayou At Western (AB3)	10442	6.73	5%	21	0.891
0508	1700	Adams Bayou At Green Ave (AB4)	16059	6.56	19%	21	0.152
0508	1800	Adams Bayou At Park Ave (AB5)	14990	6.60	20%	30	0.073
0508	2000	Adams Bayou At IH 10 (AB6)	10443	6.50	0%	2	1
0508A	2100	Adams Bayou At FM 3247 (AB7)	15107	6.67	5%	63	0.958
0508A	0	Adams Bayou At FM 1078 (AB8)	14964	6.58	14%	21	0.352#
0508A	0	Adams Bayou At FM 1130 (AB9)	15742	6.30	16%	32	0.211#
0508t	0	Adams Bayou Lateral #1 (AL1)	16057	6.60	0%	21	1#
0508t	0	Adams Bayou Lateral #2 (AL2)	16053	6.74	0%	22	1#
0508t	0	Adams Bayou Lateral #3 (AL3)	16054	6.83	0%	22	1#
0508t	0	Adams Bayou Lateral #4b (AL4b)	16039	6.78	0%	3	1#
0508At	0	Adams Bayou Lateral #8 (AL8)	16056	6.86	5%	21	0.891#
0508B	0	Gum Gully At Halliburton (GG)	16049	6.92	5%	20	0.878#
0508C	0	Hudson Gully At Lexington (HG)	16041	7.12	3%	32	0.966#
0508t		A Schulman Inc 001 (AW1)	16051	7.36	0%	5	
0508t		Orange Co WCID WWTP (AW2)	16044	7.23	0%	21	
0508t		Pinehurst WWTP 001 (AW3)	16043	7.11	0%	21	
0508t		Storm Drain To Adams Bayou (SD1)	16061	6.01	50%	2	

Probability that no more than 10% of instantaneous pH samples do not meet the minimum criterion

pH criteria do not apply to these unclassified water bodies

Table 4.13 pH Concentrations in Cow Bayou and Tributaries, 1969 - 2002

Segment	Sequence	Station Short Description	Station ID	PH		
				Average	% outside 6.0-8.5	N
0511	500	Cow Bayou 2400 ft upstream of Sabine River	10446	7.45	0%	8
0511	600	Cow Bayou 6200 ft upstream of Sabine River	10447	7.53	0%	8
0511	750	Cow Bayou 6200 ft downstream of FM1442	10448	7.43	0%	8
0511	1000	Cow Bayou at FM 1442 (CB1)	10449	6.93	1%	263
0511	1500	Cow Bayou at SH 87	10451	7.29	0%	8
0511	1700	Cow Bayou Halfway Between FM 105 and SH 87	10452	7.25	0%	8
0511	2000	Cow Bayou At FM 105 (CB3)	10453	6.66	9%	129
0511	2500	Cow Bayou 50 yds Downstream Of Cole Creek	10454	6.75	0%	4
0511	3000	Cow Bayou 50 yds Downstream Of SP Railroad Bridge	10455	6.93	0%	4
0511	3250	Cow Bayou At FM 1442 North (CB4)	13781	6.48	15%	86
0511	3500	Cow Bayou Between IH 10 And SP Railroad Bridge	10456	6.91	0%	7
0511	4000	Cow Bayou At IH 10 (CB5)	10457	6.55	17%	29
0511A	0	Cow Bayou At SH 12 (CB6)	10337	6.15	23%	47
0511A	0	Cow Bayou At Jasper CR 826 (CB7)	16058	6.14	48%	23
0511B	0	Coons Bayou At SH87 (CNB)	16052	6.74	4%	24
0511C	0	Cole Creek At IH 10 (CC)	16060	6.98	3%	32
0511E	0	Terry Gully At IH 10 (TG)	16040	7.06	0%	27
0511t	0	Cow Bayou Lateral #10 (CL10)	16055	6.89	7%	14
0511t		Bridge City WWTP 001 (CW1)	16068	7.02	11%	19
0511t		Sunrise East WWTP 001 (CW2)	16071	7.30	5%	19

Segment	Sequence	Station Short Description	Station ID	PH		
				Average	% outside 6.0-8.5	N
0511t		Blackshur Develp Corp WWTP (CW3)	16067	7.19	0%	21
0511t		Bayou Pines WWTP 001 (CW4)	16070	7.29	0%	17
0511t		Orange Field ISD WWTP (CW5)	16063	7.32	0%	20
0511t		SRA WWTP 001 (CW6)	16042	6.62	5%	19
0511t		TXDOT WWTP Outfall 001 (CW7)	16066	6.50	26%	19
0511t		PCS Development Co WWTP Outfl (CW8)	16064	7.39	0%	20
0511t		Oakleaf Park WWTP (CW9)	16065	9.28	100%	19
0511t		Oak Terrace WWTP 001 (CW10)	16062	6.61	0%	20
0511At		Little Cypress-Mauriceville JH (CW11)	16069	6.88	5%	20
0511At		Crawdad WWTP 001 (CW12)	16050	6.86	0%	23
0511At		Jasper WCID WWTP 001 (CW13)	16045	8.49	55%	20
0511t		Printpak Inc 001 (CI2)	16075	7.77	0%	19
0511t		Texas Polymer Services 001 (CI6)	16072	7.81	5%	20

Table 4.14 pH Concentrations in Cow Bayou and Tributaries, 5/1997 – 5/2002

Segment	Sequence	Station Short Description	Station ID	pH			Probability Fully Support Criterion*
				Average	% outside 6.0-8.5	N	
0511	1000	Cow Bayou At FM 1442 (CB1)	10449	6.90	2%	62	0.999
0511	2000	Cow Bayou At FM 105 (CB3)	10453	6.63	10	31	0.611
0511	3250	Cow Bayou At FM 1442 North (CB4)	13781	6.46	17%	63	0.047
0511	4000	Cow Bayou At IH 10 (CB5)	10457	6.46	24%	21	0.052
0511	4100	Cow Bayou 300 m N of IH 10	14462	6.35	6%	17	0.833
0511A	0	Cow Bayou At SH 12 (CB6)	10337	6.11	46%	24	<0.001#
0511A	0	Cow Bayou At Jasper CR 826 (CB7)	16058	6.14	48%	23	<0.001#
0511B	0	Coons Bayou At SH87 (CNB)	16052	6.74	4%	24	0.920#
0511C	0	Cole Creek At IH 10 (CC)	16060	6.98	3%	32	0.966#
0511E	0	Terry Gully At IH 10 (TG)	16040	7.06	0%	27	1#
0511t	0	Cow Bayou Lateral #10 (CL10)	16055	6.89	7%	14	0.771#
0511t		Bridge City WWTP 001 (CW1)	16068	7.02	11%	19	
0511t		Sunrise East WWTP 001 (CW2)	16071	7.30	5%	19	
0511t		Blackshur Develp Corp WWTP (CW3)	16067	7.19	0%	21	
0511t		Bayou Pines WWTP 001 (CW4)	16070	7.29	0%	17	
0511t		Orange Field ISD WWTP (CW5)	16063	7.32	0%	20	
0511t		SRA WWTP 001 (CW6)	16042	6.61	5%	20	
0511t		TXDOT WWTP Outfall 001 (CW7)	16066	6.50	26%	19	
0511t		PCS Development Co WWTP Outfl (CW8)	16064	7.39	0%	20	
0511t		Oakleaf Park WWTP (CW9)	16065	9.28	100%	19	

Segment	Sequence	Station Short Description	Station ID	pH			Probability Fully Support Criterion*
				Average	% outside 6.0-8.5	N	
0511t		Oak Terrace WWTP 001 (CW10)	16062	6.61	0%	20	
0511At		Little Cypress-Mauriceville JH (CW11)	16069	6.88	5%	20	
0511At		Crawdad WWTP 001 (CW12)	16050	6.86	0%	23	
0511At		Jasper WCID WWTP 001 (CW13)	16045	8.49	55%	20	
0511t		Printpak Inc 001 (CI2)	16075	7.77	0%	19	
0511t		Texas Polymer Services 001 (CI6)	16072	7.81	5%	20	

Probability that no more than 10% of instantaneous pH samples do not meet the minimum criterion

pH criteria do not apply to these unclassified water bodies

4.5 OTHER RELATED WATER QUALITY PARAMETERS

4.5.1 Organic Matter

Dissolved and particulate organic matter contributes a substantial portion of the oxygen demand in most natural waters. Autochthonous organic matter is produced in the stream through photosynthesis. Allochthonous organic matter originates outside the stream and is introduced primarily through effluents, runoff, and riparian vegetation.

The respiration (degradation) of organic matter consumes oxygen in a process called carbonaceous oxygen demand. Organic matter is carbon-based, and carbon in water is typically quantified as a measured of organic matter.

Figure 4.20 shows the dissolved organic carbon (DOC) concentration profiles of Cow Bayou during two intensive surveys. DOC levels decline from upstream to downstream in Cow Bayou. Many factors may contribute to this observed profile. First, algal populations may increase downstream, utilizing the dissolved organic carbon in photosynthesis. Another factor is likely more important. DOC is charge-stabilized in aqueous solution in low ionic strength fresh water. As the salinity of the water increases along a tidal gradient, the increasing ionic strength causes the DOC to precipitate to form particulate organic carbon (POC), or sorb onto other particle surfaces. The POC either settles out to contribute to sediment oxygen demand (SOD), is degraded (in a process consuming oxygen) by bacteria and other heterotrophic organisms, or remains suspended and is discharged downstream to another water body. Because current speed is reduced in the flat, tidal section of Adams and Cow Bayous, the former two processes are expected to predominate. Figures 4.21 and 4.22, showing POC concentration declines with distance downstream on a number of different dates in Adams and Cow Bayou, lend support to this hypothesis. The higher POC levels in upstream portions of the bayous appear to be either deposited to sediments or consumed in the bayou.

4.5.2 Suspended Solids

Adams and Cow Bayous are relatively turbid streams, with high levels of suspended solids. This high turbidity hinders light penetration and, hence, oxygen-producing photosynthesis. Total suspended solids (TSS), a measure of the mass of suspended particles in water, tends to decline with distance downstream in Cow Bayou. The change is primarily apparent where the zone of tidal influence and higher salinity begins. As with DOC, an increase in salinity tends to de-stabilize suspended particles, causing them to aggregate together. These larger particle aggregates tend to settle rapidly out of the water column.

4.5.3 Nutrients

Nitrogen and phosphorus are essential substances needed in small quantities by aquatic algae for growth. In addition to contributing to growth of aquatic plants, some nutrients contribute to oxygen demand directly. Nitrogenous oxygen demand, which involves the

oxidation of reduced nitrogen species such as ammonia to nitrite, then nitrate, can constitute a substantial portion of the total oxygen demand.

Nitrogen and phosphorus occur in natural waters in a number of different species and forms. This variety of forms, together with a variety of methods of separating and quantifying them, often confuses the interpretation of nutrient concentration data. Nitrogen typically occurs in natural waters as ammonia (NH_3) and ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), and organic nitrogen. Phosphorus typically occurs as orthophosphate (PO_4^{-3}), polyphosphate, and numerous organic phosphorus species. These species may be present in several physical forms: dissolved, colloidal, and particulate. Nutrients are typically measured in the dissolved (passed through a filter), particulate (retained on a filter), or total (all combined) phases.

Figures 4.24 and 4.25 show the concentration profiles of a number of different nutrient species in Cow Bayou during a 1982 intensive survey. Ammonia nitrogen and total nitrogen levels increase from the upper reaches to a peak near the middle of the segment, at Stations 10453 and 10454, then steadily decline toward the confluence with the Sabine. Levels of total phosphorus and orthophosphate reached minima at the point where ammonia and total nitrogen species peaked, then stay relatively steady in lower reaches of the bayou.

Figures 4.26, 4.27, and 4.28 display additional nutrient concentration profiles in Adams and Cow Bayou from the 1998-1999 Special Studies of the Sabine River Authority. In contrast to Cow Bayou, nutrient levels in Adams Bayou appear to be higher in the lower reaches of the bayou, perhaps because that is where the majority of permitted wastewater discharges occur.

Figure 4.1 Spatial Trends in Fecal Coliform Concentrations in Adams Bayou and Tributaries: Most Recent Five Year Period

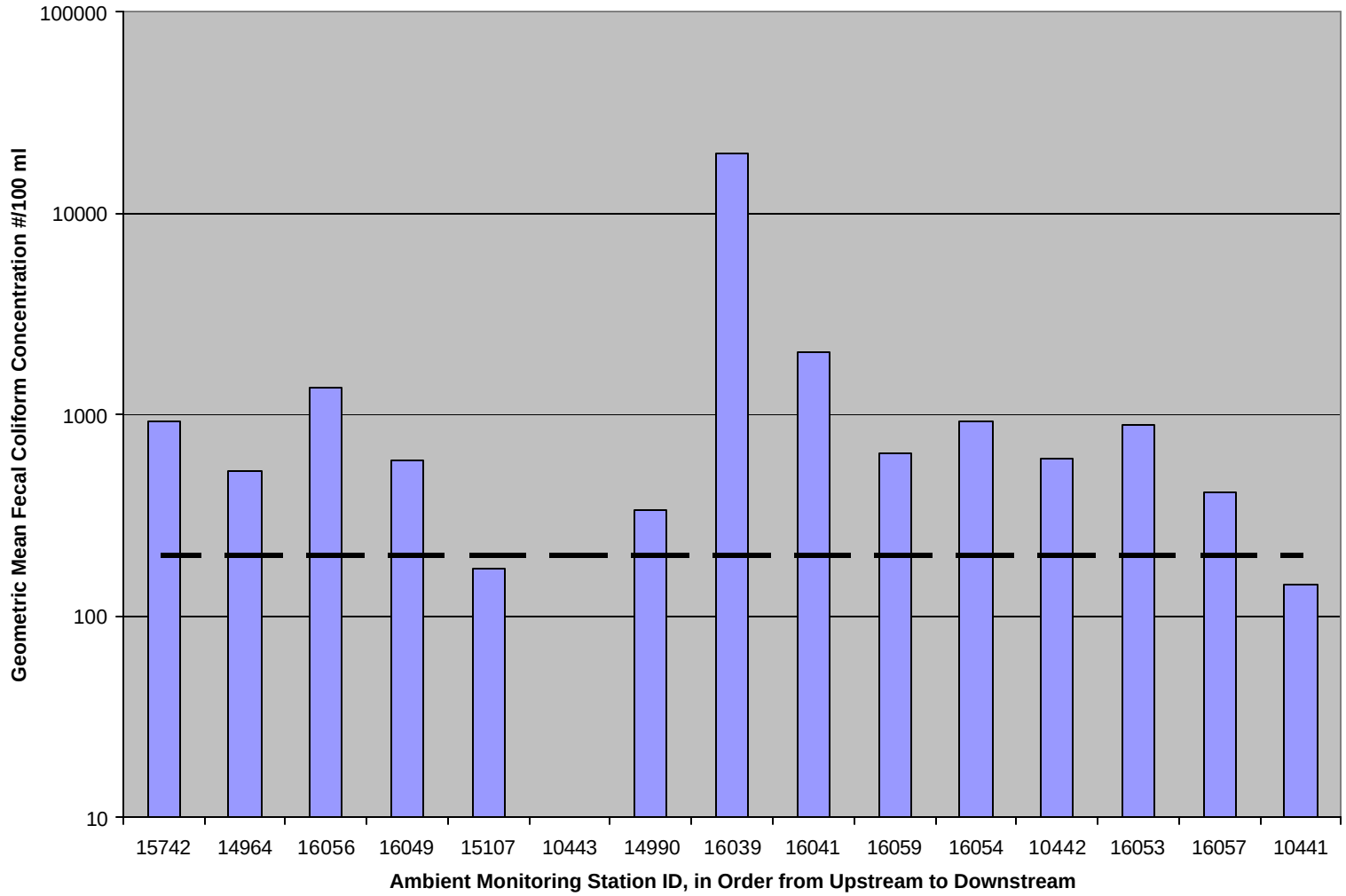


Figure 4.2 Spatial Trends in Fecal Coliform Concentrations in Cow Bayou and Tributaries: Most Recent Five Year Period

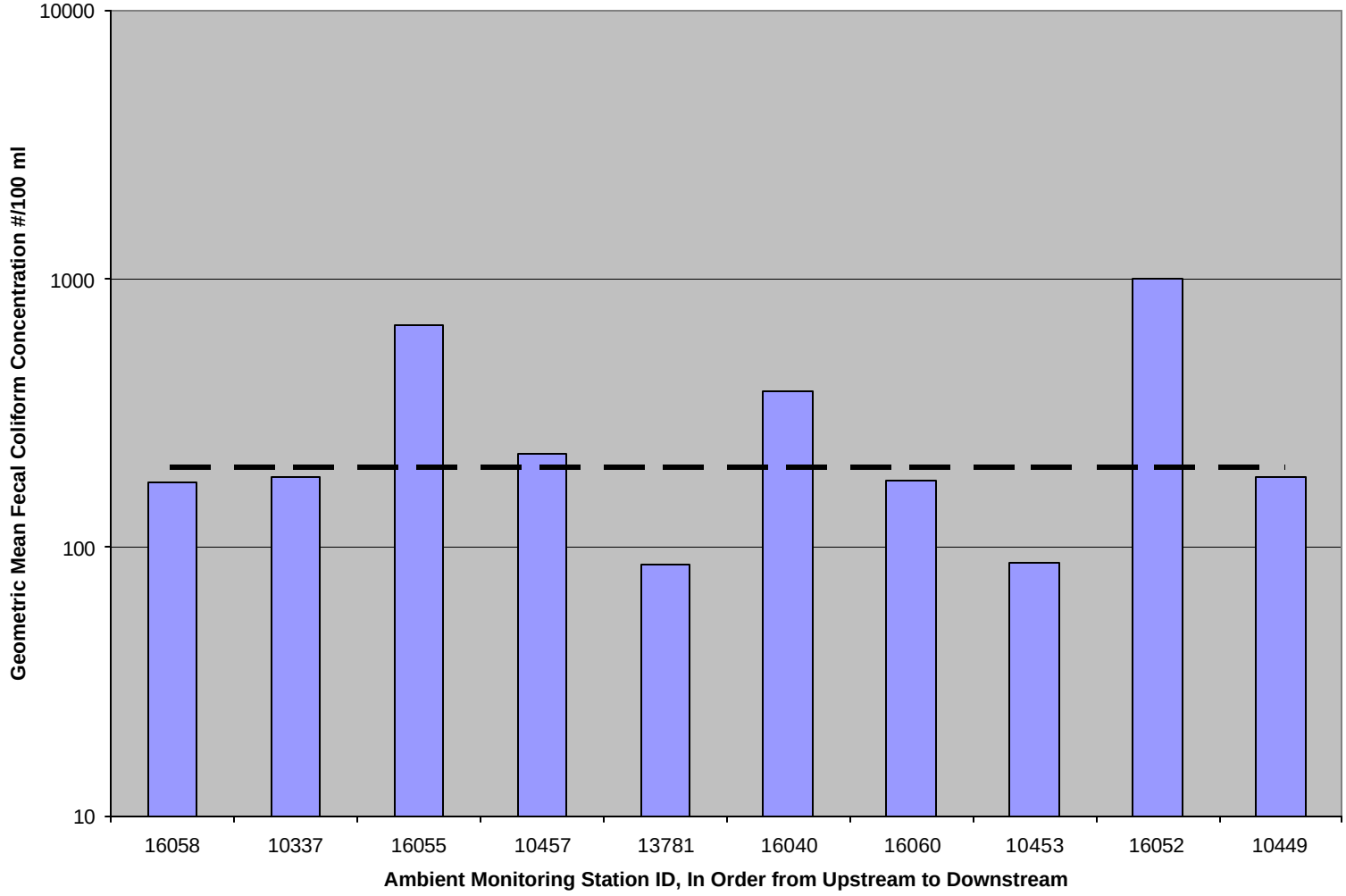


Figure 4.3 Fecal Coliform vs. Flow Severity in Adams Bayou and Tributaries, 1969 - 2002

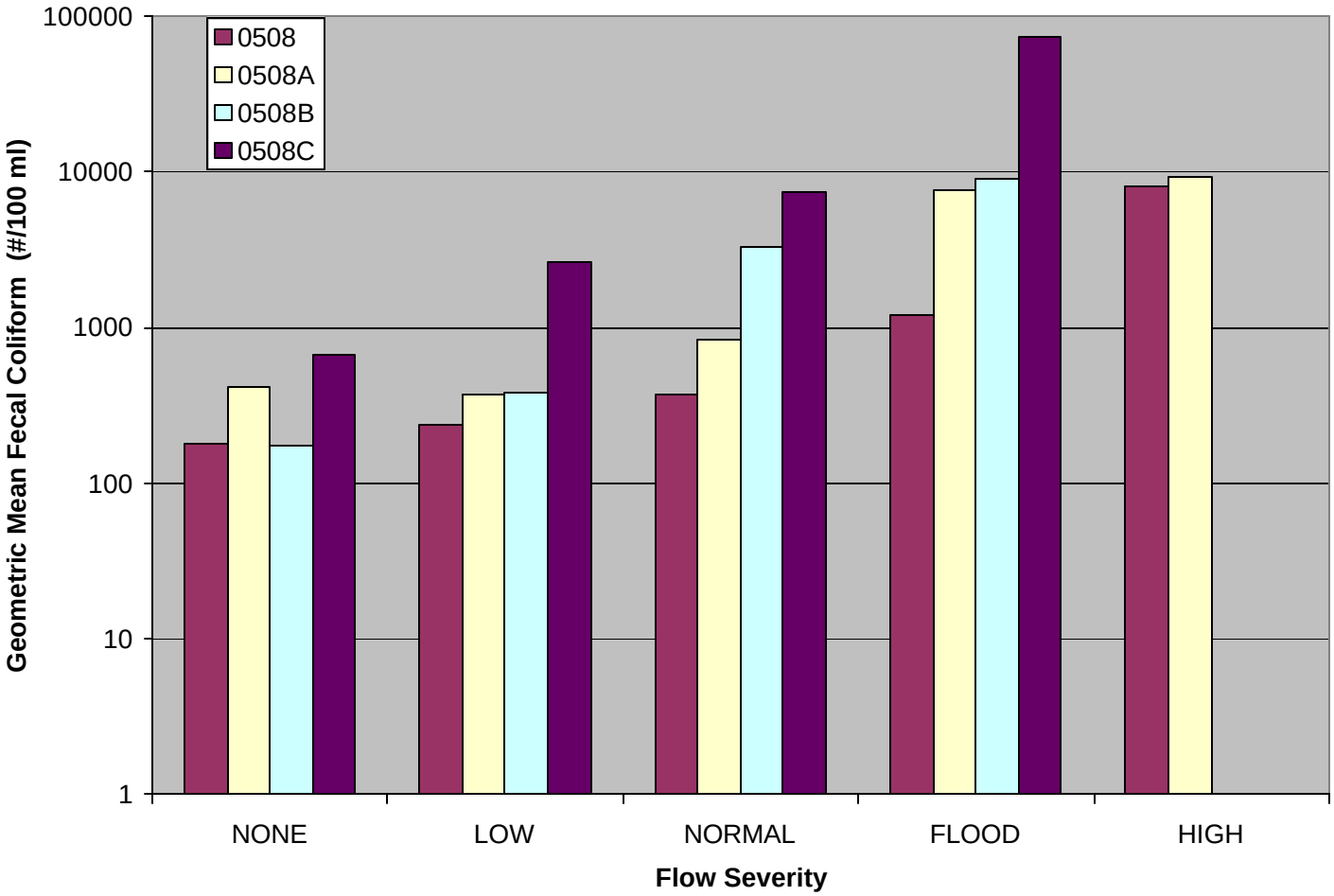


Figure 4.4 Fecal Coliform vs. Flow Severity in Cow Bayou and Tributaries, 1969 - 2002

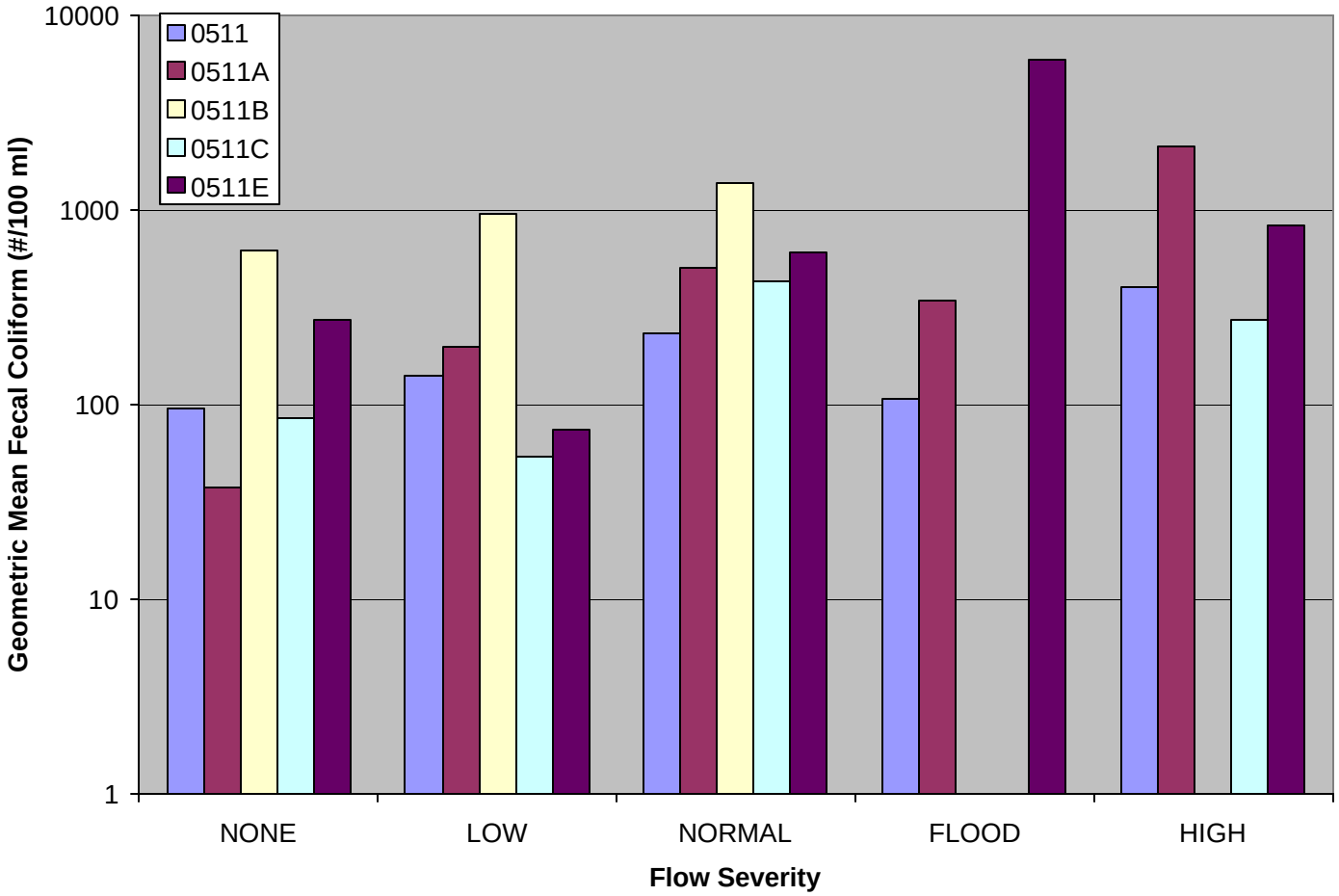


Figure 4.5 Seasonal Variations in Fecal Coliform Concentrations at Long-Term Monitoring Stations in Adams and Cow Bayous, 1969 - 2002

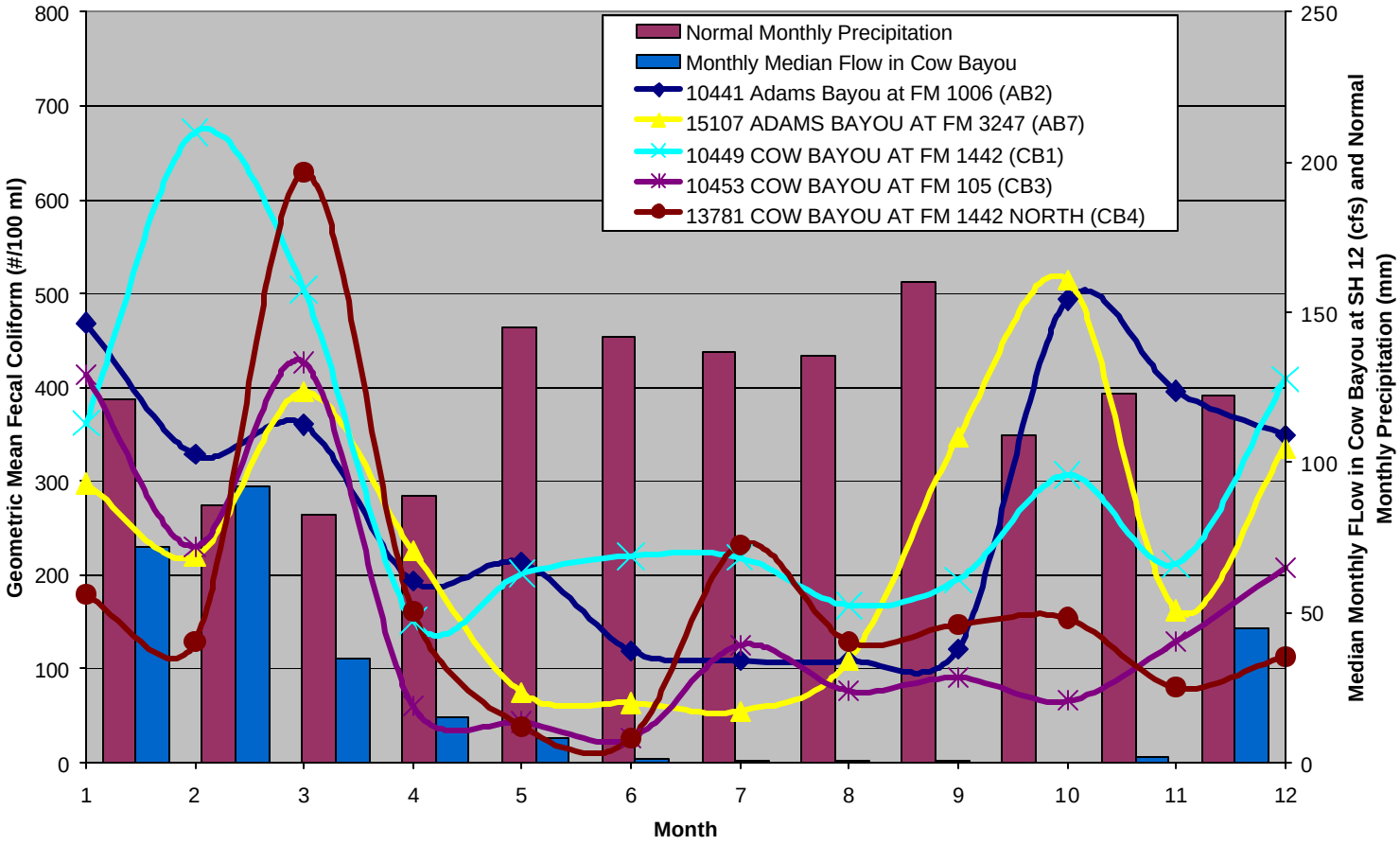


Figure 4.6 Temporal Trends in Fecal Coliform Concentrations at Long-Term Monitoring Stations of Adams and Cow Bayous

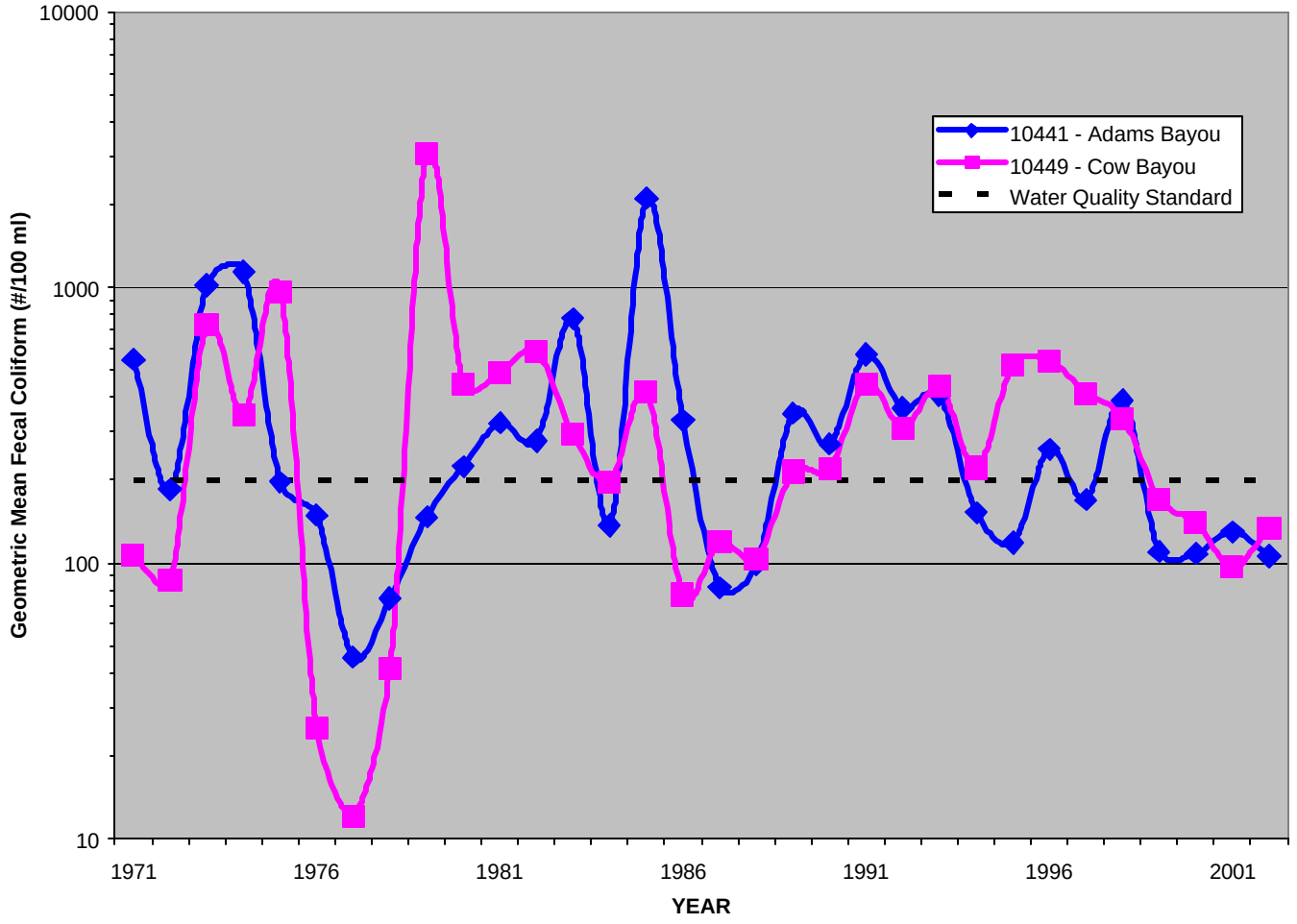


Figure 4.7 Spatial Trends in Dissolved Oxygen Concentrations in Adams Bayou and Tributaries: Most Recent Five Year Period

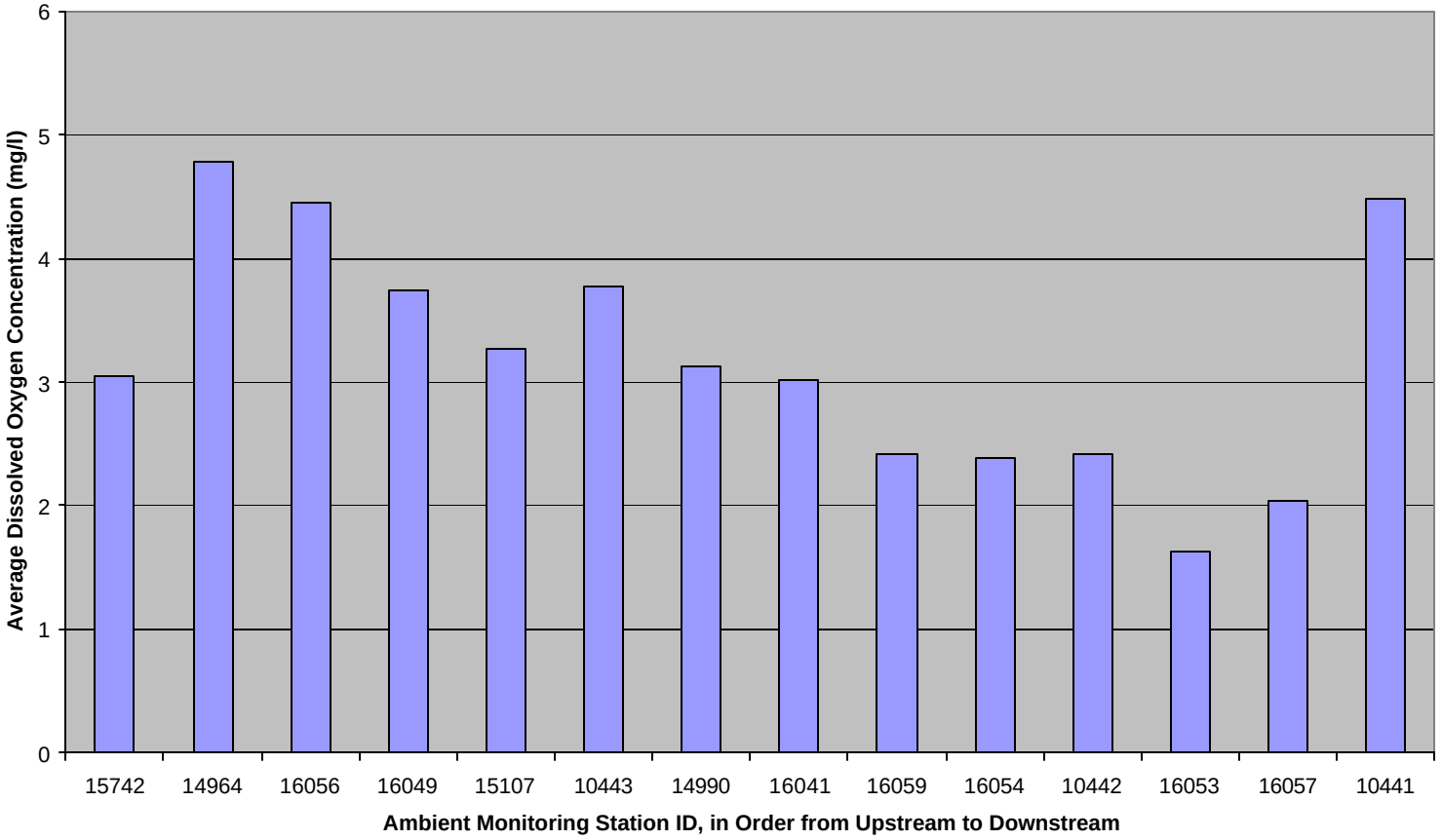


Figure 4.8 Spatial Trends in Dissolved Oxygen Concentrations in Cow Bayou and Tributaries: Most Recent Five Year Period

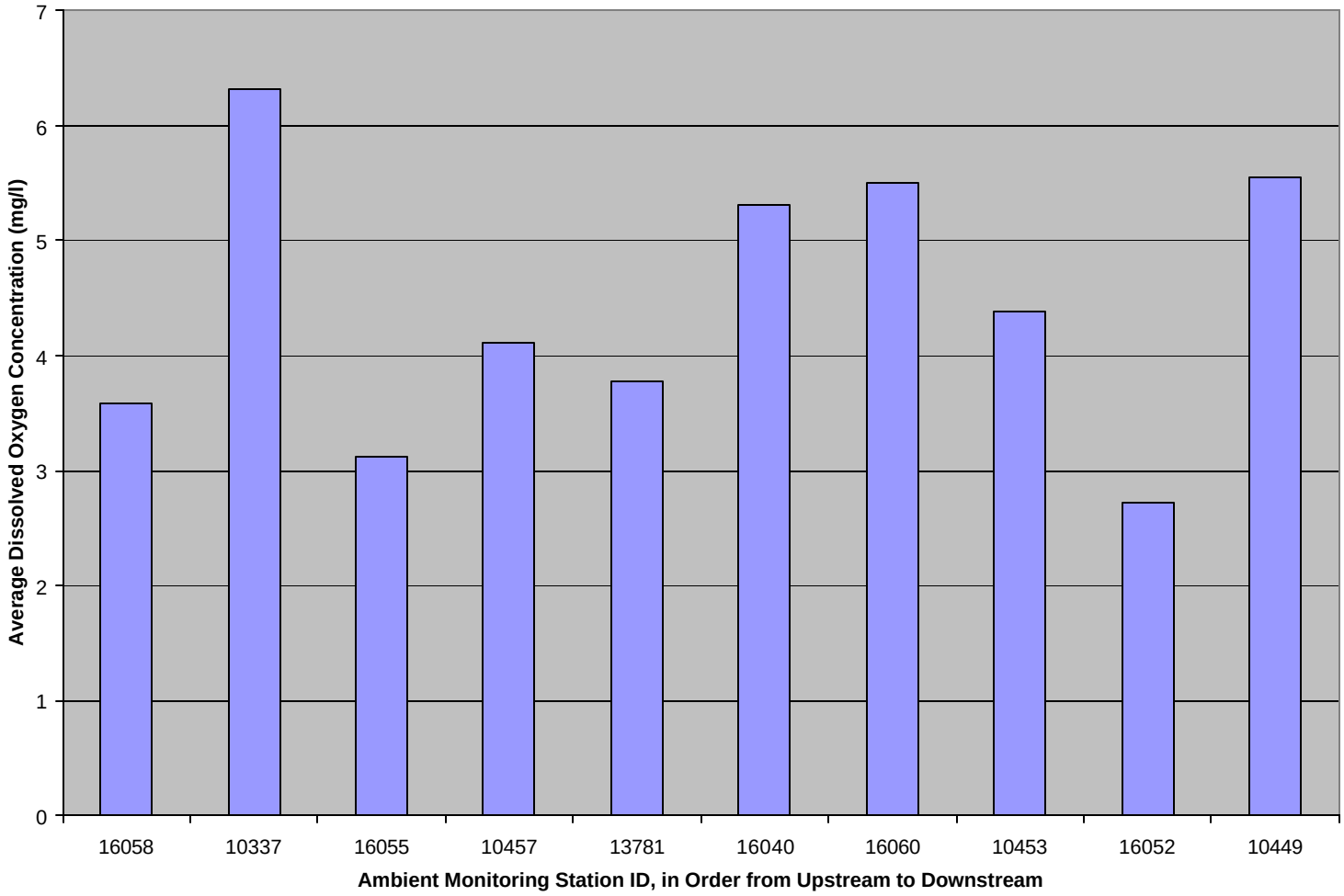


Figure 4.9 Dissolved Oxygen vs. Flow Severity in Adams Bayou and Tributaries, 1969 - 2002

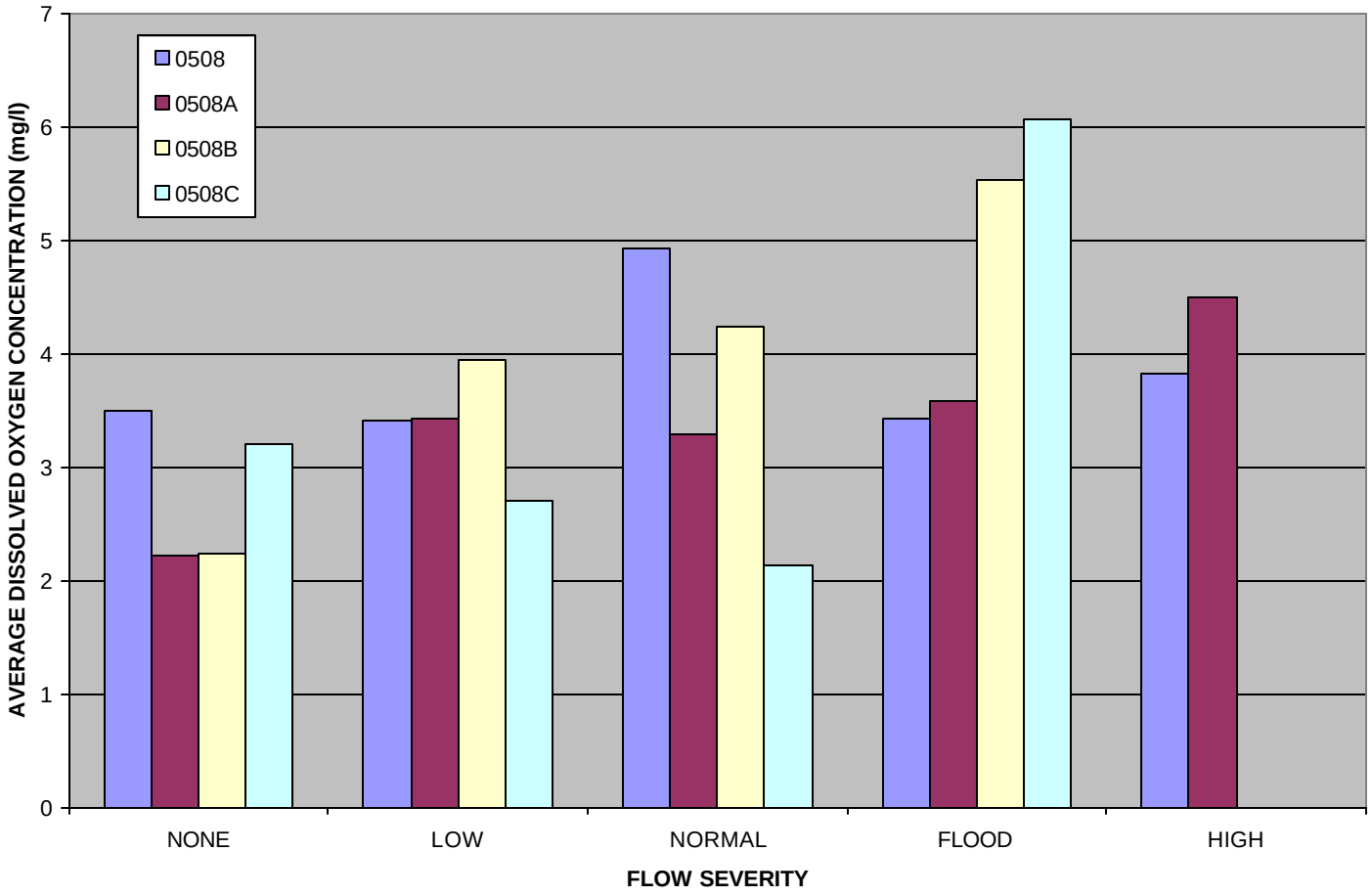


Figure 4.10 Dissolved Oxygen vs. Flow Severity in Cow Bayou and Tributaries, 1969 - 2002

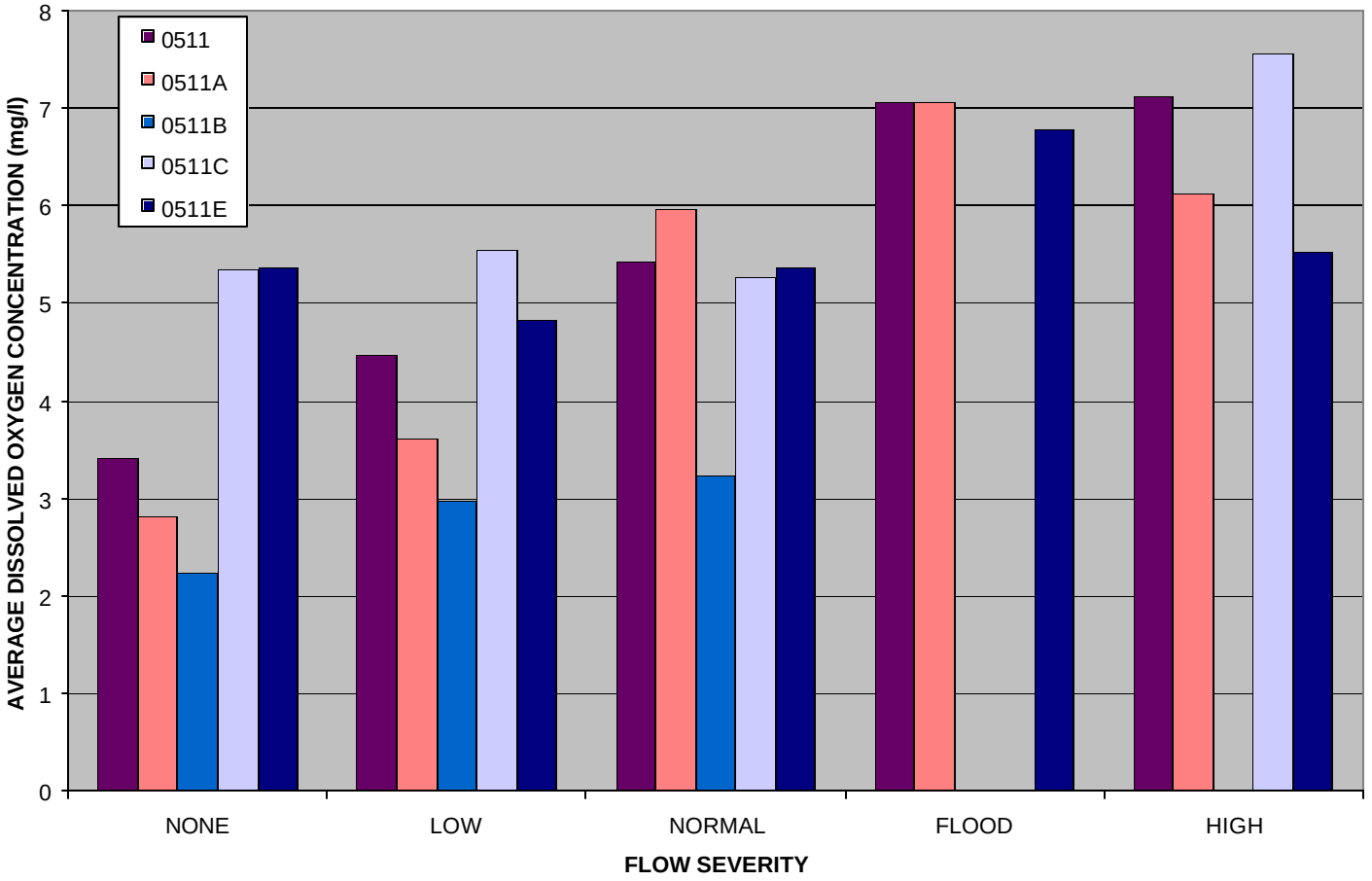


Figure 4.11 Seasonal Variations in Dissolved Oxygen Concentrations at Long-Term Monitoring Stations in Adams and Cow Bayous, 1969 - 2002

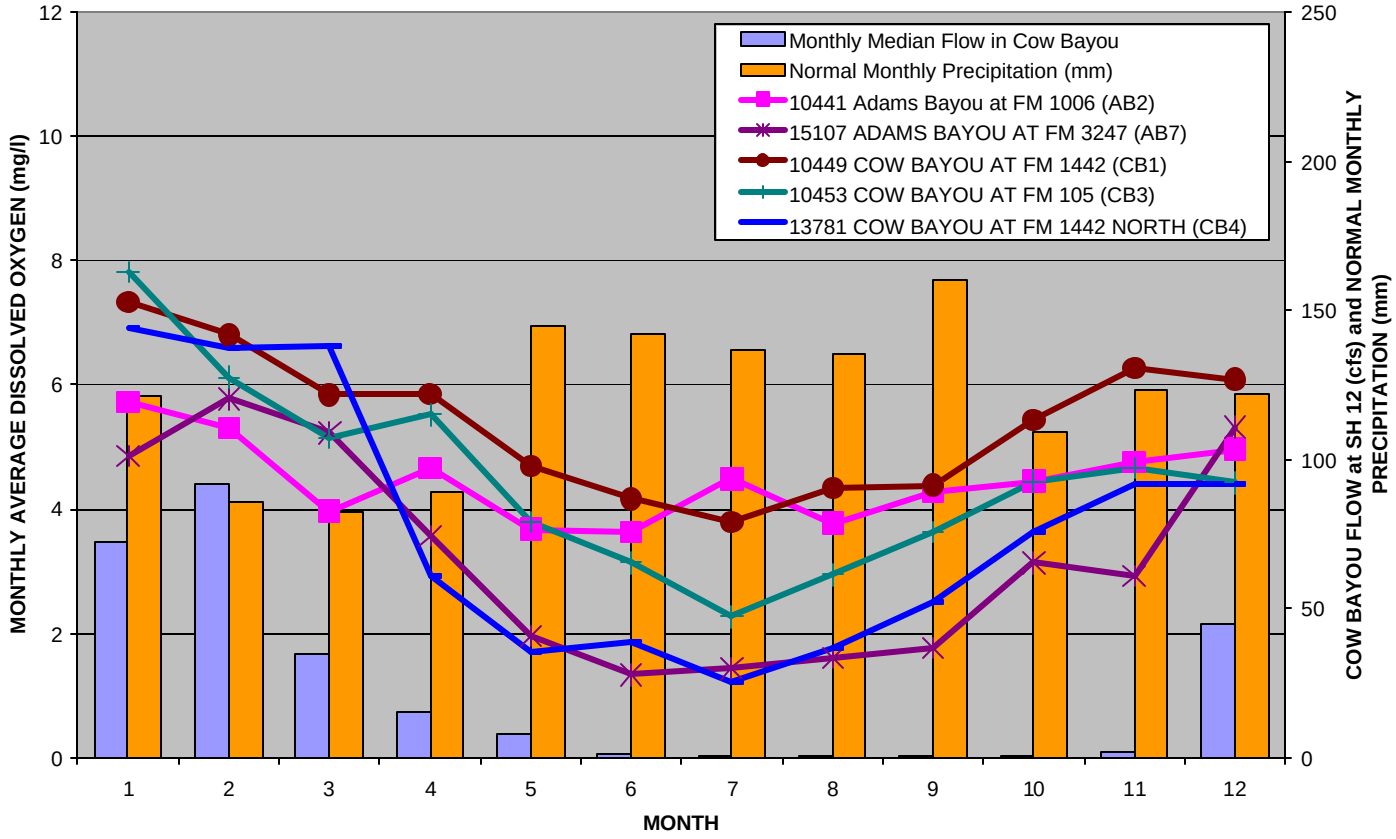


Figure 4.12 Temporal Trends in Dissolved Oxygen Concentrations at Long-Term Monitoring Stations of Adams and Cow Bayous

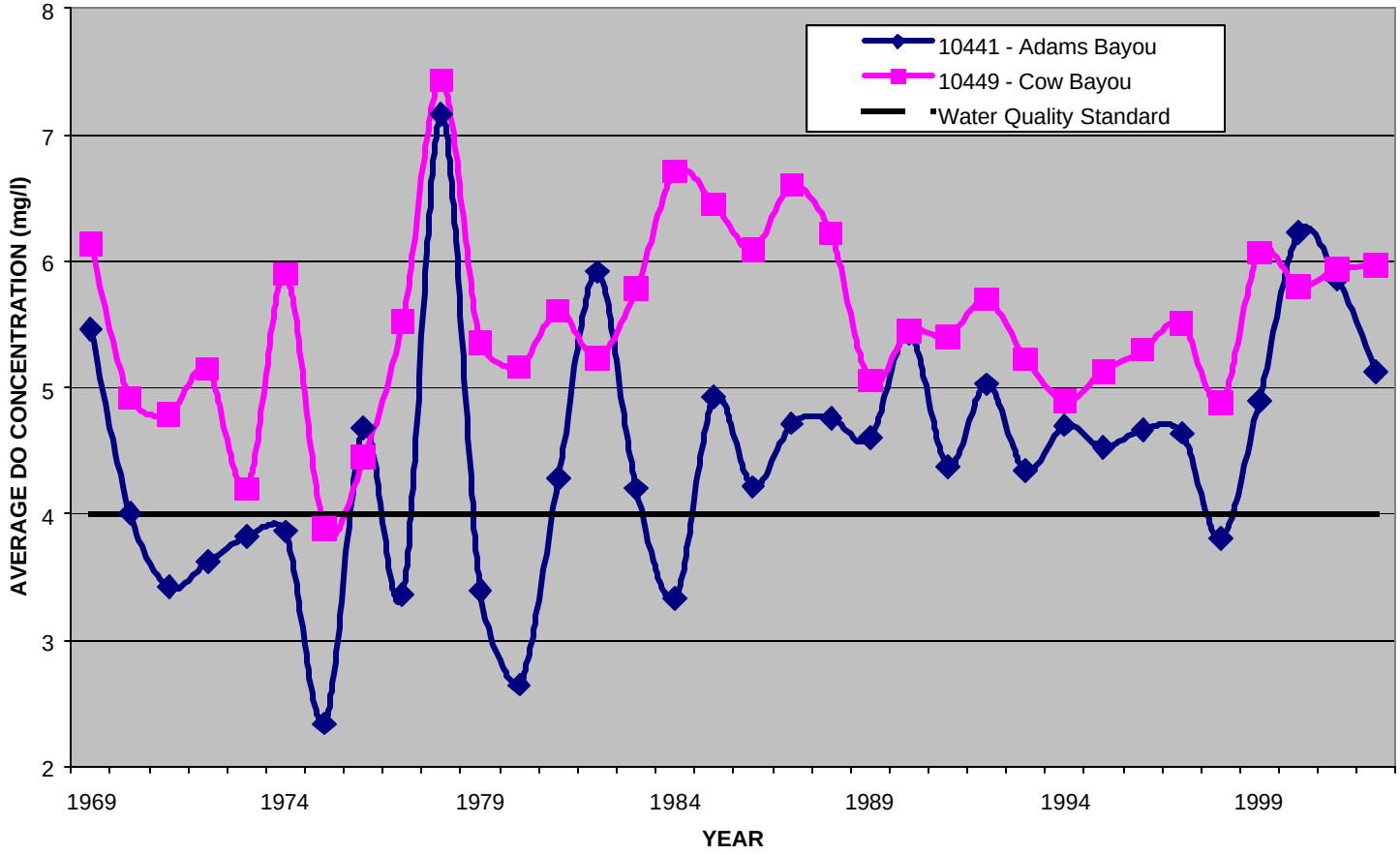


Figure 4.13 Spatial Trends in pH in Adams Bayou and Tributaries: Most Recent Five Year Period

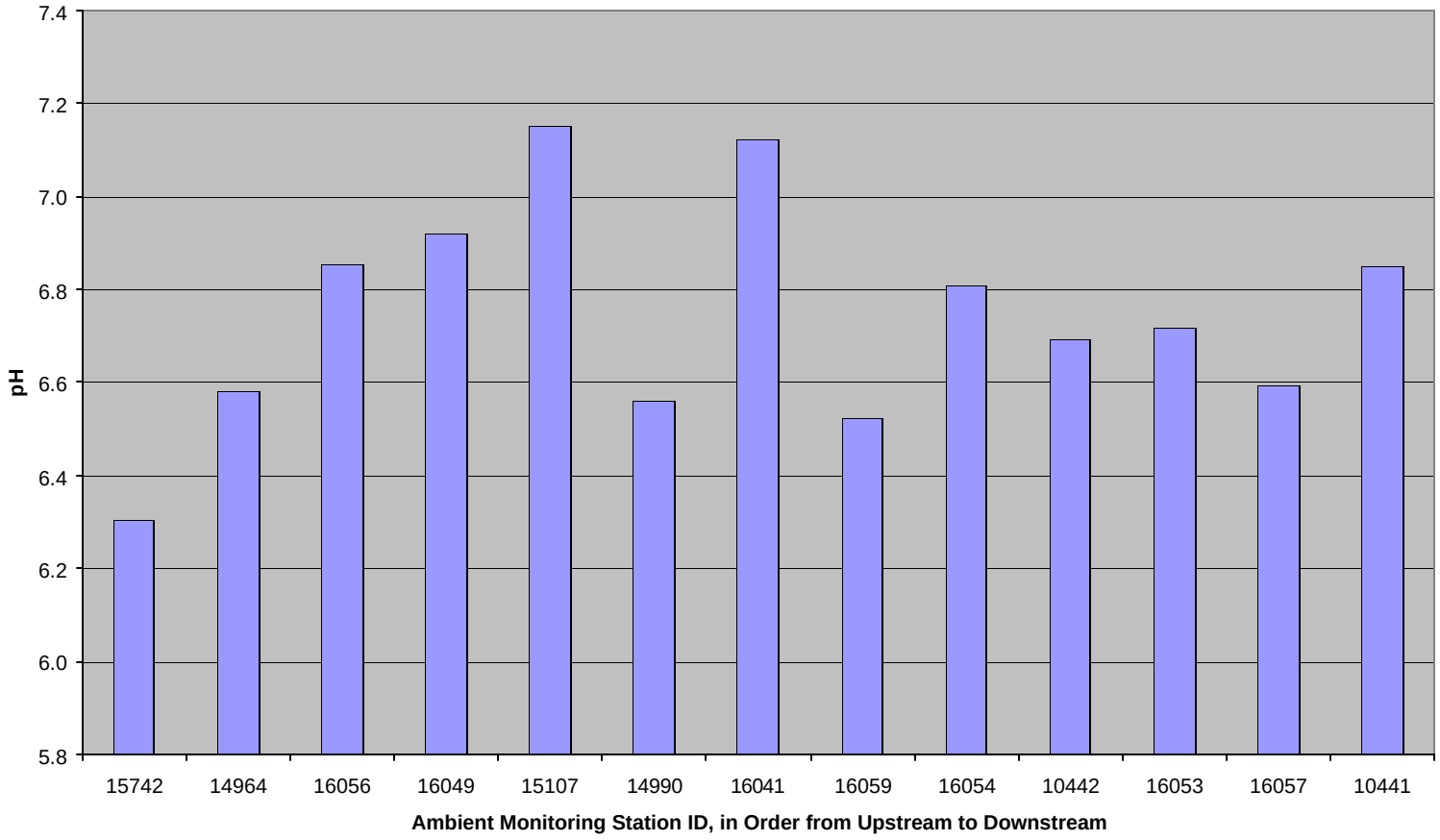


Figure 4.14 Spatial Trends in pH in Cow Bayou and Tributaries: Most Recent Five Year Period

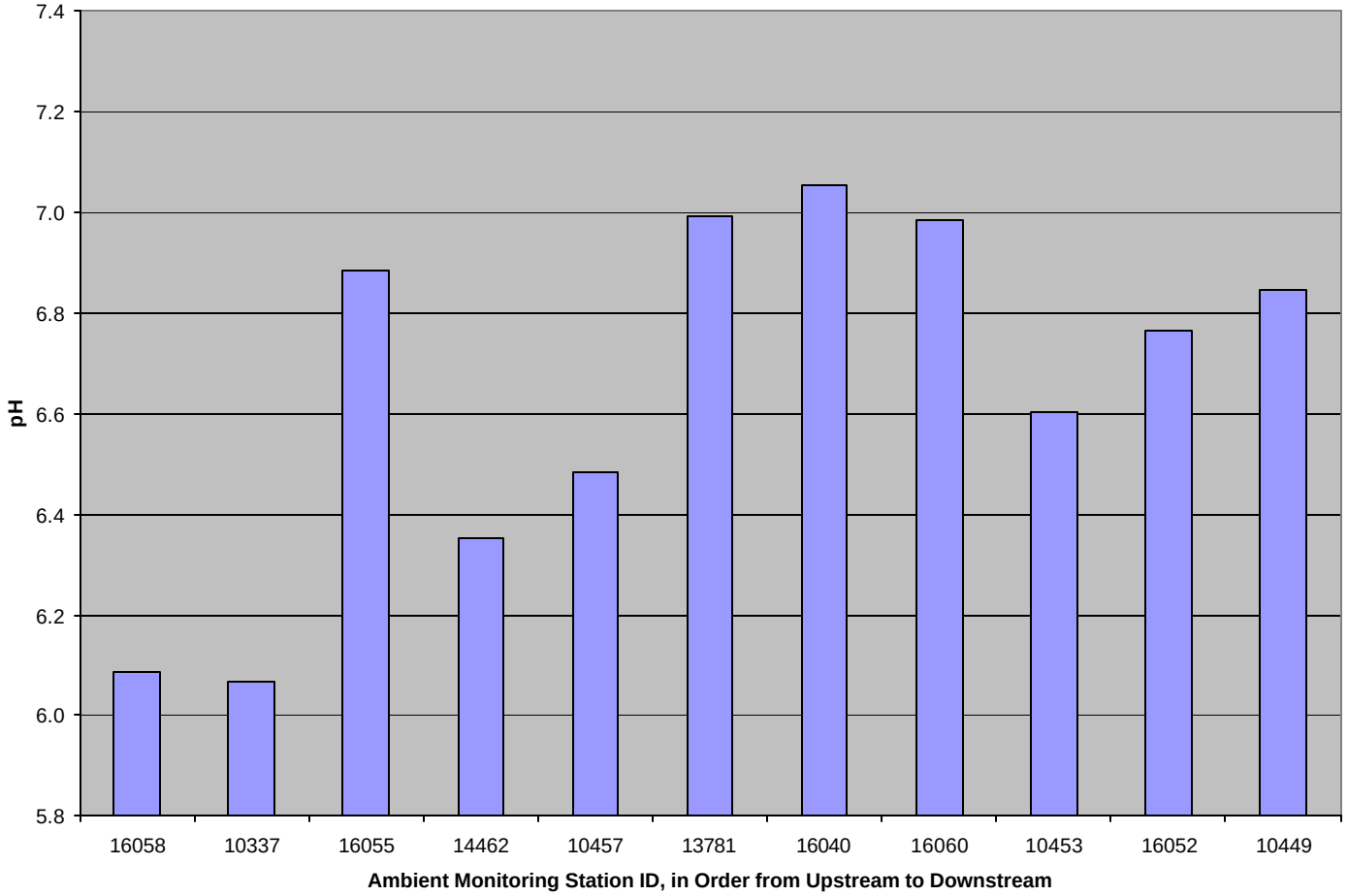


Figure 4.15 pH vs. Flow Severity in Adams Bayou and Tributaries, 1969 - 2002

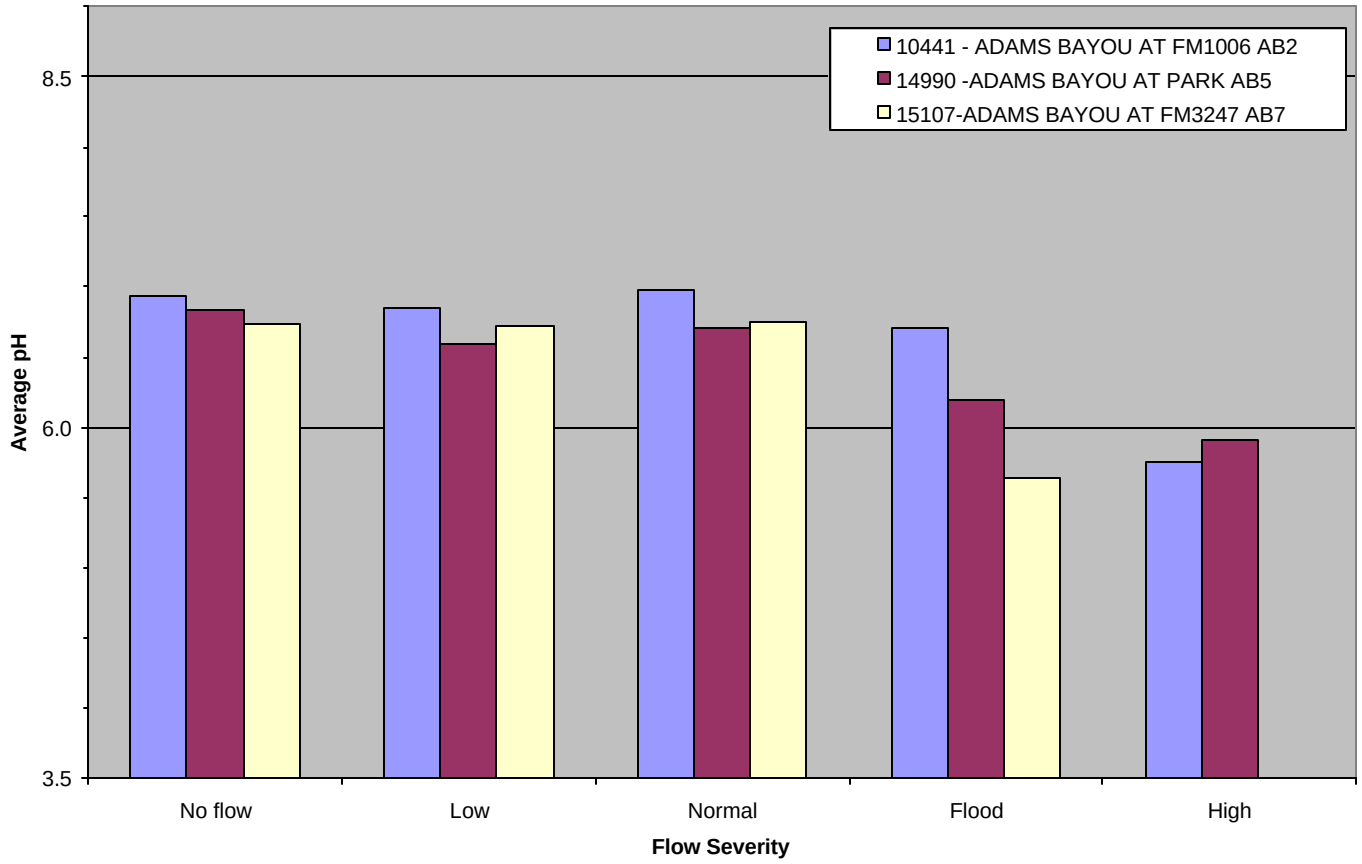


Figure 4.16 pH vs. Flow Severity in Cow Bayou and Tributaries, 1969 - 2002

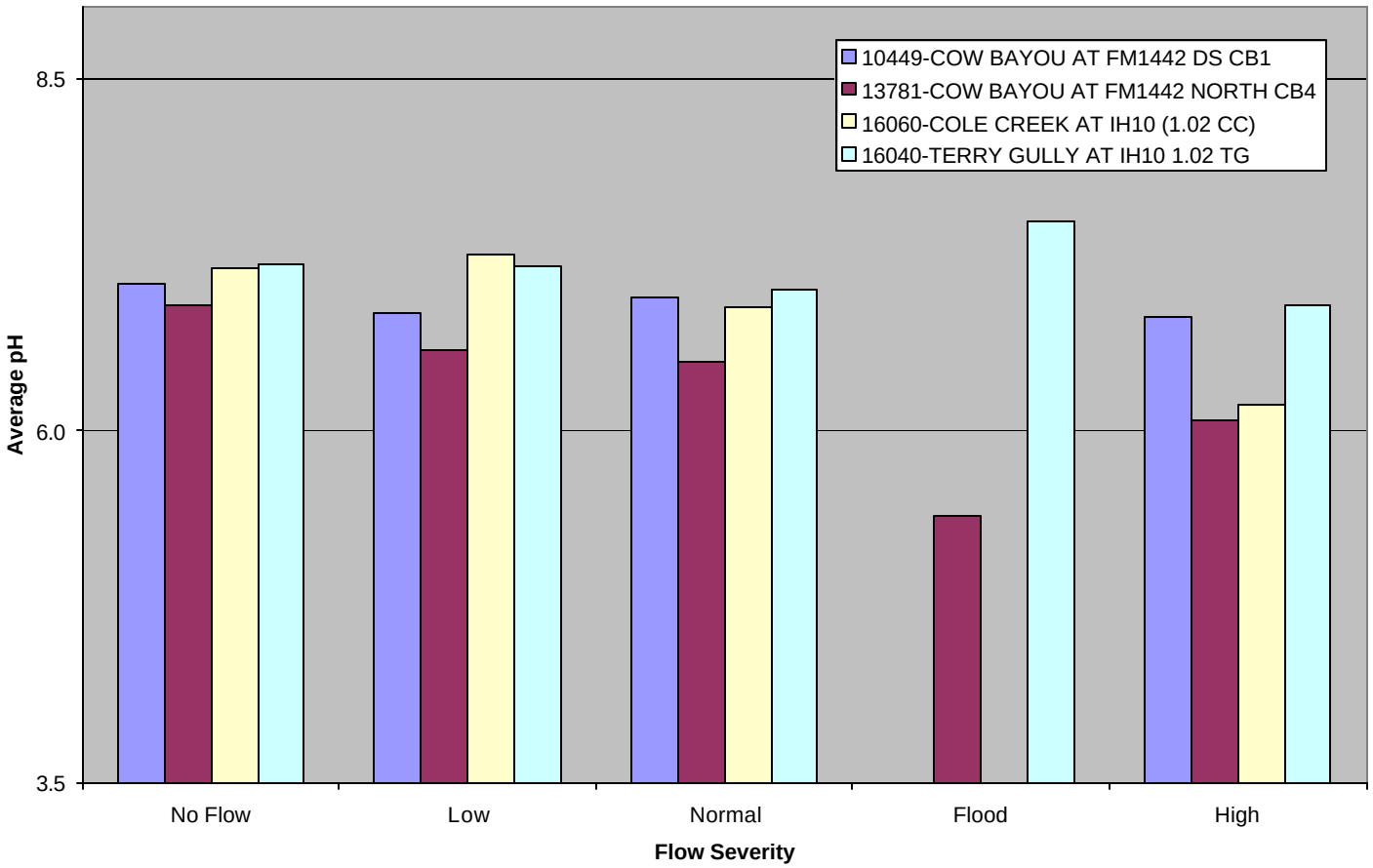


Figure 4.17 Seasonal Variation in pH at Long-Term Monitoring Stations in Adams and Cow Bayous, 1969 - 2002

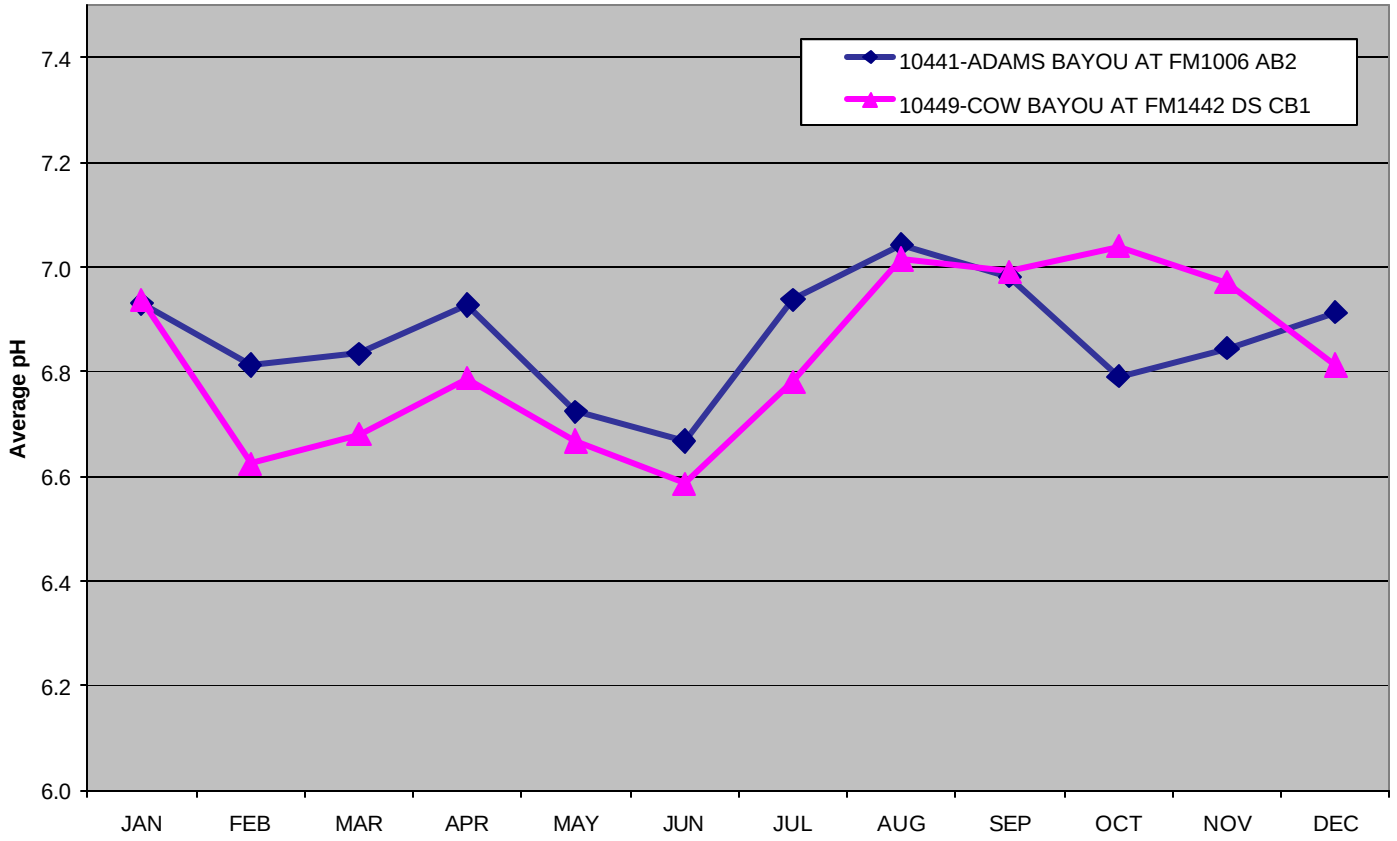


Figure 4.18 Temporal Trends in pH at a Long-Term Monitoring Station on Adams Bayou

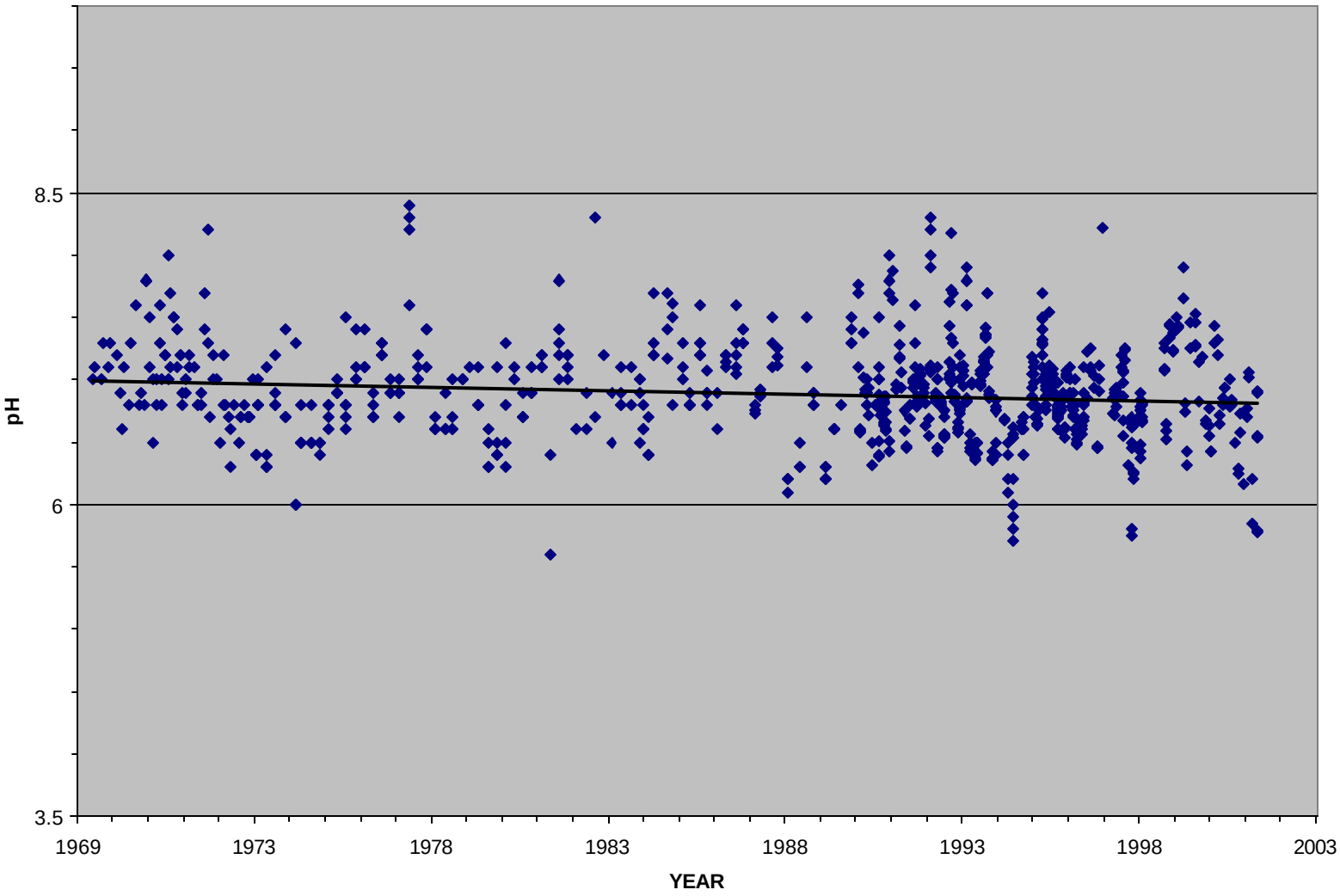


Figure 4.19 Temporal Trends in pH at a Long-Term Monitoring Station on Cow Bayou

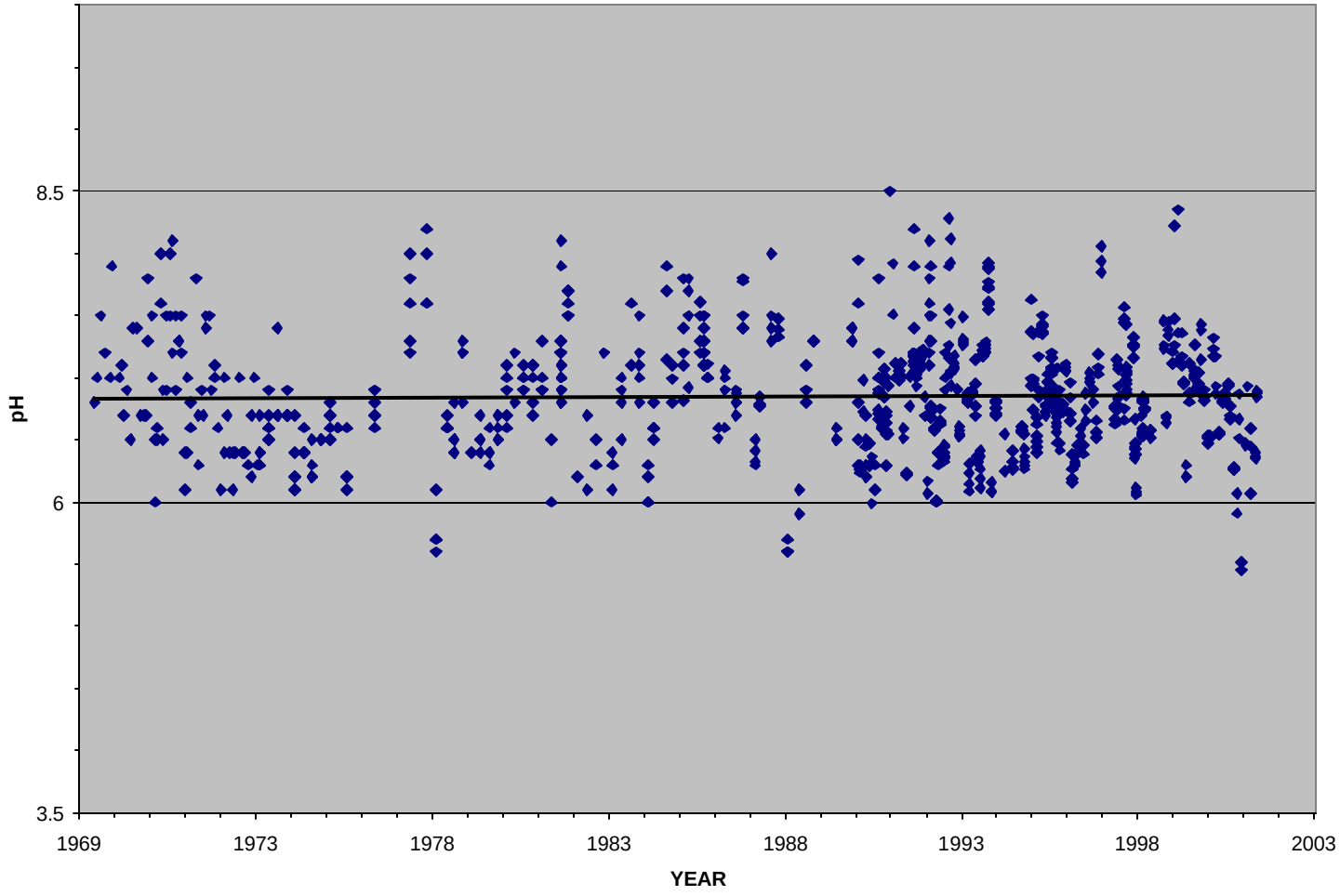


Figure 4.20 Dissolved Organic Carbon in Cow Bayou During Two Intensive Surveys

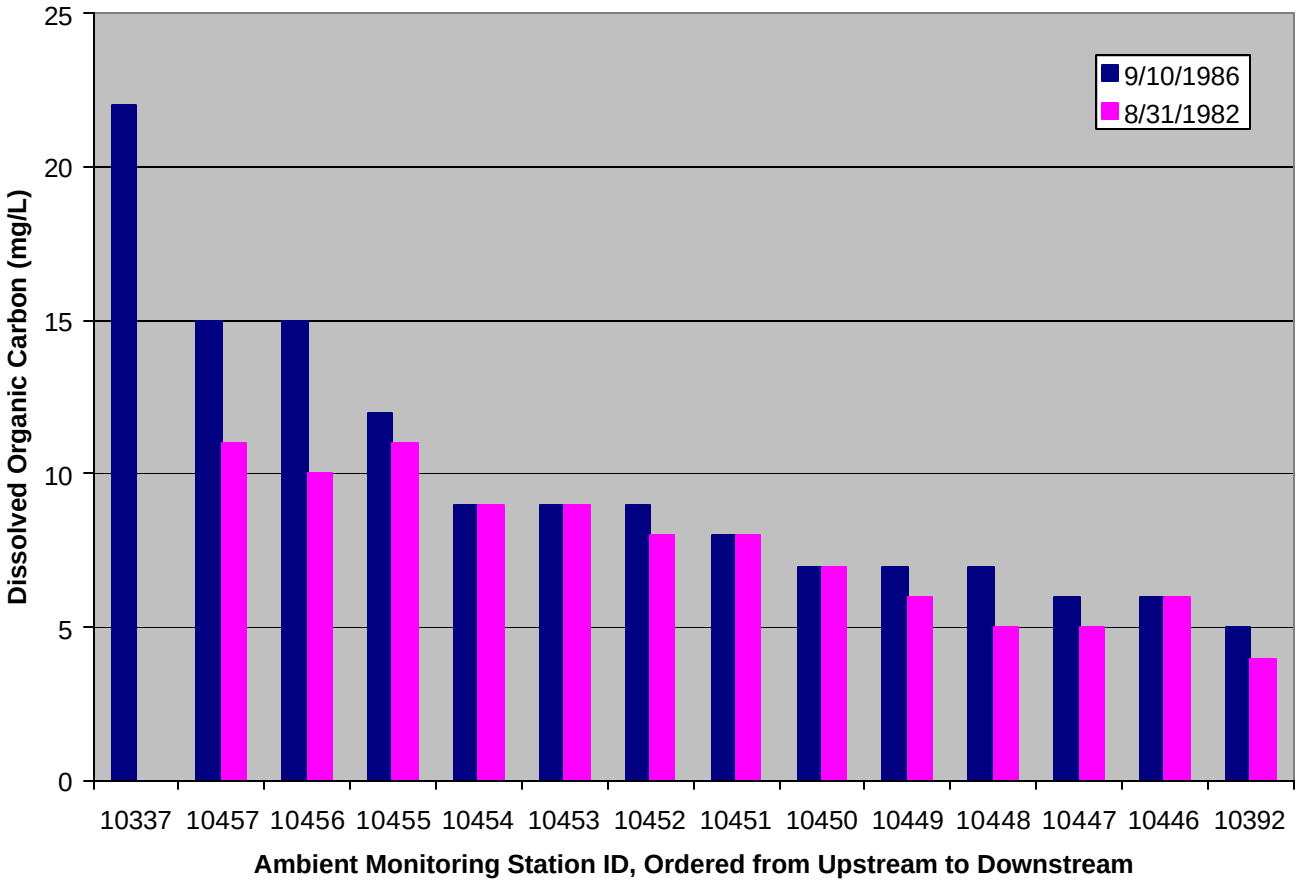


Figure 4.21 Spatial Trends in Total Organic Carbon in Adams Bayou and Tributaries

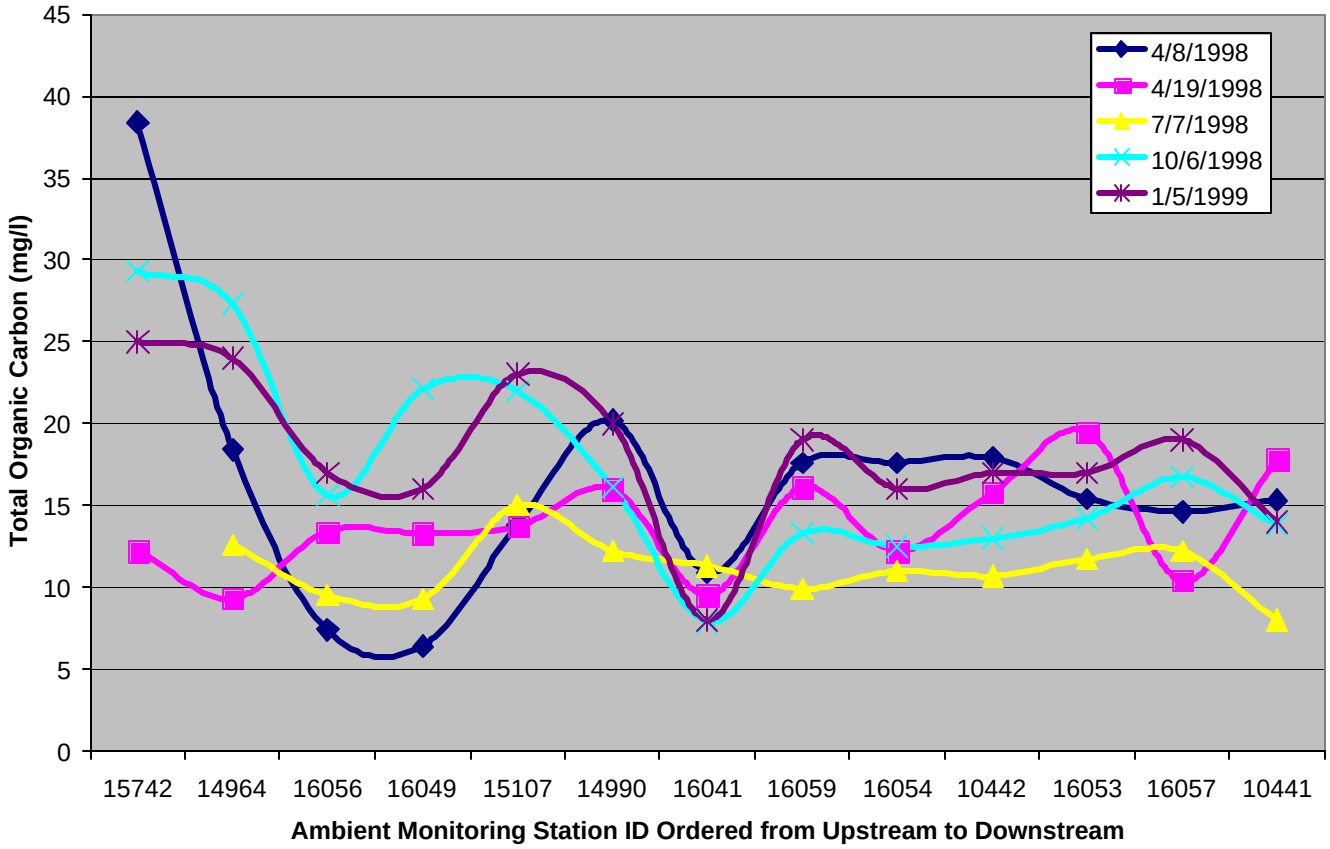


Figure 4.22 Spatial Trends in Total Organic Carbon in Cow Bayou and Tributaries

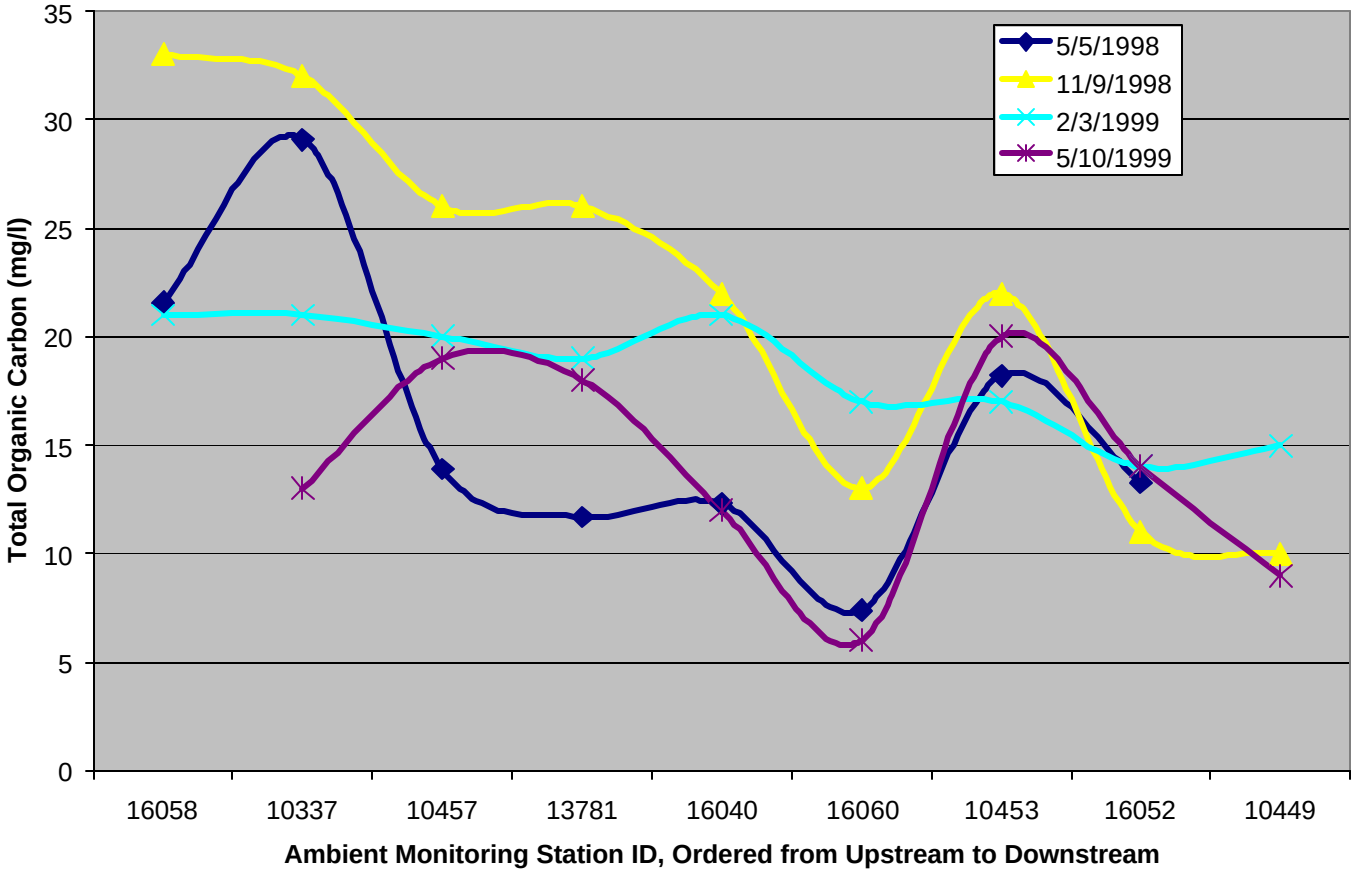


Figure 4.23 Spatial Trends in Total Suspended Solids in Cow Bayou and Tributaries

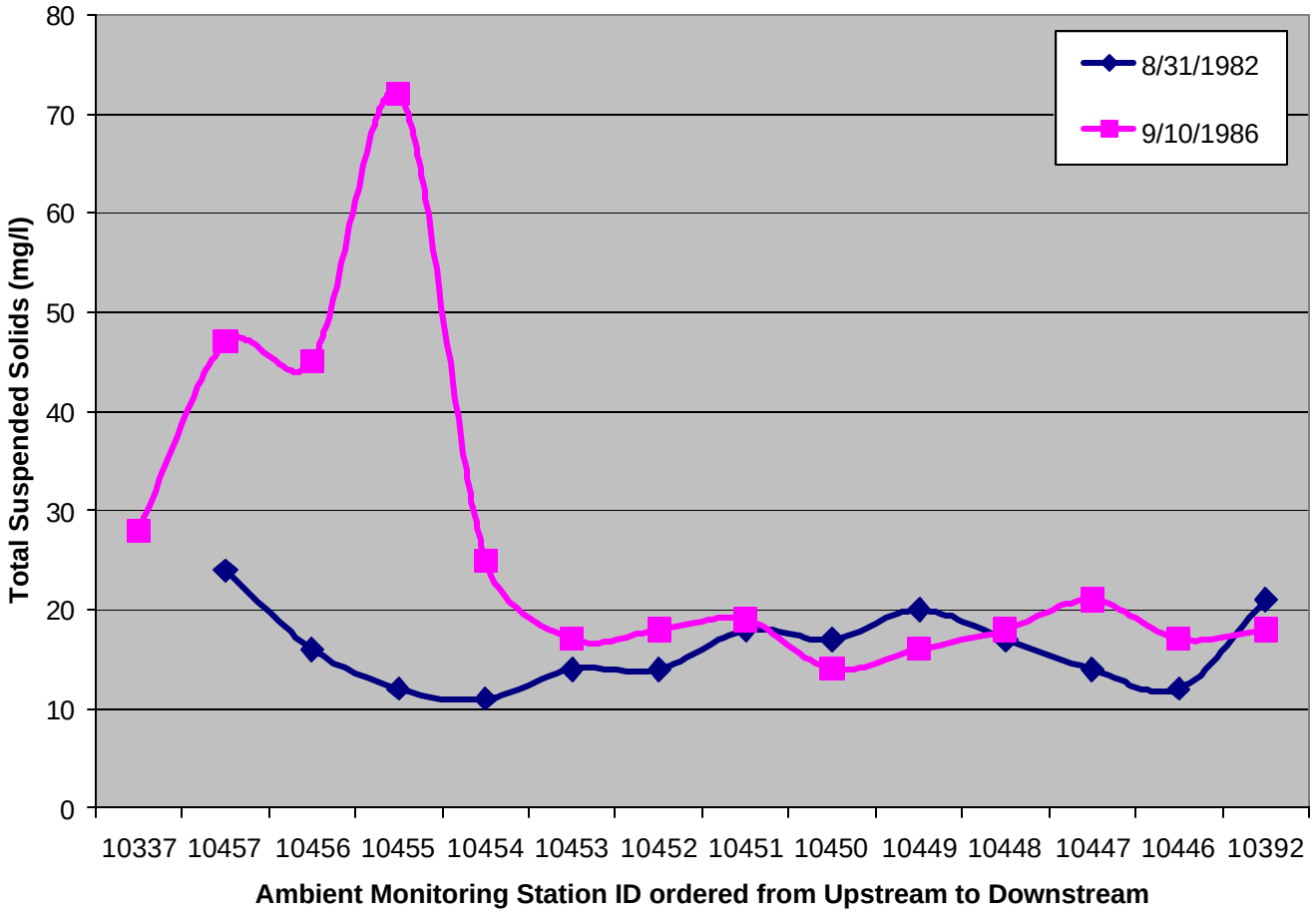


Figure 4.24 Spatial Trends in Nutrient Concentrations in Cow Bayou, August 31, 1982

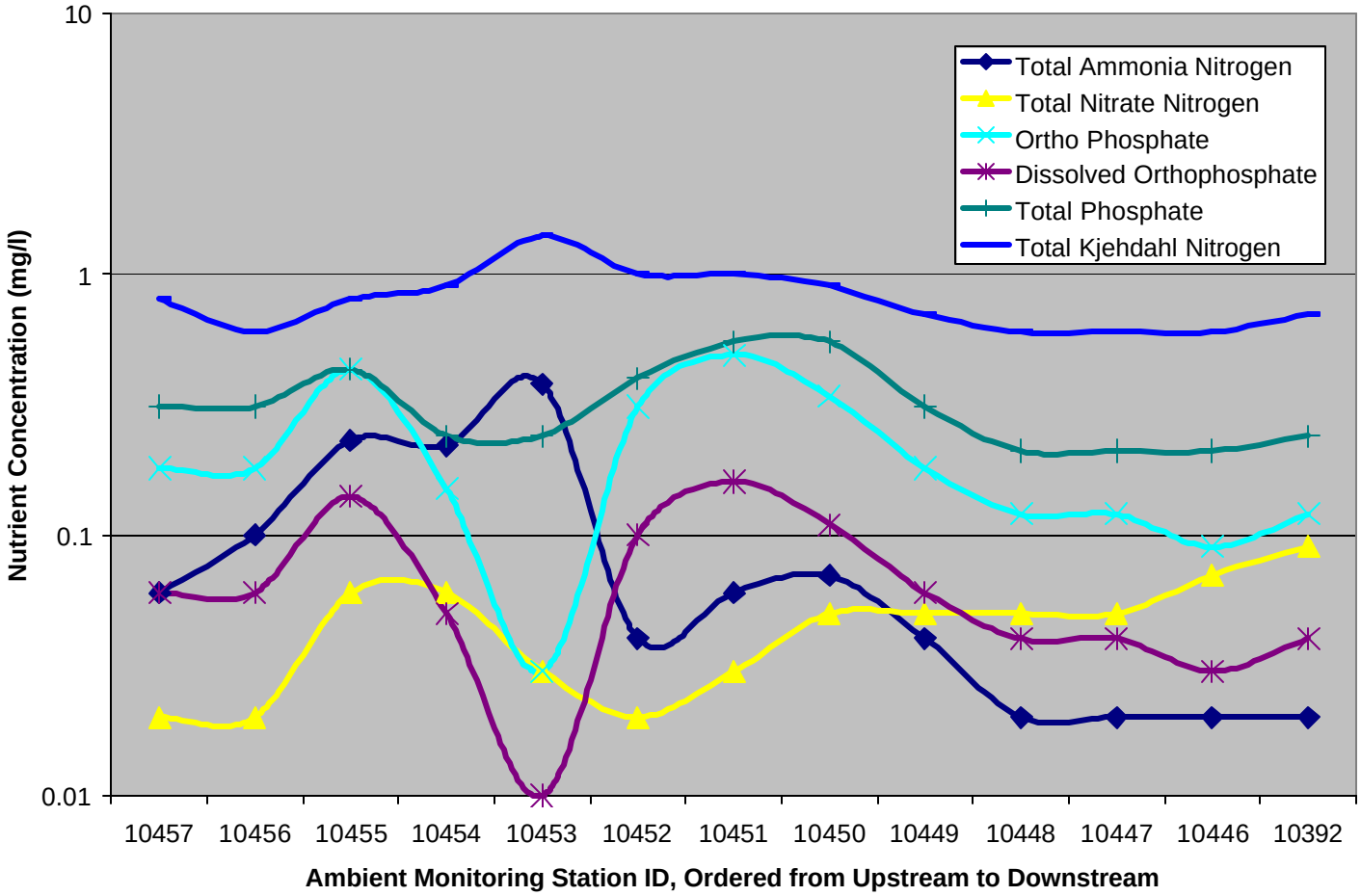


Figure 4.25 Spatial Trends in Nutrient Concentrations in Cow Bayou, September 10, 1986

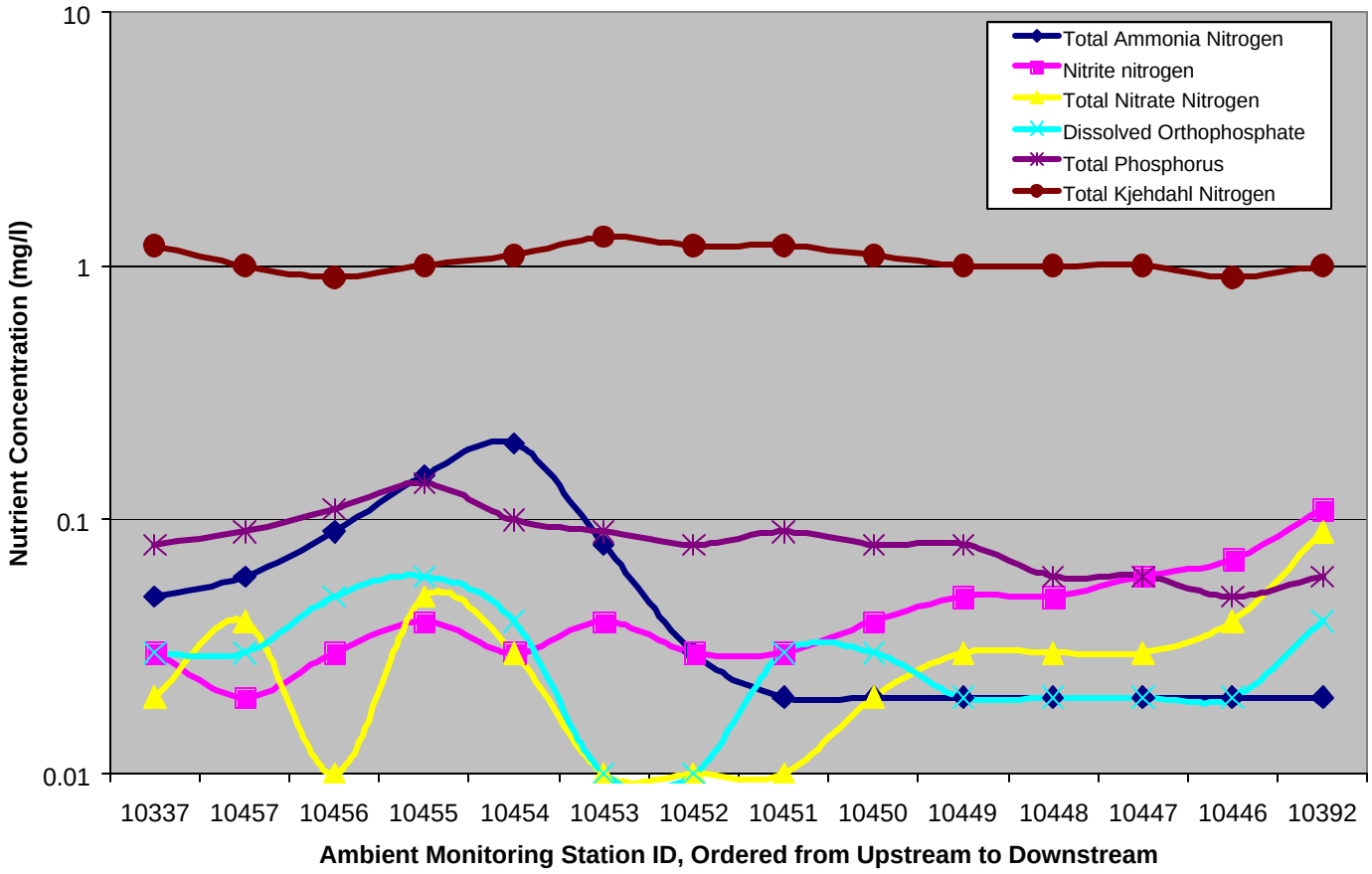


Figure 4.26 Spatial Trends in Nutrient Concentrations in Cow Bayou, May 5, 1998

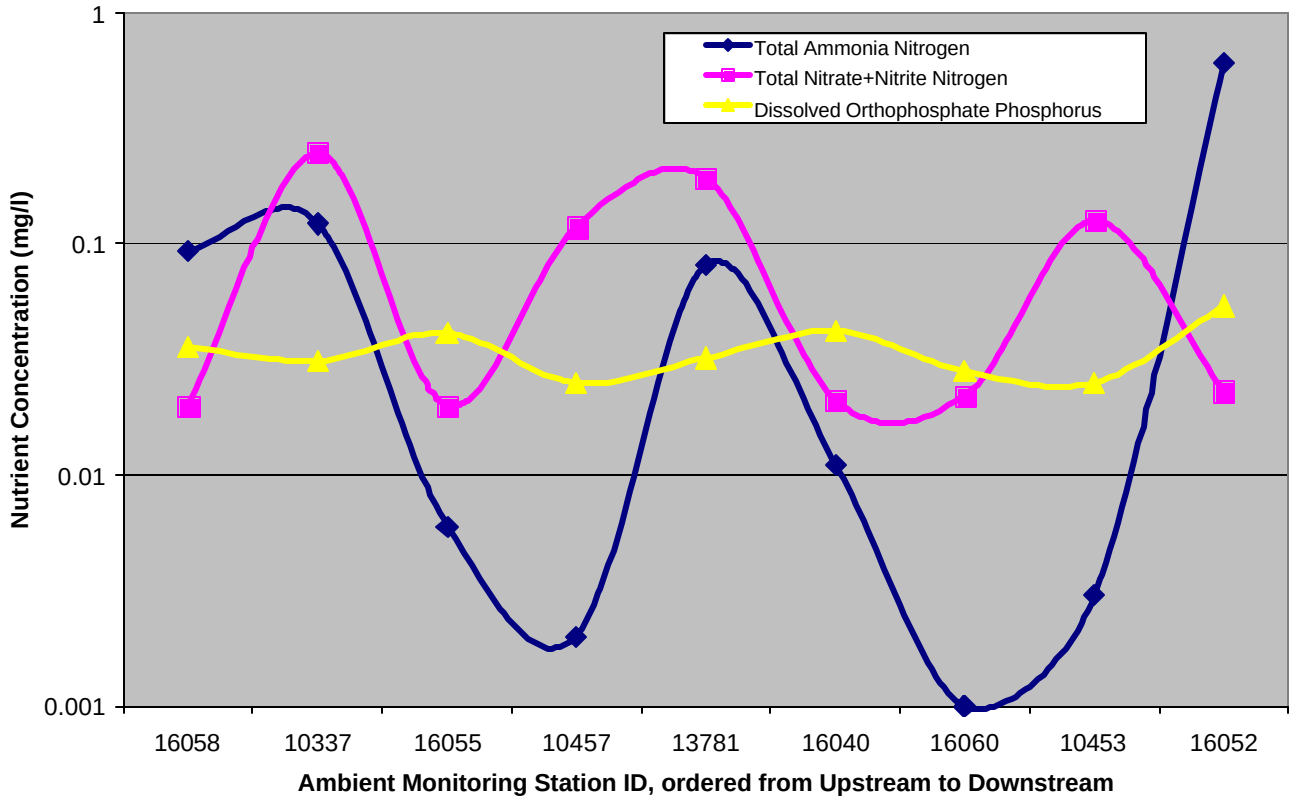


Figure 4.27 Spatial Trends in Nutrient Concentrations in Adams Bayou, April 8, 1998

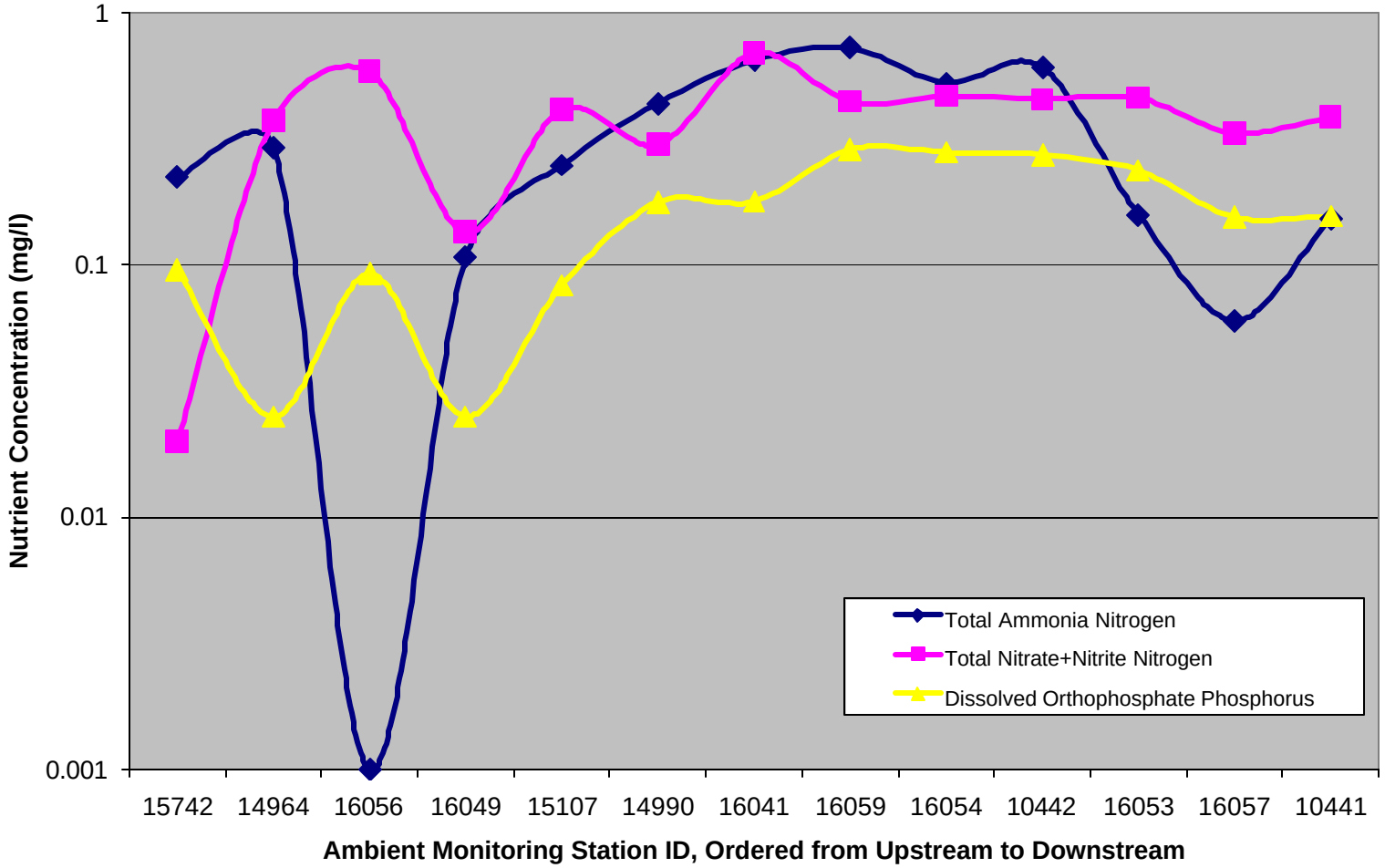
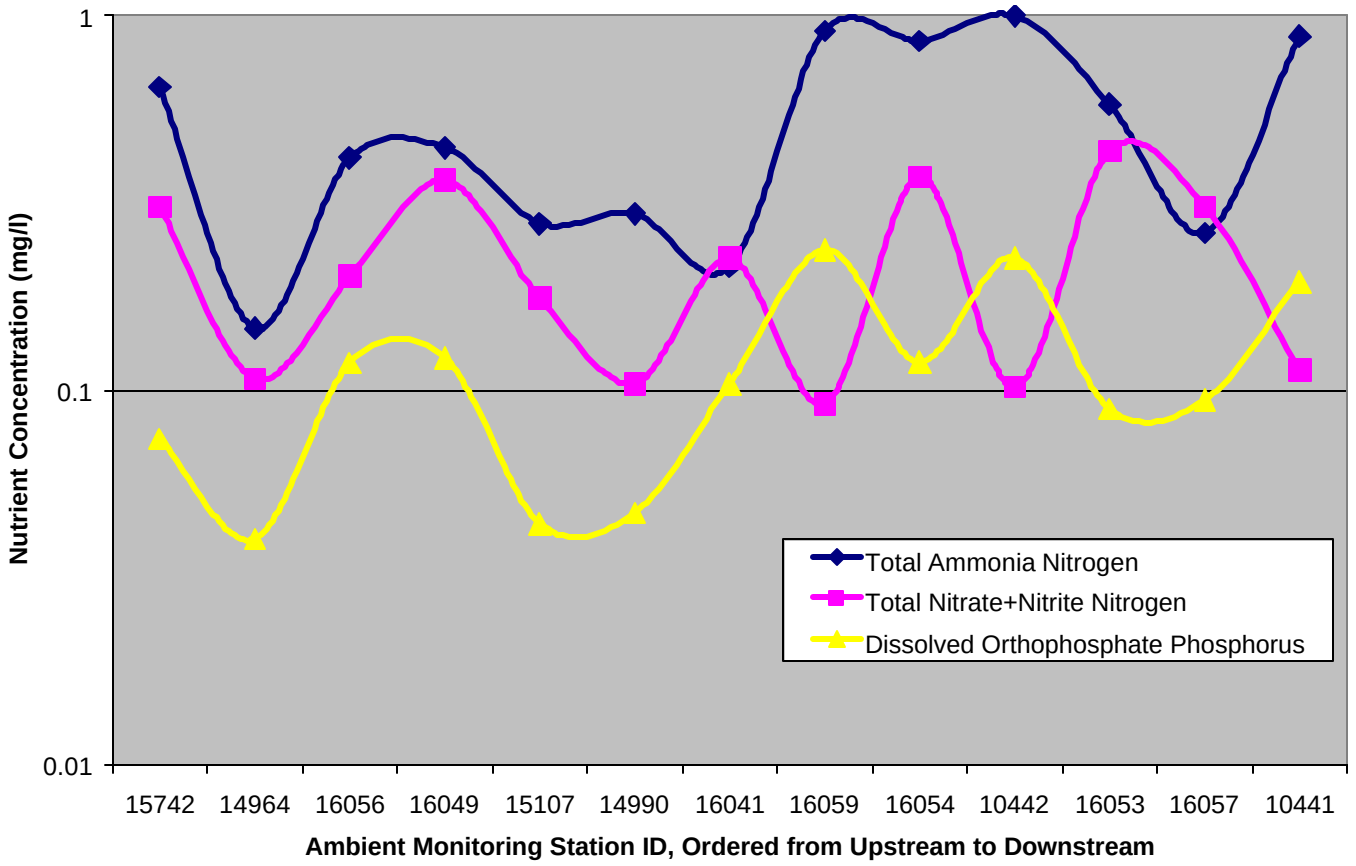


Figure 4.28 Spatial Trends in Nutrient Concentrations in Adams Bayou, April 19, 1998



SECTION 5
POLLUTANT SOURCES

Pollutant sources are typically divided into two categories: point and nonpoint. Point sources of pollutants typically enter a water body at a wastewater outfall, or pipe, and are subject to specific permitting and monitoring requirements. Nonpoint sources of pollutants typically enter a water body at diffuse points, including direct overland runoff and through storm drains. The quantity and types of nonpoint source pollutants are poorly understood and seldom monitored. Permit requirements for nonpoint sources are typically technology-based, and are not covered by specific effluent limits.

5.1 POINT SOURCE EVALUATION

There are currently five point source wastewater discharges to Adams Bayou from four facilities (Table 5.1). Of these, three facilities are public sewage treatment plants with a total permitted discharge of approximately 8.75 MGD. The lone industrial facility is permitted to discharge only approximately 0.01 MGD of process wastewater and storm water, on average. Actual reported discharges totaled approximately 9.1 MGD in 2000, the latest year for which complete reports are available. The locations of the wastewater discharges are primarily in the lower reaches of the bayou (Figure 5.1).

In Cow Bayou, there are currently twenty point source wastewater discharges from fifteen facilities (Table 5.2). The total permitted industrial and domestic wastewater discharges are approximately 9.1 and 2.3 MGD, respectively. Actual reported discharges totaled approximately 10.5 MGD in the year 2000. The City of Bridge City and Jasper County Water Control and Improvement District (WCID) #1 are the only sewage treatment plant discharges of greater than 0.1 MGD. Chevron, Honeywell, Firestone, and Bayer all have major industrial wastewater discharges to Cow Bayou. The major wastewater discharges are primarily located in the lower reaches of the bayou (Figure 5.2), though smaller discharges are scattered along the bayou.

Total point source BOD and TSS loading to Adams Bayou appears to have averaged approximately 170 and 390 lbs/day, respectively, in recent years, based on self-reported effluent quality data collected by the dischargers (Table 5.3). Total point source BOD and TSS loading to Cow Bayou totaled approximately 280 and 835 lbs/day, respectively (Table 5.4).

Table 5.5 shows the exceedance rates of permit effluent quality limits for wastewater discharges to Adams and Cow Bayous. The permit exceedance rate represents the percentage of effluent quality reports in which one or more permit limits were not met. These permit exceedance rates ranged from 1 percent to 78 percent. Exceedance of permit limits is one possible reason why water quality criteria would not be met in Adams and Cow Bayous.

As noted in Section 4, the dissolved oxygen, fecal coliform, and pH impairments tend to be more pronounced in the middle and upper reaches of the classified segments of Adams and Cow Bayous, as well as in tributaries. However, the major wastewater discharges are located

in the lower reaches of Adams and Cow Bayou near the Sabine River. Some have questioned whether the tidal ebb carries the discharged effluents upstream, thereby contributing to the observed impairments. Water quality monitoring personnel have in fact frequently observed water moving upstream (reverse flow) in tidal portions of these bayous, particularly when freshwater flow from non-tidal streams is low or non-existent. Also, dissolved oxygen criteria exceedances are more frequent under these low flow conditions, though pH and fecal coliform criteria exceedances are not. However, profiles of nutrients, TSS, TOC, and DOC do not indicate high levels of these substances in the vicinity of the major wastewater discharges that could serve as a major source of pollutants to upstream reaches.

5.2 NONPOINT SOURCE EVALUATION

Some potential nonpoint source sub-categories include treatment plant bypasses, sewer overflows, urban runoff, malfunctioning septic tanks, livestock and pet wastes, urban runoff, wildlife waste, and other natural loadings. The relative importance of some of these sub-categories was evaluated during the 1980 -1981 Southeast Texas Nonpoint Source Study (Section 3.1). At that time, urban runoff was considered the most significant source of fecal coliforms, followed by sewer overflows, wastewater treatment plant bypasses, agricultural and rural runoff, and wastewater treatment plant discharges. Wastewater treatment plant effluents were considered the largest source of dissolved oxygen-depleting pollutants, followed by urban runoff, agricultural and rural runoff, wastewater treatment plant bypasses, and sewer overflows. Since the time of that study, changes in the sources have doubtless occurred. Permitted wastewater discharges have been more tightly controlled, and the frequency of sewer overflows and wastewater treatment bypasses has likely been reduced with the construction of new treatment plants. However, the population and developed area have increased slightly since that time. Also, new rural and suburban residential developments have been built that rely on septic tanks. The observed spatial pattern of fecal coliform abundance in water tends to corroborate the importance of urban runoff (or sewer overflows), as the small tributaries and laterals draining urbanized areas experience the highest levels.

5.2.1 Livestock Inventory

Livestock waste represents a potential nonpoint source of fecal coliform and oxygen demand to Adams and Cow Bayous. Fecal coliform bacteria reside in the gut of all warm-blooded animals, including mammals and birds. The abundance of livestock in the watersheds can be estimated from the county agricultural census data from 1997 (Table 5.6). Cattle are the major livestock species, followed by horses and poultry. Cattle are estimated to release approximately 100 billion fecal coliform each day per animal. Other fecal coliform production rates include: horses: 400 million/day; pigs: 11 billion/day; chickens: 1.4 billion/day; turkey: 1 billion/day; ducks: 2.5 billion/day; sheep: 12 billion/day (ASAE 1998). Humans also produce fecal coliform at a rate of approximately two billion/day (Metcalf and Eddy 1991). With typical summertime flows of approximately 1 cfs (roughly 2.4 million liters per day), a fecal coliform loading equivalent to that produced from a single animal could cause exceedance of the criteria. Clearly, if much of the avian and mammalian fecal waste enters the bayou, water quality criteria will not be met.

Table 5.1 Active Wastewater Discharges to Adams Bayou and Some Relevant Effluent Limitations

TCEQ Permit No.	EPA Permit No.	Facility Name	Class	Permit Category	Extension	Flow (mgd) avg/max	Flow (gpm) 2hr peak
WQ0000337-000	TPDES0008281	A. Schulman, Inc. West Orange Carbon Black Plant	Minor	Industrial	OTFL 001 DOM	0.01/0.02	
WQ0000337-000	TPDES0008281	A. Schulman, Inc. West Orange Carbon Black Plant	Minor	Industrial	OTFL 002 SW/UW	x/0.04	
WQ0010240-001	TPDES0054810	Orange County WCID No. 2 West Orange Plant	Minor	Public Domestic	OTFL 001	1.22/x	2394
WQ0010597-001	TPDES0024171	City of Pinehurst WWTP	Minor	Public Domestic	OTFL 001	0.5/x	1042
WQ0010626-001	TPDES0073423	City of Orange Jackson St. Plant	Major	Private Domestic	OTFL 002	7/x	5556

TCEQ Permit No.	DO min (mg/l)	pH	BOD5 (mg/l) avg/max/inst	BOD5 (lbs/d) avg/max/inst	COD (mg/l) avg/max/inst	TSS (mg/l) avg/max/inst	TSS (lbs/d) avg/max	O & G (mg/l) avg/max/inst	Chlorine residual (mg/l)	FC avg/inst	WET
WQ0000337-000	2	6-9	65/x/x	1.66/3.32		x/x/65	1.66/3.32		1-4		
WQ0000337-000		6-9			x/150/150	1500/x/1500		x/15/15			
WQ0010240-001	4	6-9	10/25/35	102/x		15/40/60	153/x		1 (0.099*)		Y
WQ0010597-001	3	6-9	20/45/65	83/x		20/45/65	83/x		1-4		
WQ0010626-001	2	6-9	20/45/65	1168/x		20/45/65	1168/x			200/800	Y

OTFL = outfall
DOM = domestic sewage
SW = stormwater
UW = utility water
PW = process water
DO = dissolved oxygen
WET = whole effluent toxicity
NH3-N = ammonia nitrogen

BOD5 = 5-day biochemical oxygen demand
COD = chemical oxygen demand
TSS = total suspended solids
O & G = oil and grease
TOC = total organic carbon
Cl2 = residual chlorine
FC = fecal coliform

Table 5.2 Active Wastewater Discharges to Cow Bayou and Some Relevant Effluent Limitations

TCEQ Permit No.	EPA Permit No.	Facility Name	Class	Permit Category	Extension	Flow (mgd) avg/max	Flow (gpm) 2hr peak
WQ0000359-000	TPDES0004839	Chevron Phillips Chemical Orange Plant	Major	Industrial	OTFL 001	3.15/8.6	
WQ0000454-000	TPDES0002968	Firestone Polymers Orange Plant	Major	Industrial	OTFL 001	1/2	
WQ0000454-000	TPDES0002968	Firestone Polymers Orange Plant	Major	Industrial	OTFL 002		
WQ0000670-000	TPDES0007897	Honeywell International Inc-Orange	Major	Industrial	OTFL 001	1.4/2.1	
WQ0000670-000	TPDES0007897	Honeywell International Inc-Orange	Major	Industrial	OTFL 002		
WQ0001167-000	TPDES0003654	BAYER Corp. COBR Unit	Major	Industrial	OTFL 001	3.5/12.4	
WQ0001167-000	TPDES0003654	BAYER Corp. COBR Unit	Major	Industrial	OTFL 002		
WQ0002835-000	TPDES0104710	Texas Polymer Services, Inc. (Jim Huber)	Minor	Industrial	OTFL 001		
WQ0002835-000	TPDES0104710	Texas Polymer Services, Inc. (Jim Huber)	Minor	Industrial	OTFL 002		
WQ0002835-000	TPDES0104710	Texas Polymer Services, Inc. (Jim Huber)	Minor	Industrial	OTFL 003		
WQ0002858-000	TPDES0101192	Printpak, Inc. Orange County Plant	Minor	Industrial	OTFL 001	0.085/0.18	
WQ0010051-001	TPDES0025500	City of Bridge City	Major	Public Domestic	OTFL 001	1.6/x	2896
WQ0010808-001	TPDES0021300	Jasper County WCID No. 1 Plant No. 1	Minor	Private Domestic	OTFL 001	0.41/x	
WQ0011315-001	TPDES0066389	Bayou Pines Park (Edward N. Smith, Jr.)	Minor	Private Domestic	OTFL 001	0.009/x	19
WQ0011457-001	TPDES0075558	TXDOT Orange Co. Comfort Station	Minor	Private Domestic	OTFL 001	0.011/x	32
WQ0011607-001	TPDES0062278	Orangefield ISD High School Plant	Minor	Public Domestic	OTFL 001	0.032/x	65
WQ0011916-001	TPDES0074250	PCS Development Co.	Minor	Private Domestic	OTFL 001	0.09/x	187
WQ0012134-001	TPDES0079651	Sabine River Authority 1 Plant	Minor	Public Domestic	OTFL 001	0.003/x	6.2
WQ0013488-001	TPDES0106437	Sunrise East Apt. (Gulflander Partners Group, L.P.)	Minor	Private Domestic	OTFL 001	0.01/x	28
WQ0013691-001	TPDES0113751	Waterwood Estates (Blacksher Development Corp)	Minor	Private Domestic	OTFL 001	0.02/x	56

TCEQ Permit No.	DO min (mg/l)	pH	BOD5 (mg/l) avg/max/inst	BOD5 (lbs/d) avg/max/inst	COD (mg/l) avg/max/inst	COD (lbs/d) avg/max	TSS (mg/l) avg/max/inst	TSS (lbs/d) avg/max	O&G (mg/l) avg/max/inst	O&G (lbs/d) avg/max	TOC (mg/l) avg/max/inst	Chlorine residual (mg/l)
WQ0000359-000		6-9	x/x/120	460/1036	x/x/200	2234/3943	x/x/183	1454/4711/x	40/127/20	263/526		
WQ0000454-000		6-9	x/x/45	110/175	x/x/400	1800/2700	x/x/100	477/719/x	x/x/15	80/125		1-4
WQ0000454-000		6-9			x/x/200				x/15/15			
WQ0000670-000		6-9	x/x/92	117/300	x/x/495	825/1650	x/x/140	185/500/x	10/15/15			
WQ0000670-000		6-9									x/70/70	
WQ0001167-000		6-9	x/x/40	350/700	x/x/400	3500/7000	x/x/120	1170/2026/x	x/x/19	175/350		
WQ0001167-000		6-9									x/55/55	
WQ0002835-000		6-9	26/x/26				x/19/19		10/15/15		55/75/75	
WQ0002835-000			45/20/45									
WQ0002835-000												
WQ0002858-000		6-9	65/20	1.7/x	150/200/200		20/65/65	1.7/x/x	x/15/15			
WQ0010051-001	4	6-9	10/25/35	133/x			15/40/60	200/x/x				0.09999
WQ0010808-001	4		x/30/x*	103/x*			90/x/x	308/x/x				
WQ0011315-001	4		100/30/70	2.3/x			90/x/x	6.8/x/x				
WQ0011457-001	2		65/20/45	1.8/x			20/45/65	1.8/x/x				
WQ0011607-001	2		65/20/45	5.3/x			20/45/65	5.3/x/x				
WQ0011916-001	2		65/20/45	15/x			20/45/65	15/x/x				
WQ0012134-001	2		65/20/45	0.5/x			20/45/65	0.5/x/x				
WQ0013488-001	2		65/20/45	1.7/x			20/45/65	1.7/x/x				
WQ0013691-001	2		65/20/45	3.3/x			20/45/65	3.3/x/x				

OTFL = outfall
DOM = domestic sewage
SW = stormwater
UW = utility water
PW = process water
DO = dissolved oxygen
WET = whole effluent toxicity
NH3-N = ammonia nitrogen

BOD5 = 5-day biochemical oxygen demand
COD = chemical oxygen demand
TSS = total suspended solids
O & G = oil and grease
TOC = total organic carbon
Cl2 = residual chlorine
FC = fecal coliform

Table 5.3 Summary of Self-Reported Effluent Quality for Adams Bayou Dischargers

PERMIT NO.	OUTFALL	PARAMETER	PERIOD	N	MIN	AVG	MAX
WQ0000337-000	1	BOD5 Loading(lbs/day)Daily Maximum	1994-1999	207	0.018	0.650	5.0
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-1999	207	0.018	0.424	2.7
		Chlorine, Residual (mg/L) Maximum	1994-1999	201	1.400	3.381	28
		Chlorine, Residual(mg/L) Minimum	1994-1999	204	0.000	1.113	2.3
		Discharge Days (Days) Days Per Month	1994-1999	210	20.0	30.2	31
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-1999	210	0.000	0.004	0.006
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-1999	210	0.001	0.008	0.066
		pH (Standard Units) Maximum	1994-1999	204	7.530	7.892	8.5
		pH (Standard Units) Minimum	1994-1999	204	6.350	7.115	7.6
		Solids, Total Suspended(Lb/Day)Daily Maximum	1994-1999	207	0.074	0.945	13.4
		Solids, Total Suspended (Lb/Day)Dly Or 30-Day Avg	1994-1999	207	0.023	0.634	8.5
	2	Discharge Days (Days) Days Per Month	1994-1999	210	0.000	23.6	31.0
		Flow, Rate Of (MGD) Dly Or 30-Day Average	1994-1999	192	0.000	0.001	0.008
		Flow, Rate Of (MGD) Dly Or 30-Day Max	1994-1999	192	0.000	0.005	0.067
		pH (Standard Units) Maximum	1994-1999	186	7.400	8.460	9.1
		pH (Standard Units) Minimum	1994-1999	186	6.400	7.645	8.6
		Solids, Total Suspended(Lb/Day)Daily Maximum	1994-1999	189	0.001	0.230	1.4
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-1999	189	0.001	0.154	1.3
WQ0010240-001	1	BOD5 Concentration(mg/L)Daily Maximum	1994-2000	234	2.000	15.803	106
		BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	234	2.000	9.480	44.0
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	234	4.400	48.6	225
		Chlorination After Dechlorination(mg/L)Instant Max	1999-2000	51	0.040	0.059	0.100
		Chlorine, Residual (mg/L) Maximum	1994-1999	183	1.600	2.836	4.1
		Chlorine, Residual(mg/Ll) Minimum	1994-2000	234	0.500	1.083	1.890
		Discharge Days (Days) Days Per Month	1994-2000	234	28.0	30.4	31.0
		Flow, Rate Of (MGD) Dly Or 30-Day Average	1994-2000	234	0.292	0.666	1.419
		Flow, Rate Of (MGD) Dly Or 30-Day Max	1994-2000	234	0.458	14.268	1030
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2000	234	1.170	5.097	7.2
		pH (Standard Units) Maximum	1994-2000	234	6.930	7.282	7.6
		pH (Standard Units) Minimum	1994-2000	234	6.560	6.998	7.3
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	234	9.110	133	834
		Solids, Total Suspended(mg/L) Daily Maximum	1994-2000	234	3.000	31.7	118
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2000	234	2.030	19.9	64.0

PERMIT NO.	OUTFALL	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Solids, Total Suspended (mg/L) Indiv. Grab	1994-94	3	16.0	16.0	16.0
WQ0010597-001	1	BOD5 Concentration(mg/L)Daily Maximum	1994-2000	222	2.000	11.122	69.6
		BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	222	2.000	7.140	36.2
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	222	4.674	23.9	129
		Chlorine, Residual (mg/L) Maximum	1994-2000	219	1.900	3.740	6.5
		Chlorine, Residual(mg/L) Minimum	1994-2000	219	0.200	1.243	2.5
		Discharge Days (Days) Days Per Month	1994-2000	222	28.0	30.3	31.0
		Flow, Rate Of (MGD) Dly Or 30-Day Average	1994-2000	222	0.219	0.353	0.669
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	222	0.278	1.114	2.4
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2000	222	1.600	5.338	7.5
		pH (Standard Units) Maximum	1994-2000	222	7.100	7.379	8.0
		pH (Standard Units) Minimum	1994-2000	222	6.000	6.852	7.5
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	222	2.800	49	544
		Solids, Total Suspended(mg/L) Daily Maximum	1994-2000	222	7.000	23	212
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2000	222	4.250	13.63	69.3
WQ0010626-001	2	BOD5 Concentration(mg/L)Daily Maximum	1998-2000	2	3.000	7.450	11.9
		BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1998-2000	2	2.300	2.450	2.6
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1998-2000	2	81	87	94
		Discharge Days (Days) Days Per Month	1997-2001	49	0.000	0.050	2.0
		Fecal Coliform Memb. Filt. (#/100mL) 7 Day Average	1998-2000	2	1.210	135	269
		Fecal Coliform Memb. Filt. (#/100mL) Daily Average	1998-2000	2	0.000	0.000	0.0
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1998-2000	2	0.184	2.027	3.9
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1998-2000	2	0.197	9.890	19.6
		Oxygen, Dissolved (mg/L) Minimum Grab	1998-2000	2	5.200	5.850	6.5
		pH (Standard Units) Maximum	1998-2000	2	7.700	7.800	7.9
		pH (Standard Units) Minimum	1998-2000	2	6.800	6.950	7.1
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1998-2000	2	104	131	157
		Solids, Total Suspended(mg/L) Daily Maximum	1998-2000	2	4.000	7.750	11.5
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1998-2000	2	3.500	3.650	3.800

Table 5.4 Summary of Self-Reported Effluent Quality for Cow Bayou Dischargers

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
WQ0000359-000	1	BOD5 Loading(lbs/day)Daily Maximum	1994-2001	273	30	140	772
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2001	273	19	59.42	333
		Discharge Days (Days) Days Per Month	1994-2001	273	28	30.44	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2001	273	1.04	2.03	3.13
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2001	273	1.28	3.86	8.30
		Oil And Grease Hexane Extract (Lb/Day) Dly. Avg.	1994-2001	273	15	42.38	316
		Oil And Grease Hexane Extract (Lb/Day) Dly. Max.	1994-2001	273	20	102	2005
		Oxygen Demand, Chem.(Lb/Day)Daily Average	1994-2001	270	257	648	1784
		Oxygen Demand, Chem.(Lb/Day)Daily Maximum	1994-2001	273	389	1249	4370
		pH (Standard Units) Maximum	1994-2001	273	7.3	8.02	9.80
		pH (Standard Units) Minimum	1994-2001	273	4.3	6.96	7.70
		Solids, Total Suspended(Lb/Day)Daily Maximum	1994-2001	273	138	951	5357
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2001	270	109	341	1476
WQ0000454-000	1	BOD5 Loading(lbs/day)Daily Maximum	1994-2002	288	20	235	20000
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2002	288	11.75	26.56	53.00
		Discharge Days (Days) Days Per Month	1994-2002	285	24	30.26	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2002	288	0.32	6.73	665
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2002	288	0.528	9.84	973
		Oil & Grease Hexane Extract Lb/Day Maximum	1994-2002	288	3	19.07	94.00

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Oil And Grease Hexane Extract (Lb/Day) Dly. Avg.	1994-2002	288	2	9.11	20.30
		Oxygen Demand, Chem.(Lb/Day)Daily Average	1994-2002	288	63	1644	157000
		Oxygen Demand, Chem.(Lb/Day)Daily Maximum	1994-2002	288	92	2130	198000
		pH (Standard Units) Maximum	1994-2002	288	7.6	8.19	9.00
		pH (Standard Units) Minimum	1994-2002	288	6	6.95	7.60
		Solids, Total Suspended(Lb/Day)Daily Maximum	1994-2002	288	50	161	828
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2002	288	23	74	286
	2	Discharge Days (Days) Days Per Month	1994-2002	288	0	3.65	31.00
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-2002	237	0	2.06	8.10
		Oxygen Demand, Chem.(mg/L)Maximum	1994-2002	240	0	300	23400
		pH (Standard Units) Maximum	1994-2002	243	6.8	7.71	9.40
		pH (Standard Units) Minimum	1994-2002	243	5.8	7.09	9.40
WQ0000670-000	**1**	BOD5 Loading(lbs/day)Daily Maximum	1994-1999	204	10	48.27	225
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-1999	204	7	25.28	94
		Discharge Days (Days) Days Per Month	1994-1999	201	28	30.41	31
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-1999	201	0.162	0.46	1.02
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-1999	204	0.24	0.70	2.08
		Oil And Grease Hexane Extract (mg/L) Dly. Avg.	1994-1999	204	1	1.08	2.00
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-1999	204	1	1.47	8.00
		Oxygen Demand, Chem.(Lb/Day)Daily Average	1994-1999	204	54	162	333
		Oxygen Demand, Chem.(Lb/Day)Daily Maximum	1994-1999	204	84	255	782

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		pH (Standard Units) Maximum	1994-1999	204	6.4	6.96	8.50
		pH (Standard Units) Minimum	1994-1999	204	6	6.47	7.20
		Solids, Total Suspended(Lb/Day)Daily Maximum	1994-1999	204	8	51.66	414
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-1999	204	4	22.74	101
	2	Carbon, Tot Org. Conc.(mg/L) Maximum	1994-1999	123	13	30.14	59
		Discharge Days (Days) Days Per Month	1994-1999	207	0	2.38	14.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-1999	123	0.298	0.85	1.41
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-1999	123	1	1.18	3.00
		pH (Standard Units) Maximum	1994-1999	123	6.2	7.03	8.40
		pH (Standard Units) Minimum	1994-1999	120	5.6	6.53	7.50
WQ0001167-000	1	BOD5 Loading(lbs/day)Daily Maximum	1994-2000	146	27	111	438
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	146	21	53.44	130
		Discharge Days (Days) Days Per Month	1994-2000	146	28	30.51	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	146	1.26	2.59	7.99
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	146	1.59	5.29	17.16
		Oil & Grease Hexane Extract Lb/Day Maximum	1994-2000	146	11	60.79	219
		Oil And Grease Hexane Extract (Lb/Day) Dly. Avg.	1994-2000	146	10	34.94	71
		Oxygen Demand, Chem.(Lb/Day)Daily Average	1994-2000	146	255	592	1190
		Oxygen Demand, Chem.(Lb/Day)Daily Maximum	1994-2000	146	336	1144	6712
		pH (Standard Units) Maximum	1994-2000	146	7	7.66	8.70
		pH (Standard Units) Minimum	1994-2000	146	6.2	6.85	7.20

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Solids, Total Suspended(Lb/Day)Daily Maximum	1994-2000	146	15.3	452	1555
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	144	32	156	408
	2	Carbon, Tot Org. Conc.(mg/L) Maximum	1996-1998	4	6.31	7.11	7.90
		Discharge Days (Days) Days Per Month	1994-2000	146	0	0	3
		Flow, Rate Of (MGD) Dly Or 30-Day Average	1996-1998	4	0.5	0.59	0.68
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1996-1998	4	1.01	1.20	1.38
		Oil And Grease Hexane Extract(mg/L) Maximum	1996-1998	4	2	2.25	2.50
		pH (Standard Units) Maximum	1996-1998	4	7.7	8.40	9.10
		pH (Standard Units) Minimum	1996-1998	4	7	7.25	7.50
WQ0002835-000	1	Carbon, Tot Org. Conc.(mg/L) Dly Or 30-Day Avg.	1994-2000	158	1.45	8.52	25.53
		Carbon, Tot Org. Conc.(mg/L) Maximum	1994-2000	158	2.65	13.95	50.50
		Discharge Days (Days) Days Per Month	1994-2000	162	0	21.37	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	158	0.00010	0.03	0.17
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	158	0.00020	0.09	0.86
		Oil And Grease Hexane Extract (mg/Ll) Dly. Avg.	1994-2000	158	1	3.81	14.80
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-2000	158	1	7.79	52.00
		pH (Standard Units) Maximum	1994-2000	158	7.2	9.49	88.00
		pH (Standard Units) Minimum	1994-2000	158	5.2	7.39	8.90
	2	BOD5 Concentration (mg/L) Maximum	1994-2000	160	2.2	15.24	65.00
		BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	160	2.05	5.74	20.00
		Carbon, Tot Org. Conc.(mg/L) Dly Or 30-Day Avg.	1994-2000	160	1.33	8.02	29.66

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Carbon, Tot Org. Conc.(mg/L) Maximum	1994-2000	160	1.57	15.16	59.60
		Discharge Days (Days) Days Per Month	1994-2000	162	0	30.06	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	160	0.03	0.18	2.03
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	160	0.127	0.33	2.89
		Oil And Grease Hexane Extract (mg/L) Dly. Avg.	1994-2000	160	1	2.21	5.20
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-2000	160	1	2.96	11.00
		pH (Standard Units) Maximum	1994-2000	158	7.4	8.14	9.10
		pH (Standard Units) Minimum	1994-2000	160	6.6	7.54	8.40
	3	Carbon, Tot Org. Conc.(mg/L) Dly Or 30-Day Avg.	1994-2000	162	1	8.20	51
		Carbon, Tot Org. Conc.(mg/L) Maximum	1994-2000	162	1	14.07	130
		Discharge Days (Days) Days Per Month	1994-2000	162	3	29.85	190
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	162	0.0010	0.01	0.03
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	162	0.0070	0.07	0.45
		Oil And Grease Hexane Extract (mg/L) Dly. Avg.	1994-2000	162	1	1.98	5.00
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-2000	162	1	2.32	7.70
		pH (Standard Units) Maximum	1994-2000	162	7	8.37	9.70
		pH (Standard Units) Minimum	1994-2000	162	6.1	7.45	8.60
WQ0002858-000	**1**	BOD5 Concentration (mg/L) Maximum	1994-95	64	1.9	2.45	4.00
		BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-95	64	1.43	2.02	2.70
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-95	64	0.01	0.02	0.09
		Chlorine, Residual (mg/L) Maximum	1994-95	64	2.5	3.54	7.00
		Chlorine, Residual(mg/L) Minimum	1994-95	64	1	1.41	1.90

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Discharge Days (Days) Days Per Month	1994-2000	292	0	251	3131
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	280	0.0049	0.03	0.07
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	280	0.0063	0.23	10.13
		Oil And Grease Hexane Extract (mg/L) Dly. Avg.	1995-2000	216	0.94	2.94	5.80
		Oil And Grease Hexane Extract (mg/L) Dly. Max.	1995-2000	216	0.94	4.34	15.00
		Oxygen Demand, Chem.(mg/L)Daily Average	1995-2000	216	17.8	38.74	90.16
		Oxygen Demand, Chem.(mg/L)Daily Maximum	1995-2000	216	23	60.22	193
		pH (Standard Units) Maximum	1994-2000	280	6.92	7.97	8.85
		pH (Standard Units) Minimum	1994-2000	280	6.6	7.36	8.41
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-95	64	0.02	0.05	0.15
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-95	64	2.32	4.72	11.00
		Solids, Total Suspended(mg/L) Maximum	1994-95	64	3	7.92	21.00
	2	Carbon, Tot Org. Conc.(mg/L) Maximum	1994-95	32	6.16	25.81	78.40
		Discharge Days (Days) Days Per Month	1994-95	32	28	30.21	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-95	32	0.011	0.03	0.07
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-95	32	0.030	0.32	1.18
		Oil And Grease Hexane Extract(mg/L) Maximum	1994-95	32	3	7.18	16.30
		pH (Standard Units) Maximum	1994-95	32	7.8	8.66	9.00
		pH (Standard Units) Minimum	1994-95	32	6.2	7.09	8.40
WQ0010051-001	**1**	BOD5 Concentration(mg/L)Daily Maximum	1994-2000	385	1.3	9.23	41.30
		BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	385	2.87	4.75	21.01
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	385	4.78	39.47	294

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Chlorination After Dechlorination(mg/L)Instant Max	1994-2000	345	0	0.01	0.09
		Chlorine, Residual (mg/L) Maximum	1994-94	40	2.2	2.66	3.10
		Chlorine, Residual(mg/L) Minimum	1994-2000	385	0.837	1.11	1.40
		Discharge Days (Days) Days Per Month	1994-2000	385	28	30.41	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	385	0.081	1.00	8.41
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	385	0.690	2.13	3.53
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2000	385	4	5.73	9.00
		pH (Standard Units) Maximum	1994-2000	385	7.01	7.31	8.50
		pH (Standard Units) Minimum	1994-2000	385	6.27	6.78	7.47
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	385	13.35	40.75	188
		Solids, Total Suspended(mg/L) Daily Maximum	1994-2000	385	3	9.57	27.00
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2000	385	2.76	4.81	13.89
WQ0010808-001	**1**	BOD5, Carbonaceous lbs/day Daily Average	1994-2001	270	8.12	18.08	46.32
		BOD5, Carbonaceous Conc. (mg/L) Daily Avg	1994-2001	270	6.17	14.41	37.75
		Discharge Days (Days) Days Per Month	1994-2001	270	0	29.99	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2001	270	0.081	0.15	0.25
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2001	270	0.088	0.21	0.78
		Nitrogen, Tot Ammonia Conc.(mg/L)Dly Or 30-D Avg	1994-2001	270	0.05	0.77	4.30
		Nitrogen, Tot Ammonia Conc. (mg/L) Indiv. Grab	1994-2001	270	0.05	0.97	5.20
		Nitrogen, Tot Ammonia Lbs /Dly	1994-2001	270	0.039	1.02	5.53
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2001	270	2	5.36	9.40
		pH (Standard Units) Maximum	1994-2001	270	7	8.69	9.60

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		pH (Standard Units) Minimum	1994-2001	270	6.5	7.52	9.00
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2001	270	15.35	43.43	112
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2001	267	14.25	34.27	76
WQ0011315-001	1	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	288	2.62	22.39	75
		BOD5 Concentration(mg/L)Individual Grab	1994-2000	288	2.62	29.30	105
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	288	0.048	0.98	5.43
		Discharge Days (Days) Days Per Month	1994-2000	300	0	21.73	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	292	0.00075	0.00	0.04
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	292	0.0018	0.01	0.06
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2000	284	0	3.00	10.90
		pH (Standard Units) Maximum	1994-2000	288	6.1	7.38	8.90
		pH (Standard Units) Minimum	1994-2000	288	6.1	7.19	8.22
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	288	0.03	1.81	6.37
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2000	284	3.1	41.19	172
WQ0011457-001	1	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-1999	180	2	9.98	46.50
		BOD5 Concentration(mg/L)Individual Grab	1994-1999	180	2	18.22	81
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-1999	180	0.0204	0.59	2.84
		Chlorine, Residual (mg/L) Maximum	1994-1999	180	2	3.35	4.00
		Chlorine, Residual(mg/L) Minimum	1994-1999	180	1	1.38	3.00
		Discharge Days (Days) Days Per Month	1994-1999	201	0	26.66	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-1999	180	0.0023	0.01	0.05

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-1999	180	0.0017	0.02	0.08
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-1999	180	1.8	2.73	5.90
		pH (Standard Units) Maximum	1994-1999	180	6.5	7.34	8.30
		pH (Standard Units) Minimum	1994-1999	180	5.4	6.61	8.00
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-1999	180	0.15	0.94	5.84
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-1999	180	6.2	16.49	71
		Solids, Total Suspended (mg/L) Indiv. Grab	1994-1999	180	6.45	25.89	146
WQ0011607-001	**1**	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	308	0	2.41	12.80
		BOD5 Concentration(mg/L)Individual Grab	1994-2000	308	0	3.47	40.90
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	308	0.12	0.48	6.80
		Chlorine, Residual (mg/L) Maximum	1994-2000	304	2	3.43	4.70
		Chlorine, Residual(mg/L) Minimum	1994-2000	300	0.9	1.99	17.71
		Discharge Days (Days) Days Per Month	1994-2000	220	0	24.53	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	308	0.0068	0.02	0.23
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	304	0.0094	0.09	3.80
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2000	308	2.06	4.73	8.70
		pH (Standard Units) Maximum	1994-2000	308	6.4	7.22	8.30
		pH (Standard Units) Minimum	1994-2000	308	3.25	7.04	8.04
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	304	0.2	0.65	1.30
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2000	308	2.6	4.21	12.30
		Solids, Total Suspended (mg/L) Indiv. Grab	1994-2000	308	0.37	6.67	46.00

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
WQ0011916-001	1	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-1999	216	2	3.35	18.90
		BOD5 Concentration(mg/L)Individual Grab	1994-1999	216	2	3.50	18.90
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-1999	216	0.01	0.20	2.47
		Chlorine, Residual (mg/L) Maximum	1994-1999	216	1.5	2.48	3.60
		Chlorine, Residual(mg/L) Minimum	1994-1999	216	1	1.36	1.90
		Discharge Days (Days) Days Per Month	1994-1999	216	27	30.35	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-1999	216	0.0018	0.01	0.03
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-1999	216	0.0030	0.03	1.01
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-1999	216	3	7.19	12.00
		pH (Standard Units) Maximum	1994-1999	216	6	7.31	8.50
		pH (Standard Units) Minimum	1994-1999	216	6	7.25	8.40
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-1999	216	0.01	0.99	9.43
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-1999	216	0.107	13.30	47.00
		Solids, Total Suspended (mg/L) Indiv. Grab	1994-1999	216	0.5	13.90	47.00
WQ0012134-001	1	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-2000	219	2	4.84	16.00
		BOD5 Concentration(mg/L)Individual Grab	1994-2000	219	2	8.86	33.00
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-2000	219	0.0053	0.02	0.05
		Chlorine, Residual (mg/L) Maximum	1994-2000	219	1.7	3.18	3.80
		Chlorine, Residual(mg/L) Minimum	1994-2000	219	1	1.46	3.80
		Discharge Days (Days) Days Per Month	1994-2000	219	28	30.38	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-2000	219	0.0002	0.00	0.00

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-2000	219	0	0.00	0.00
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-2000	186	3.2	4.82	6.70
		pH (Standard Units) Maximum	1994-2000	219	6.3	7.07	7.90
		pH (Standard Units) Minimum	1994-2000	219	4.9	6.55	7.10
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-2000	219	0.0089	0.09	1.99
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-2000	219	2.51	14.39	110
		Solids, Total Suspended (mg/L) Indiv. Grab	1994-2000	219	3	22.67	254
WQ0013488-001	**1**	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1994-1999	216	2.13	5.72	15.13
		BOD5 Concentration(mg/L)Individual Grab	1994-1999	216	2.52	9.37	31.90
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1994-1999	216	0.01	0.13	0.68
		Chlorine, Residual (mg/L) Maximum	1994-1999	216	1.4	2.45	4.00
		Chlorine, Residual(mg/L) Minimum	1994-1999	216	1	1.40	3.10
		Discharge Days (Days) Days Per Month	1994-1999	216	28	30.42	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1994-1999	216	0.0017	0.01	0.06
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1994-1999	216	0.0054	0.16	11.01
		Oxygen, Dissolved (mg/L) Minimum Grab	1994-1999	186	2.3	3.89	4.70
		pH (Standard Units) Maximum	1994-1999	216	7.1	7.69	8.70
		pH (Standard Units) Minimum	1994-1999	216	6.7	7.25	8.20
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1994-1999	216	0.03	0.26	1.18
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1994-1999	216	6.53	12.27	25.50
		Solids, Total Suspended (mg/L) Indiv. Grab	1994-1999	216	8	20.10	53.90

PERMIT NO.	EXTENSION	PARAMETER	PERIOD	N	MIN	AVG	MAX
WQ0013691-001	1	BOD5 Concentration(mg/L)Daily Or 30-Day Avg.	1995-2001	124	2	4.75	24.60
		BOD5 Concentration(mg/L)Individual Grab	1995-2001	124	2	9.45	89
		BOD5 Loading(lbs/day)Daily Or 30-Day Avg.	1995-2001	124	0.01	0.12	0.34
		Chlorine, Residual (mg/L) Maximum	1995-2001	124	1.6	2.64	3.70
		Chlorine, Residual (mg/L) Minimum	1995-2001	124	1	1.36	2.80
		Discharge Days (Days) Days Per Month	1995-2001	124	28	30.53	31.00
		Flow, Rate Of(MGD) Dly Or 30-Day Average	1995-2001	124	0.0013	0.00	0.01
		Flow, Rate Of(MGD) Dly Or 30-Day Max	1995-2001	124	0.0023	0.01	0.01
		Oxygen, Dissolved (mg/L) Minimum Grab	1995-2001	124	2.3	3.89	5.90
		pH (Standard Units) Maximum	1995-2001	124	7.2	7.48	8.37
		pH (Standard Units) Minimum	1995-2001	124	6.72	7.13	7.91
		Solids, Total Suspended(Lb/Day)Dly Or 30-Day Avg	1995-2001	124	0.01	0.32	1.46
		Solids, Total Suspended(mg/L) Daily Maximum	1995-2001	124	3	18.26	88
		Solids, Total Suspended(mg/L) Dly Or 30-Day Avg	1995-2001	124	3	9.72	26.90

Table 5.5 Permit Limit Exceedance Rates

Segment	Permit Number	Name on Permit	Outfall	Percent Exceedance Rate*
508	WQ0000337-000	A. Schulman, Inc	1	41%
508	WQ0000337-000	A. Schulman, Inc	2	41%
508	WQ0000337-000	A. Schulman, Inc	3	8%
508	WQ0010240-001	Orange County WCID No. 2	1	78%
508	WQ0010597-001	Pinehurst, City Of	1	49%
511	WQ0000359-000	Chevron Phillips Chemical Co. LP	1	42%
511	WQ0000454-000	Firestone Polymers LLC	1	5%
511	WQ0000454-000	Firestone Polymers LLC	2	4%
511	WQ0000670-000	Honeywell International Inc.	1	1%
511	WQ0000670-000	Honeywell International Inc.	2	3%
511	WQ0001167-000	Bayer Corporation	1	7%
511	WQ0001167-000	Bayer Corporation	2	1%
511	WQ0002835-000	Texas Polymer Services, Inc.	1	35%
511	WQ0002835-000	Texas Polymer Services, Inc.	2	5%
511	WQ0002835-000	Texas Polymer Services, Inc.	3	10%
511	WQ0002858-000	Printpack, Inc.	1	10%
511	WQ0002858-000	Printpack, Inc.	2	13%
511	WQ0010051-001	Bridge City, City of	1	15%
511	WQ0010808-001	Jasper County WCID No. 1	1	33%
511	WQ0011315-001	Bayou Pines Park (Edward N. Smith Jr.)	1	60%
511	WQ0011457-001	Texas Department of Transportation	1	42%
511	WQ0011607-001	Orangefield Independent School District	1	5%
511	WQ0011916-001	PCS Development Company	1	21%
511	WQ0012134-001	Sabine River Authority	1	19%
511	WQ0013488-001	Sunrise East Apt. (Gulflander Partners Group, LP)	1	8%
511	WQ0013691-001	Blacksher Development Corporation, Inc.	1	4%

*represents the frequency of an exceedance by any parameter

Table 5.6 1997 County-Level Agricultural Census Data

Species	Orange	Jasper	Newton
Cattle/Calves	10,202	14,570	6,416
Hogs/Pigs	118	319	88
Poultry	764	875	577
Sheep/Lamb	18	D	D
Horses/Ponies	487	649	273
Goats*	248	291	282
Bees**	3,600	2,240	-
Ducks	469	108	35
Geese	D	35	-
Mules/Burros/Donkeys	35	19	167
Rabbits and their Pelts	526	136	400

* Except for Angora and Milk goats

** Colonies of bees

D -Withheld to avoid disclosing data from individual farms

- represents zero

5.2.2 Pets and Wildlife

In addition to humans and livestock, pets and wildlife represent additional sources of fecal coliform and oxygen-depleting substances to natural waters. Cats and dogs may comprise a significant portion of the fecal coliform in urban runoff, with fecal coliform production rates of approximately 5 billion per day (Horsley and Whitten 1996). Colonies and congregations of bats and birds near water have been linked with high fecal coliform levels in water elsewhere.

5.2.3 Fecal Coliform to Fecal Streptococcus Ratios

In order to help to identify the sources of fecal contamination in Adams and Cow Bayous, previous investigators have measured the ratios of fecal coliform (FC) and fecal streptococci (FS) concentrations in water. Humans tend to have higher FC levels, while most other animal species have a higher abundance of FS bacteria. FC/FS ratios of greater than 4.3 are typically identified as primarily human in origin, and ratios of less than 0.7 are typically attributed primarily to other animals. Ratios between 0.7 and 4.3 indicate a mixture of human and animal sources. Because FC and FS tend to die at different rates in water once removed from their animal host, these ratios tend to work best with recently-contaminated waters.

Table 5.7 summarizes the FC/FS ratio measurements in Adams and Cow Bayou. In Adams Bayou, FC/FS ratios at ambient stations showed approximately 25 percent of samples with primarily animal sources, 25 percent with primarily human sources, and 50 percent intermediate. FC/FS ratios in Hudson Gully and in Adams Bayou at Western Avenue indicated a primarily human contribution, while Adams Bayou at FM 3247 and Adams Bayou laterals #1 and #2 indicated primarily animal sources. In Cow Bayou, approximately 29 percent of the ambient samples indicated animal origin, 12 percent indicated human origin, and 59 percent indicated a mixture of human and animal sources. FC/FS ratios are more indicative of animal sources at all of the ambient monitoring stations in Cow Bayou.

The number of domestic wastewater treatment plant effluents that FC/FS ratios imply have primarily an animal fecal source exceeds those indicating a primarily human source, a surprising and probably inaccurate result. This may be due to the rapid death of FC bacteria relative to FS bacteria in wastewater treatment processes and in estuarine waters. This likely biases the results toward indicating an animal source.

Table 5.7 Fecal Coliform: Fecal Streptococcus Ratios in Ambient Waters and Effluents

Segment	Type	Short Name	Station ID	Fecal Coliform/Fecal Streptococcus Ratio			
				Count of Measurements			
				<0.7	0.7 - 4.3	>4.3	AVG
0508	Ambient	Adams Bayou At FM 1006 AB2	10441	22	58	21	41.08
0508	Ambient	Adams Bayou At Western AB3	10442	3	9	9	11.15
0508	Ambient	Adams Bayou At Park AB5	14990	8	24	10	5.19
0508A	Ambient	Adams Bayou At FM 3247 AB7	15107	22	29	10	2.26
0508A	Ambient	Adams Bayou At FM 1078 AB8	14964	6	13	4	3.31
0508A	Ambient	Adams Bayou At FM 1130 AB9	15742	4	6	6	5.08
0508A	Ambient	Adams Bayou Lateral AL2	16053	9	9	3	2.59
0508A	Ambient	Adams Bayou Lateral #3 AL3	16054	6	7	8	12.41
0508A	Ambient	Adams Bayou Lateral #8 AL8	16056	2	16	3	2.58
0508A	Ambient	Adams Bayou Lateral #1 AL1	16057	8	11	2	1.70
0508A	Ambient	Adams Bayou At Green Ave.	16059	1	12	8	10.38
0508B	Ambient	Gum Gully At Halliburton Rd GG	16049	7	6	7	3.40
0508C	Ambient	Hudson Gully At Lexington	16041	2	19	10	20.26
0508	Effluent	Pinehurst WWTP 001 AW3	16043	11	4	6	4.38
0508	Effluent	Orange Co WCID WWTP AW2	16044	4	8	9	11.11
0508	Effluent	A Schulman Inc 001 AW1	16051	1	4	0	0.90
		0508 Ambient Total		**100**	**222**	**103**	
0511	Ambient	Cow Bayou At FM 1442 ds CB1	10449	26	63	14	7.14
0511	Ambient	Cow Bayou At FM 105 CB3	10453	13	25	5	2.41
0511	Ambient	Cow Bayou At FM 1442 North CB4	13781	23	34	4	1.33
0511	Ambient	Cow Bayou At IH 10 CB5	10457	5	16	2	1.88

Segment	Type	Short Name	Station ID	Fecal Coliform/Fecal Streptococcus Ratio			
				Count of Measurements			AVG
				<0.7	0.7 - 4.3	>4.3	
0511A	Ambient	Cow Bayou At SH 12 CB6	10337	6	15	0	1.39
0511A	Ambient	Cow Bayou Lateral #10 CL10	16055	6	4	4	5.52
0511A	Ambient	Cow Bayou At Jasper CR 826 CB7	16058	5	13	2	3.22
0511B	Ambient	Coons Bayou At SH 87 CNB	16052	7	9	5	3.40
0511C	Ambient	Cole Creek At IH 10 (CC)	16060	9	19	3	3.88
0511E	Ambient	Terry Gully At IH 10 TG	16040	7	16	4	5.54
0511	Effluent	SRA WWTP 001 CW6	16042	2	18	0	1.00
0511	Effluent	Jasper WCID WWTP 001 CW13	16045	3	7	10	14.12
0511	Effluent	Crawdad WWTP 001 CW12	16050	7	10	6	5.86
0511	Effluent	Oak Terrace WWTP 001 CW10	16062	3	13	5	3.36
0511	Effluent	Orange Field ISD WWTP CW5	16063	0	20	0	1.00
0511	Effluent	PCS Development Co WWTP Outfl	16064	0	10	11	9.57
0511	Effluent	Oakleaf Park WWTP	16065	9	6	4	3.60
0511	Effluent	TXDot WWTP Outfall 001	16066	2	16	2	4.51
0511	Effluent	Bridge City WWTP 001	16068	4	14	2	2.88
0511	Effluent	Little Cypress-Mauriceville JH	16069	1	15	4	6.53
0511	Effluent	Sunrise East WWTP 001	16071	4	12	2	1.85
0511	Effluent	Texas Polymer Services 001	16072	5	10	6	5.08
0511	Effluent	Printpak Inc 001	16075	15	3	2	2.31
0511B	Effluent	Blackshur Develp Corp WWTP	16067	7	10	4	3.92
0511B	Effluent	Bayou Pines WWTP 001	16070	1	6	10	18.44
0511 Ambient Total				**107**	**214**	**43**	

SECTION 6
CONCLUSIONS AND RECOMMENDATIONS

Adams Bayou Tidal (Segment 0508) and Cow Bayou Tidal (Segment 0511) and several of their tributaries were placed on the §303(d) List of impaired water bodies by the TCEQ because they do not support or only partially support some of their designated uses. The tributaries include the above tidal portions of Adams Bayou (0508A) and Cow Bayou (0511A), Gum Gully (0508B), Hudson Gully (0508C), Cole Creek (0511C), Coon Bayou (0511B), and Terry Gully (0511E). The designated uses of these water bodies that are not supported include contact recreation (all except 0511A), high aquatic life use (0508, 0511, 0508C), and limited aquatic life use (0508A, 0508B). The designated uses that are only partly supported include general uses (0511, due to low pH), high aquatic life use (0511B, 0511C), and limited aquatic life use (0511A).

A review of the designated uses assigned to these water bodies indicated that they were generally appropriate and consistent with TCEQ standard practice. A use attainability analysis completed by the TCEQ for Cow Bayou in 1988 found that although habitat conditions did not seem to allow a high aquatic life use, a healthy and moderately diverse fish community existed in portions of the bayou. This community indicated a high or intermediate aquatic life use existed. In order to protect this fish community, a high aquatic life use was recommended by the UAA. EPA policy is that where a use exists, it may not be downgraded. A UAA has not been completed in Adams Bayou. It may be useful to perform a use attainability analysis for Adams Bayou to determine whether the high aquatic life use is attainable.

The contact recreation use is applied to all water bodies, except where contact recreation is considered unsafe for reasons unrelated to water quality, such as ship traffic, or if elevated bacterial concentrations occur due to sources of pollution which cannot be reasonably controlled by existing regulations, as in portions of the Rio Grande due to discharge of untreated sewage from Mexico. General uses are applied to all classified water bodies. These designated uses appear to be appropriate.

One designated use issue that deserves further investigation is the assumption by the TCEQ that Terry Gully is a perennial freshwater stream.

Another issue, separate from that of whether designated uses are appropriate, is that of whether the water quality criteria assigned to protect those designated uses are appropriate. The current 4.0/3.0 mg/l dissolved oxygen criteria are the default criteria applied by the TCEQ to tidal water bodies with high aquatic life uses. These criteria may not be necessary or attainable in these water bodies, based on high natural loading of oxygen-depleting substances and the natural hydraulics of the systems. The historical data record indicates that these criteria have not been met since DO levels were first measured in the 1970's, but a moderately diverse and healthy fish community was found to exist in Cow Bayou under these conditions. The Sabine River Authority showed that Black Bayou, an adjacent bayou in a predominantly natural watershed, did meet the DO criteria. However, because Black Bayou is intersected by the intracoastal waterway, the hydrology is different.

The basis of the pH criteria applied to Segments 0508 and 0511 is not well-documented, and may be inappropriate due to naturally low pH levels. An adjacent bayou, Big Cow Creek, has a minimum pH criterion of 5.5.

The contact recreation criteria were recently revised by the TCEQ to more appropriate indicator organisms.

While criteria revisions for DO and pH may be appropriate, the procedures to prove it are not well-defined and are addressed on a water body by water body basis. Because reductions of existing water quality protection are scrutinized carefully, the burden of evidence required will likely be very high. Thus, an attempt to revise these criteria is not recommended at this time unless a water quality model developed as part of a TMDL indicates that the current criteria cannot be attained, and the TCEQ supports this strategy. The criteria applied to support the designated uses are consistent with TCEQ standard practice.

A review of ambient water quality data collected in the latest five-year period indicated a high degree of confidence (>99%) that the dissolved oxygen criteria are not met in portions of Segments 0508, 0508A, 0508C, 0511, 0511A, and 0511B. Similarly, data indicated with a high degree of confidence that fecal coliform criteria are not met in portions of Segments 0508, 0508A, 0508B, 0508C, 0511B, and 0511E. There is a small chance (about 5%) that the decision that the minimum pH criterion was not met in Cow Bayou Tidal was incorrect.

In cases where there is substantial uncertainty regarding whether criteria are met, it is often advisable to perform additional monitoring to confirm the presence or absence of an impairment before developing a TMDL. Developing a TMDL is typically much more expensive and time-consuming, and involves intensive monitoring to calibrate and verify a water quality model, as well as source identification and quantification and other tasks. However, in this case, because one or more water bodies within each of the Adams and Cow Bayou systems will almost certainly require a TMDL, it will likely save time to proceed to developing TMDLs for the entire systems. Additional monitoring to determine standards attainment typically requires at least one and a half years. For this reason, additional monitoring to determine use attainment is not recommended at this time.

Following selection of an appropriate water quality model for these systems and parameters, the data required to calibrate and verify the models will be identified. The currently available data, primarily from intensive surveys, will be compared to these data requirements, and its sufficiency will be assessed. If additional data is required, a quality assurance project plan will be prepared for that data collection effort and approved before data collection begins.

SECTION 7
REFERENCES

Alan Plummer and Associates, Inc. 1982. South East Texas Nonpoint Source Study.

ASAE (American Society of Agricultural Engineers) 1998. ASAE Standards, 45th edition. Standards, engineering practices, data.

Horsley and Whitten, Inc. 1996. Identification and evaluation of nutrient and bacterial loadings to Maquoit Bay, New Brunswick, and Freeport, Maine. Final Report.

Kirkpatrick, Jeffrey S. 1985. Intensive survey of Cow Bayou, segment 0511, August 30-September 1, 1982 : hydrology, field measurements, and water chemistry. IS-77. Texas Dept. of Water Resources, Austin, TX

Kirkpatrick, Jeffrey S. 1988. Intensive survey of Cow Bayou Tidal, segment 0511, September 9-11, 1986: hydrology, field measurements, water chemistry, sediment oxygen demand, primary productivity, and fecal coliforms. IS-88-02. Texas Water Commission, Austin, TX.

Linam, G. and R. Kleinsasser. 1987. Fisheries use attainability study for Cow Bayou, Segment 0511. July 29-30, 1987. Texas Parks and Wildlife Department: Austin, TX.

Metcalf and Eddy. 1991. Wastewater engineering: treatment, disposal, reuse. 3rd edition. McGraw-Hill, Inc. New York.

Sabine River Authority of Texas. 1999a. Adams Bayou Special Study – Subwatershed 1.03. August 31, 1999.

Sabine River Authority of Texas. 1999b. Cow Bayou Special Study – Subwatershed 1.03. August 31, 1999.

TCEQ. 2002. Draft 2002 Texas §303(d) List (October 1, 2002). Austin, TX.

Texas Water Commission. 1986. Waste load evaluation for the Adams Bayou Tidal in the Sabine River Basin, Segment 0508. Austin, TX.

Texas Water Commission. 1988. Waste load evaluation for the Cow Bayou Tidal in the Sabine River Basin, Segment 0511. Draft subject to revision. Austin, TX.

TNRCC 1999. Surface Water Quality Monitoring Procedures Manual. Austin, TX.

TNRCC 2000. Texas Surface Water Quality Standards. 30 TAC §307.

TNRCC 2002. Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data, 2002. Austin, TX.

Twidwell, S.R. 1988. Use attainability analysis of Cow Bayou segment 0511. Texas Water Commission: Austin, TX.

U.S. Geological Survey. 2000. Texas-Southeast Land Cover Data Set. Sioux Falls, SD. Also see http://edcwww.cr.usgs.gov/programs/lccp/natllandcover.html

Werkenthin, Fred. 1984. Intensive survey of the Adams Bayou segment 0508: hydrology, field measurements, water chemistry. IS-65. Texas Dept. of Water Resources, Austin, TX.

APPENDIX

Segment ID: 0508 **Water body name:** Adams Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Use Concern	1 mile reach near Green Avenue	1	44	19	
Dissolved Oxygen grab average	Use Concern	2 mile reach near Western Avenue	2	21	16	
Dissolved Oxygen grab average	Use Concern	Lower 3 miles of segment	3	64	24	
Dissolved Oxygen grab average	Use Concern	Upper 2 miles of segment	2	49	38	
Dissolved Oxygen grab minimum	Not Supporting	1 mile reach near Green Avenue	1	44	14	
Dissolved Oxygen grab minimum	Not Supporting	2 mile reach near Western Avenue	2	21	15	
Dissolved Oxygen grab minimum	Partially Supporting	Lower 3 miles of segment	3	64	16	
Dissolved Oxygen grab minimum	Not Supporting	Upper 2 miles of segment	2	49	30	
Dissolved Oxygen 24hr average	Not Assessed	1 mile reach near Green Avenue	1	0		
Dissolved Oxygen 24hr average	Not Assessed	2 mile reach near Western Avenue	2	0		
Dissolved Oxygen 24hr average	Not Assessed	Lower 3 miles of segment	3	0		
Dissolved Oxygen 24hr average	Not Assessed	Upper 2 miles of segment	2	0		
Dissolved Oxygen 24hr minimum	Not Assessed	1 mile reach near Green Avenue	1	0		
Dissolved Oxygen 24hr minimum	Not Assessed	2 mile reach near Western Avenue	2	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Lower 3 miles of segment	3	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Upper 2 miles of segment	2	0		
Acute Metals in water	Not Assessed	2 mile reach near Western Avenue	2	3		
Acute Metals in water	No Concern-Limited Data	Lower 3 miles of segment	3	5	0	
Acute Metals in water	Not Assessed	Upper 2 miles of segment	2	1		
Chronic Metals in water	Not Assessed	2 mile reach near Western Avenue	2	3		
Chronic Metals in water	No Concern-Limited Data	Lower 3 miles of segment	3	5		
Chronic Metals in water	Not Assessed	Upper 2 miles of segment	2	1		
Chronic Toxicity tests in water	Not Assessed	Lower 3 miles of segment	3	1		

Segment ID: 0508 **Water body name:** Adams Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use (continued)						
Overall Aquatic Life Use	Not Supporting	1 mile reach near Green Avenue	1			
Overall Aquatic Life Use	Not Supporting	2 mile reach near Western Avenue	2			
Overall Aquatic Life Use	Partially Supporting	Lower 3 miles of segment	3			
Overall Aquatic Life Use	Not Supporting	Upper 2 miles of segment	2			
Contact Recreation Use						
Enterococci single sample	Not Assessed	1 mile reach near Green Avenue	1	0		
Enterococci single sample	Not Assessed	2 mile reach near Western Avenue	2	0		
Enterococci single sample	Not Assessed	Lower 3 miles of segment	3	0		
Enterococci single sample	Not Assessed	Upper 2 miles of segment	2	0		
Enterococci geometric mean	Not Assessed	1 mile reach near Green Avenue	1	0		
Enterococci geometric mean	Not Assessed	2 mile reach near Western Avenue	2	0		
Enterococci geometric mean	Not Assessed	Lower 3 miles of segment	3	0		
Enterococci geometric mean	Not Assessed	Upper 2 miles of segment	2	0		
Fecal coliform single sample	Not Supporting	1 mile reach near Green Avenue	1	21	12	
Fecal coliform single sample	Not Supporting	2 mile reach near Western Avenue	2	21	12	
Fecal coliform single sample	Use Concern	Lower 3 miles of segment	3	61	18	
Fecal coliform single sample	Not Supporting	Upper 2 miles of segment	2	43	18	
Fecal coliform geometric mean	Not Supporting	1 mile reach near Green Avenue	1	21		641
Fecal coliform geometric mean	Not Supporting	2 mile reach near Western Avenue	2	21		600
Fecal coliform geometric mean	Fully Supporting	Lower 3 miles of segment	3	61		200
Fecal coliform geometric mean	Not Supporting	Upper 2 miles of segment	2	43		357
Overall Recreation Use	Not Supporting	1 mile reach near Green Avenue	1			
Overall Recreation Use	Not Supporting	2 mile reach near Western Avenue	2			
Overall Recreation Use	Fully Supporting	Lower 3 miles of segment	3			

Segment ID: 0508 **Water body name:** Adams Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Contact Recreation Use (continued)						
Overall Recreation Use	Not Supporting	Upper 2 miles of segment	2			
General Use						
Water Temperature	Fully Supporting	1 mile reach near Green Avenue	1	44	0	
Water Temperature	Fully Supporting	2 mile reach near Western Avenue	2	21	0	
Water Temperature	Fully Supporting	Lower 3 miles of segment	3	64	0	
Water Temperature	Fully Supporting	Upper 2 miles of segment	2	49	0	
pH	Fully Supporting	1 mile reach near Green Avenue	1	44	4	
pH	Fully Supporting	2 mile reach near Western Avenue	2	21	1	
pH	Fully Supporting	Lower 3 miles of segment	3	64	1	
pH	Use Concern	Upper 2 miles of segment	2	44	6	
Overall General Use	Fully Supporting	1 mile reach near Green Avenue	1			
Overall General Use	Fully Supporting	2 mile reach near Western Avenue	2			
Overall General Use	Fully Supporting	Lower 3 miles of segment	3			
Overall General Use	Fully Supporting	Upper 2 miles of segment	2			
Fish Consumption Use						
Human Health Criteria Metals	Not Assessed	Lower 3 miles of segment	3	2		
Human Health Criteria Metals	Not Assessed	Upper 2 miles of segment	2	1		
Overall Fish Consumption Use	Not Assessed	1 mile reach near Green Avenue	1			
Overall Fish Consumption Use	Not Assessed	2 mile reach near Western Avenue	2			
Overall Fish Consumption Use	Not Assessed	Lower 3 miles of segment	3			
Overall Fish Consumption Use	Not Assessed	Upper 2 miles of segment	2			
Overall Use Support						
	Not Supporting	1 mile reach near Green Avenue	1			

Segment ID: 0508 **Water body name:** Adams Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Overall Use Support (continued)						
	Not Supporting	2 mile reach near Western Avenue	2			
	Partially Supporting	Lower 3 miles of segment	3			
	Not Supporting	Upper 2 miles of segment	2			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	1 mile reach near Green Avenue	1	3		
Ammonia Nitrogen	Not Assessed	2 mile reach near Western Avenue	2	3		
Ammonia Nitrogen	No Concern	Lower 3 miles of segment	3	39	2	
Ammonia Nitrogen	Not Assessed	Upper 2 miles of segment	2	4		
Nitrite + Nitrate Nitrogen	Not Assessed	1 mile reach near Green Avenue	1	5		
Nitrite + Nitrate Nitrogen	Not Assessed	2 mile reach near Western Avenue	2	5		
Nitrite + Nitrate Nitrogen	No Concern	Lower 3 miles of segment	3	45	3	
Nitrite + Nitrate Nitrogen	No Concern	Upper 2 miles of segment	2	23	0	
Orthophosphorus	Not Assessed	1 mile reach near Green Avenue	1	5		
Orthophosphorus	Not Assessed	2 mile reach near Western Avenue	2	4		
Orthophosphorus	No Concern	Lower 3 miles of segment	3	43	1	
Orthophosphorus	No Concern	Upper 2 miles of segment	2	24	0	
Total Phosphorus	Not Assessed	1 mile reach near Green Avenue	1	0		
Total Phosphorus	Not Assessed	2 mile reach near Western Avenue	2	0		
Total Phosphorus	No Concern	Lower 3 miles of segment	3	23	0	
Total Phosphorus	Not Assessed	Upper 2 miles of segment	2	1		
Overall Nutrient Enrichment Concerns	Not Assessed	1 mile reach near Green Avenue	1			
Overall Nutrient Enrichment Concerns	Not Assessed	2 mile reach near Western Avenue	2			
Overall Nutrient Enrichment Concerns	No Concern	Lower 3 miles of segment	3			
Overall Nutrient Enrichment Concerns	No Concern	Upper 2 miles of segment	2			

Segment ID: 0508 **Water body name:** Adams Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Algal Growth Concern						
Chlorophyll a	Not Assessed	1 mile reach near Green Avenue	1	0		
Chlorophyll a	Not Assessed	2 mile reach near Western Avenue	2	0		
Chlorophyll a	Not Assessed	Lower 3 miles of segment	3	6		
Chlorophyll a	Not Assessed	Upper 2 miles of segment	2	0		
Sediment Contaminants Concern						
Metals in sediment	Not Assessed	Lower 3 miles of segment	3	1		
Overall Sediment Contaminant Concerns	Not Assessed	1 mile reach near Green Avenue	1			
Overall Sediment Contaminant Concerns	Not Assessed	2 mile reach near Western Avenue	2			
Overall Sediment Contaminant Concerns	Not Assessed	Lower 3 miles of segment	3			
Overall Sediment Contaminant Concerns	Not Assessed	Upper 2 miles of segment	2			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	1 mile reach near Green Avenue	1			
Overall Fish Tissue Contaminant Concerns	Not Assessed	2 mile reach near Western Avenue	2			
Overall Fish Tissue Contaminant Concerns	Not Assessed	Lower 3 miles of segment	3			
Overall Fish Tissue Contaminant Concerns	Not Assessed	Upper 2 miles of segment	2			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	1 mile reach near Green Avenue	1			
Overall Narrative Criteria Concerns	No Concern	2 mile reach near Western Avenue	2			

Segment ID: 0508 **Water body name:** Adams Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Narrative Criteria Concern (continued)						
Overall Narrative Criteria Concerns	No Concern	Lower 3 miles of segment	3			
Overall Narrative Criteria Concerns	No Concern	Upper 2 miles of segment	2			
Overall Secondary Concern						
	No Concern	1 mile reach near Green Avenue	1			
	No Concern	2 mile reach near Western Avenue	2			
	No Concern	Lower 3 miles of segment	3			
	No Concern	Upper 2 miles of segment	2			

Segment ID: 0511E **Water body name:** Terry Gully (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 8.6 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Use Concern	Entire creek	8.6	26	11	
Dissolved Oxygen grab minimum	Use Concern	Entire creek	8.6	26	3	
Dissolved Oxygen 24hr average	Not Assessed	Entire creek	8.6	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Entire creek	8.6	0		
Overall Aquatic Life Use	Fully Supporting	Entire creek	8.6			
Contact Recreation Use						
E. coli single sample	Not Assessed	Entire creek	8.6	0		
E. coli geometric mean	Not Assessed	Entire creek	8.6	0		
Fecal coliform single sample	Not Supporting	Entire creek	8.6	26	13	
Fecal coliform geometric mean	Not Supporting	Entire creek	8.6	26		363
Overall Recreation Use	Not Supporting	Entire creek	8.6			
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Entire creek	8.6			
Overall Use Support						
	Not Supporting	Entire creek	8.6			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Entire creek	8.6	2	1	
Nitrite + Nitrate Nitrogen	Not Assessed	Entire creek	8.6	7	0	
Orthophosphorus	Not Assessed	Entire creek	8.6	9	2	

Segment ID: 0511E **Water body name:** Terry Gully (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 8.6 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Nutrient Enrichment Concern (continued)						
Total Phosphorus	Not Assessed	Entire creek	8.6	0		
Overall Nutrient Enrichment Concerns	Not Assessed	Entire creek	8.6			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Entire creek	8.6	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Entire creek	8.6			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Entire creek	8.6			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Entire creek	8.6			
Overall Secondary Concern						
	No Concern	Entire creek	8.6			

(based on data from 03/01/1996 to 02/28/2001)

Cole Creek (unclassified water body)

Segment: 0511C Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence of Cow Bayou west of Orange in Orange County to the upstream perennial portion of the stream south of Mauriceville in Orange County
Water body classification: Unclassified
Water body type: Tidal Stream
Water body length / area: 9.5 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
Entire tidal reach	Contact Recreation Use	Not Supporting	bacteria	5c

Standards Not Met in Previous Years Assessment Area	Use	Support Status	Parameter	Category
Entire tidal reach	Aquatic Life Use	Partially Supporting	depressed dissolved oxygen	5c

Additional Information: The fish consumption use was not assessed.

This water body was identified on the 2000 303(d) List as partially supporting the aquatic life use due to depressed dissolved oxygen. Because an insufficient number of 24-hour dissolved oxygen values were available in 2002 to determine if the criterion is supported, this water body will be identified as not meeting the standard for dissolved oxygen until sufficient 24-hour measurements are available to demonstrate support of the criterion.

Monitoring sites used: Assessment Area	Station ID	Station Description
Entire tidal reach	16060	COLE CREEK AT IH10, 6KM UPSTREAM OF THE CONFL WITH COW BAYOU AND 6.4KM WEST OF ORANGE (1.02 CC)

Segment ID: 0511C **Water body name:** Cole Creek (unclassified water body)

Tidal Stream | Sabine River Basin | Total size: 9.5 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	No Concern	Entire tidal reach	9.5	14	1	
Dissolved Oxygen grab minimum	Fully Supporting	Entire tidal reach	9.5	14	0	
Dissolved Oxygen 24hr average	Not Assessed	Entire tidal reach	9.5	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Entire tidal reach	9.5	0		
Overall Aquatic Life Use	Fully Supporting	Entire tidal reach	9.5			
Contact Recreation Use						
Enterococci single sample	Not Assessed	Entire tidal reach	9.5	0		
Enterococci geometric mean	Not Assessed	Entire tidal reach	9.5	0		
Fecal coliform single sample	Not Supporting	Entire tidal reach	9.5	30	11	
Fecal coliform geometric mean	Fully Supporting	Entire tidal reach	9.5	30		159
Overall Recreation Use	Not Supporting	Entire tidal reach	9.5			
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Entire tidal reach	9.5			
Overall Use Support						
	Not Supporting	Entire tidal reach	9.5			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Entire tidal reach	9.5	4	0	
Nitrite + Nitrate Nitrogen	No Concern	Entire tidal reach	9.5	10	0	
Orthophosphorus	No Concern	Entire tidal reach	9.5	11	0	

Segment ID: 0511C **Water body name:** Cole Creek (unclassified water body)

Tidal Stream | Sabine River Basin | Total size: 9.5 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Nutrient Enrichment Concern (continued)						
Total Phosphorus	Not Assessed	Entire tidal reach	9.5	0		
Overall Nutrient Enrichment Concerns	No Concern	Entire tidal reach	9.5			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Entire tidal reach	9.5	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Entire tidal reach	9.5			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Entire tidal reach	9.5			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Entire tidal reach	9.5			
Overall Secondary Concern						
	No Concern	Entire tidal reach	9.5			

(based on data from 03/01/1996 to 02/28/2001)

Coon Bayou (unclassified water body)

Segment: 0511B Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence with Cow Bayou up to the extent of tidal limit in Orange County
Water body classification: Unclassified
Water body type: Tidal Stream
Water body length / area: 4.7 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
Entire tidal reach	Aquatic Life Use	Partially Supporting	depressed dissolved oxygen	5c
Entire tidal reach	Contact Recreation Use	Not Supporting	bacteria	5c

Additional Information: The fish consumption use was not assessed.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
Entire tidal reach	Aquatic Life Use	Use Concern	depressed dissolved oxygen

Monitoring sites used: Assessment Area	Station ID	Station Description
Entire tidal reach	16052	COONS BAYOU AT SH87, 2.4KM NE OF BRIDGE CITY, 2.1KM UPSTREAM OF THE CONFL WITH COW BAYOU (1.02 CNB)

Segment ID: 0511B **Water body name:** Coon Bayou (unclassified water body)

Tidal Stream | Sabine River Basin | Total size: 4.7 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Use Concern	Entire tidal reach	4.7	17	10	
Dissolved Oxygen grab minimum	Partially Supporting	Entire tidal reach	4.7	17	6	
Dissolved Oxygen 24hr average	Not Assessed	Entire tidal reach	4.7	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Entire tidal reach	4.7	0		
Overall Aquatic Life Use	Partially Supporting	Entire tidal reach	4.7			
Contact Recreation Use						
Enterococci single sample	Not Assessed	Entire tidal reach	4.7	0		
Enterococci geometric mean	Not Assessed	Entire tidal reach	4.7	0		
Fecal coliform single sample	Not Supporting	Entire tidal reach	4.7	21	16	
Fecal coliform geometric mean	Not Supporting	Entire tidal reach	4.7	21		1,002
Overall Recreation Use	Not Supporting	Entire tidal reach	4.7			
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Entire tidal reach	4.7			
Overall Use Support						
	Not Supporting	Entire tidal reach	4.7			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Entire tidal reach	4.7	2	1	
Nitrite + Nitrate Nitrogen	Not Assessed	Entire tidal reach	4.7	4	0	
Orthophosphorus	Not Assessed	Entire tidal reach	4.7	6	0	

Segment ID: 0511B **Water body name:** Coon Bayou (unclassified water body)

Tidal Stream | Sabine River Basin | Total size: 4.7 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Nutrient Enrichment Concern (continued)						
Total Phosphorus	Not Assessed	Entire tidal reach	4.7	0		
Overall Nutrient Enrichment Concerns	Not Assessed	Entire tidal reach	4.7			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Entire tidal reach	4.7	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Entire tidal reach	4.7			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Entire tidal reach	4.7			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Entire tidal reach	4.7			
Overall Secondary Concern						
	No Concern	Entire tidal reach	4.7			

(based on data from 03/01/1996 to 02/28/2001)

Cow Bayou Above Tidal (unclassified water body)

Segment: 0511A Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From a point 4.8 km (3.0 miles) upstream of IH 10 in Orange County to the upstream perennial portion of the stream northeast of Vidor in Orange County
Water body classification: Unclassified
Water body type: Freshwater Stream
Water body length / area: 10.6 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
Upper 5.3 miles of above-tidal reach	Aquatic Life Use	Partially Supporting	depressed dissolved oxygen	5c

Parameters Removed from the 2000 303(d) List: bacteria

Additional Information: The contact recreation use is fully supported. The fish consumption use was not assessed.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
Lower 5.3 miles of above-tidal reach	Contact Recreation Use	Use Concern	bacteria
Upper 5.3 miles of above-tidal reach	Aquatic Life Use	Use Concern	depressed dissolved oxygen

Monitoring sites used: Assessment Area	Station ID	Station Description
Lower 5.3 miles of above-tidal reach	10337	COW BAYOU AT SH12 SW OF MAURICEVILLE, TX, SUBWATRSHED 1.02 (CB6)
Upper 5.3 miles of above-tidal reach	16058	COW BAYOU AT JASPER CR826, 7.3KM NORTH OR MAURICEVILLE (1.02 CB7)

Segment ID: 0511A **Water body name:** Cow Bayou Above Tidal (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 10.6 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	No Concern	Lower 5.3 miles of above-tidal reach	5.3	21	2	
Dissolved Oxygen grab average	Use Concern	Upper 5.3 miles of above-tidal reach	5.3	18	6	
Dissolved Oxygen grab minimum	Fully Supporting	Lower 5.3 miles of above-tidal reach	5.3	21	0	
Dissolved Oxygen grab minimum	Partially Supporting	Upper 5.3 miles of above-tidal reach	5.3	18	6	
Dissolved Oxygen 24hr average	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	0		
Dissolved Oxygen 24hr average	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	0		
Overall Aquatic Life Use	Fully Supporting	Lower 5.3 miles of above-tidal reach	5.3			
Overall Aquatic Life Use	Partially Supporting	Upper 5.3 miles of above-tidal reach	5.3			
Contact Recreation Use						
E. coli single sample	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	0		
E. coli single sample	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	0		
E. coli geometric mean	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	0		
E. coli geometric mean	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	0		
Fecal coliform single sample	Use Concern	Lower 5.3 miles of above-tidal reach	5.3	21	6	
Fecal coliform single sample	Fully Supporting	Upper 5.3 miles of above-tidal reach	5.3	20	4	
Fecal coliform geometric mean	Fully Supporting	Lower 5.3 miles of above-tidal reach	5.3	21		183
Fecal coliform geometric mean	Fully Supporting	Upper 5.3 miles of above-tidal reach	5.3	20		174
Overall Recreation Use	Fully Supporting	Lower 5.3 miles of above-tidal reach	5.3			
Overall Recreation Use	Fully Supporting	Upper 5.3 miles of above-tidal reach	5.3			

Segment ID: 0511A **Water body name:** Cow Bayou Above Tidal (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 10.6 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3			
Overall Fish Consumption Use	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3			
Overall Use Support						
	Fully Supporting	Lower 5.3 miles of above-tidal reach	5.3			
	Partially Supporting	Upper 5.3 miles of above-tidal reach	5.3			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	2	1	
Ammonia Nitrogen	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	2	0	
Nitrite + Nitrate Nitrogen	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	4	0	
Nitrite + Nitrate Nitrogen	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	3	0	
Orthophosphorus	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	7	0	
Orthophosphorus	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	6	0	
Total Phosphorus	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	0		
Total Phosphorus	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	0		
Overall Nutrient Enrichment Concerns	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3			
Overall Nutrient Enrichment Concerns	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3	0		
Chlorophyll a	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3			

Segment ID: 0511A **Water body name:** Cow Bayou Above Tidal (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 10.6 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Sediment Contaminants Concern (continued)						
Overall Sediment Contaminant Concerns	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Lower 5.3 miles of above-tidal reach	5.3			
Overall Fish Tissue Contaminant Concerns	Not Assessed	Upper 5.3 miles of above-tidal reach	5.3			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Lower 5.3 miles of above-tidal reach	5.3			
Overall Narrative Criteria Concerns	No Concern	Upper 5.3 miles of above-tidal reach	5.3			
Overall Secondary Concern						
	No Concern	Lower 5.3 miles of above-tidal reach	5.3			
	No Concern	Upper 5.3 miles of above-tidal reach	5.3			

(based on data from 03/01/1996 to 02/28/2001)

Cow Bayou Tidal

Segment: 0511 Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence with the Sabine River in Orange County to a point 4.8 km (3.0 miles) upstream of IH 10 in Orange County
Water body classification: Classified
Water body type: Tidal Stream
Water body length / area: 20 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, General Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
5 mile reach near FM 1442 (north crossing)	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5b
6 mile reach near FM 105	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5b
Lower 5 miles	Contact Recreation Use	Not Supporting	bacteria	5c
Upper 4 miles	Aquatic Life Use	Partially Supporting	depressed dissolved oxygen	5b
Upper 4 miles	Contact Recreation Use	Not Supporting	bacteria	5c
Upper 4 miles	General Use	Partially Supporting	low pH	5b

Standards Not Met in Previous Years Assessment Area	Use	Support Status	Parameter	Category
Lower 5 miles	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5b

Additional Information: The fish consumption use was not assessed.

This segment was identified on the 2000 303(d) List as not supporting the aquatic life use due to depressed dissolved oxygen in the lower 5 miles. Because an insufficient number of 24-hour dissolved oxygen values were available in 2002 to determine if the criterion is supported, this portion of the segment will be identified as not meeting the standard for dissolved oxygen until sufficient 24-hour measurements are available to demonstrate support of the criterion.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
5 mile reach near FM 1442 (north crossing)	Aquatic Life Use	Use Concern	depressed dissolved oxygen
5 mile reach near FM 1442 (north crossing)	General Use	Use Concern	low pH

(based on data from 03/01/1996 to 02/28/2001)

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
6 mile reach near FM 105	Aquatic Life Use	Use Concern	depressed dissolved oxygen
Lower 5 miles	Aquatic Life Use	Use Concern	depressed dissolved oxygen
Upper 4 miles	Aquatic Life Use	Use Concern	depressed dissolved oxygen
Upper 4 miles	Contact Recreation Use	Use Concern	bacteria

Monitoring sites used: Assessment Area	Station ID	Station Description
5 mile reach near FM 1442 (north crossing)	13781	COW BAYOU AT FM1442 (NORTH CROSSING) BETWEEN FM105 AND IH10, SUBWATERSHED 1.02 (CB4)
6 mile reach near FM 105	10453	COW BAYOU AT FM 105 WEST OF ORANGE, TX SUBWATERSHED 1.02 (CB3)
Lower 5 miles	10449	COW BAYOU AT FM1442 (DOWNSTREAM CROSSING, ROUND BUNCH RD) EAST OF BRIDGE CITY, TX , SW 1.02 (CB1)
Upper 4 miles	10457	COW BAYOU AT IH10 WEST OF ORANGE, TX, SUBWATERSHED 1.02 (CB5)

Published studies: Publication	Date	Author
IS 77 Cow Bayou	Aug. 1985	Kirkpatrick, J.
IS 88-02 Cow Bayou	Sept. 1986	Kirkpatrick, J.

Segment ID: 0511 **Water body name:** Cow Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 20 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Use Concern	5 mile reach near FM 1442 (north crossing)	5	61	35	
Dissolved Oxygen grab average	Use Concern	6 mile reach near FM 105	6	55	25	
Dissolved Oxygen grab average	Use Concern	Lower 5 miles	5	57	14	
Dissolved Oxygen grab average	Use Concern	Upper 4 miles	4	20	9	
Dissolved Oxygen grab minimum	Not Supporting	5 mile reach near FM 1442 (north crossing)	5	61	28	
Dissolved Oxygen grab minimum	Not Supporting	6 mile reach near FM 105	6	55	18	
Dissolved Oxygen grab minimum	Fully Supporting	Lower 5 miles	5	57	2	
Dissolved Oxygen grab minimum	Partially Supporting	Upper 4 miles	4	20	5	
Dissolved Oxygen 24hr average	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	0		
Dissolved Oxygen 24hr average	Not Assessed	6 mile reach near FM 105	6	0		
Dissolved Oxygen 24hr average	Not Assessed	Lower 5 miles	5	0		
Dissolved Oxygen 24hr average	Not Assessed	Upper 4 miles	4	0		
Dissolved Oxygen 24hr minimum	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	0		
Dissolved Oxygen 24hr minimum	Not Assessed	6 mile reach near FM 105	6	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Lower 5 miles	5	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Upper 4 miles	4	0		
Acute Metals in water	No Concern-Limited Data	5 mile reach near FM 1442 (north crossing)	5	5	0	
Acute Metals in water	No Concern-Limited Data	6 mile reach near FM 105	6	5	0	
Acute Metals in water	No Concern-Limited Data	Lower 5 miles	5	5	0	
Chronic Metals in water	No Concern-Limited Data	5 mile reach near FM 1442 (north crossing)	5	5		
Chronic Metals in water	No Concern-Limited Data	6 mile reach near FM 105	6	5		
Chronic Metals in water	No Concern-Limited Data	Lower 5 miles	5	5		
Overall Aquatic Life Use	Not Supporting	5 mile reach near FM 1442 (north crossing)	5			

Segment ID: 0511 **Water body name:** Cow Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 20 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use (continued)						
Overall Aquatic Life Use	Not Supporting	6 mile reach near FM 105	6			
Overall Aquatic Life Use	Fully Supporting	Lower 5 miles	5			
Overall Aquatic Life Use	Partially Supporting	Upper 4 miles	4			
Contact Recreation Use						
Enterococci single sample	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	0		
Enterococci single sample	Not Assessed	6 mile reach near FM 105	6	0		
Enterococci single sample	Not Assessed	Lower 5 miles	5	0		
Enterococci single sample	Not Assessed	Upper 4 miles	4	0		
Enterococci geometric mean	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	0		
Enterococci geometric mean	Not Assessed	6 mile reach near FM 105	6	0		
Enterococci geometric mean	Not Assessed	Lower 5 miles	5	0		
Enterococci geometric mean	Not Assessed	Upper 4 miles	4	0		
Fecal coliform single sample	Fully Supporting	5 mile reach near FM 1442 (north crossing)	5	56	14	
Fecal coliform single sample	Fully Supporting	6 mile reach near FM 105	6	49	11	
Fecal coliform single sample	Not Supporting	Lower 5 miles	5	54	20	
Fecal coliform single sample	Use Concern	Upper 4 miles	4	21	6	
Fecal coliform geometric mean	Fully Supporting	5 mile reach near FM 1442 (north crossing)	5	56		117
Fecal coliform geometric mean	Fully Supporting	6 mile reach near FM 105	6	49		110
Fecal coliform geometric mean	Not Supporting	Lower 5 miles	5	54		283
Fecal coliform geometric mean	Not Supporting	Upper 4 miles	4	21		223
Overall Recreation Use	Fully Supporting	5 mile reach near FM 1442 (north crossing)	5			
Overall Recreation Use	Fully Supporting	6 mile reach near FM 105	6			
Overall Recreation Use	Not Supporting	Lower 5 miles	5			
Overall Recreation Use	Not Supporting	Upper 4 miles	4			

Segment ID: 0511 **Water body name:** Cow Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 20 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
General Use						
Water Temperature	Fully Supporting	5 mile reach near FM 1442 (north crossing)	5	61	0	
Water Temperature	Fully Supporting	6 mile reach near FM 105	6	55	0	
Water Temperature	Fully Supporting	Lower 5 miles	5	57	0	
Water Temperature	Fully Supporting	Upper 4 miles	4	20	0	
pH	Use Concern	5 mile reach near FM 1442 (north crossing)	5	57	7	
pH	Fully Supporting	6 mile reach near FM 105	6	52	3	
pH	Fully Supporting	Lower 5 miles	5	57	0	
pH	Partially Supporting	Upper 4 miles	4	20	5	
Overall General Use	Fully Supporting	5 mile reach near FM 1442 (north crossing)	5			
Overall General Use	Fully Supporting	6 mile reach near FM 105	6			
Overall General Use	Fully Supporting	Lower 5 miles	5			
Overall General Use	Partially Supporting	Upper 4 miles	4			
Fish Consumption Use						
Human Health Criteria Metals	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	2		
Human Health Criteria Metals	Not Assessed	6 mile reach near FM 105	6	2		
Human Health Criteria Metals	Not Assessed	Lower 5 miles	5	2		
Overall Fish Consumption Use	Not Assessed	5 mile reach near FM 1442 (north crossing)	5			
Overall Fish Consumption Use	Not Assessed	6 mile reach near FM 105	6			
Overall Fish Consumption Use	Not Assessed	Lower 5 miles	5			
Overall Fish Consumption Use	Not Assessed	Upper 4 miles	4			
Overall Use Support						
	Not Supporting	5 mile reach near FM 1442 (north crossing)	5			
	Not Supporting	6 mile reach near FM 105	6			

Segment ID: 0511 **Water body name:** Cow Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 20 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Overall Use Support (continued)						
	Not Supporting	Lower 5 miles	5			
	Not Supporting	Upper 4 miles	4			
Nutrient Enrichment Concern						
Ammonia Nitrogen	No Concern	5 mile reach near FM 1442 (north crossing)	5	11	0	
Ammonia Nitrogen	Not Assessed	6 mile reach near FM 105	6	9		
Ammonia Nitrogen	No Concern	Lower 5 miles	5	31	3	
Ammonia Nitrogen	Not Assessed	Upper 4 miles	4	2		
Nitrite + Nitrate Nitrogen	No Concern	5 mile reach near FM 1442 (north crossing)	5	34	0	
Nitrite + Nitrate Nitrogen	No Concern	6 mile reach near FM 105	6	28	1	
Nitrite + Nitrate Nitrogen	No Concern	Lower 5 miles	5	36	6	
Nitrite + Nitrate Nitrogen	Not Assessed	Upper 4 miles	4	4		
Orthophosphorus	No Concern	5 mile reach near FM 1442 (north crossing)	5	37	0	
Orthophosphorus	No Concern	6 mile reach near FM 105	6	30	0	
Orthophosphorus	No Concern	Lower 5 miles	5	38	0	
Orthophosphorus	Not Assessed	Upper 4 miles	4	7		
Total Phosphorus	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	1		
Total Phosphorus	Not Assessed	6 mile reach near FM 105	6	7		
Total Phosphorus	No Concern	Lower 5 miles	5	17	0	
Total Phosphorus	Not Assessed	Upper 4 miles	4	0		
Overall Nutrient Enrichment Concerns	No Concern	5 mile reach near FM 1442 (north crossing)	5			
Overall Nutrient Enrichment Concerns	No Concern	6 mile reach near FM 105	6			
Overall Nutrient Enrichment Concerns	No Concern	Lower 5 miles	5			
Overall Nutrient Enrichment Concerns	Not Assessed	Upper 4 miles	4			

Segment ID: 0511 **Water body name:** Cow Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 20 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Algal Growth Concern						
Chlorophyll a	Not Assessed	5 mile reach near FM 1442 (north crossing)	5	0		
Chlorophyll a	Not Assessed	6 mile reach near FM 105	6	6		
Chlorophyll a	Not Assessed	Lower 5 miles	5	0		
Chlorophyll a	Not Assessed	Upper 4 miles	4	0		
Sediment Contaminants Concern						
Metals in sediment	Not Assessed	6 mile reach near FM 105	6	1		
Overall Sediment Contaminant Concerns	Not Assessed	5 mile reach near FM 1442 (north crossing)	5			
Overall Sediment Contaminant Concerns	Not Assessed	6 mile reach near FM 105	6			
Overall Sediment Contaminant Concerns	Not Assessed	Lower 5 miles	5			
Overall Sediment Contaminant Concerns	Not Assessed	Upper 4 miles	4			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	5 mile reach near FM 1442 (north crossing)	5			
Overall Fish Tissue Contaminant Concerns	Not Assessed	6 mile reach near FM 105	6			
Overall Fish Tissue Contaminant Concerns	Not Assessed	Lower 5 miles	5			
Overall Fish Tissue Contaminant Concerns	Not Assessed	Upper 4 miles	4			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	5 mile reach near FM 1442 (north crossing)	5			
Overall Narrative Criteria Concerns	No Concern	6 mile reach near FM 105	6			

Segment ID: 0511 **Water body name:** Cow Bayou Tidal

Tidal Stream | Sabine River Basin | Total size: 20 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Narrative Criteria Concern (continued)						
Overall Narrative Criteria Concerns	No Concern	Lower 5 miles	5			
Overall Narrative Criteria Concerns	No Concern	Upper 4 miles	4			
Overall Secondary Concern						
	No Concern	5 mile reach near FM 1442 (north crossing)	5			
	No Concern	6 mile reach near FM 105	6			
	No Concern	Lower 5 miles	5			
	No Concern	Upper 4 miles	4			

(based on data from 03/01/1996 to 02/28/2001)

Hudson Gully (unclassified water body)

Segment: 0508C Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence with Adams Bayou to the headwaters near US 890 in Pinehurst in Orange County
Water body classification: Unclassified
Water body type: Tidal Stream
Water body length / area: 0.5 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
Entire creek	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5c
Entire creek	Contact Recreation Use	Not Supporting	bacteria	5a

Additional Information: The fish consumption use was not assessed.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
Entire creek	Aquatic Life Use	Use Concern	depressed dissolved oxygen

Monitoring sites used: Assessment Area	Station ID	Station Description
Entire creek	16041	HUDSON GULLY AT LEXINGTON DR., 0.6 KM UPSTREAM FROM CONFL WITH ADAMS BAYOU IN PINEHURST (SUBWATERSHED 1.03 HG)

Segment ID: 0508C **Water body name:** Hudson Gully (unclassified water body)

Tidal Stream | Sabine River Basin | Total size: 0.5 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Use Concern	Entire creek	0.5	18	12	
Dissolved Oxygen grab minimum	Not Supporting	Entire creek	0.5	18	10	
Dissolved Oxygen 24hr average	Not Assessed	Entire creek	0.5	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Entire creek	0.5	0		
Overall Aquatic Life Use	Not Supporting	Entire creek	0.5			
Contact Recreation Use						
Enterococci single sample	Not Assessed	Entire creek	0.5	0		
Enterococci geometric mean	Not Assessed	Entire creek	0.5	0		
Fecal coliform single sample	Not Supporting	Entire creek	0.5	30	25	
Fecal coliform geometric mean	Not Supporting	Entire creek	0.5	30		2,159
Overall Recreation Use	Not Supporting	Entire creek	0.5			
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Entire creek	0.5			
Overall Use Support						
	Not Supporting	Entire creek	0.5			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Entire creek	0.5	5	1	
Nitrite + Nitrate Nitrogen	No Concern	Entire creek	0.5	10	0	
Orthophosphorus	Not Assessed	Entire creek	0.5	9	2	

Segment ID: 0508C **Water body name:** Hudson Gully (unclassified water body)

Tidal Stream | Sabine River Basin | Total size: 0.5 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Nutrient Enrichment Concern (continued)						
Total Phosphorus	Not Assessed	Entire creek	0.5	0		
Overall Nutrient Enrichment Concerns	No Concern	Entire creek	0.5			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Entire creek	0.5	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Entire creek	0.5			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Entire creek	0.5			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Entire creek	0.5			
Overall Secondary Concern						
	No Concern	Entire creek	0.5			

(based on data from 03/01/1996 to 02/28/2001)

Gum Gully (unclassified water body)

Segment: 0508B Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence of Adams Bayou to the upstream perennial portion of the stream northwest of Orange in Orange County
Water body classification: Unclassified
Water body type: Freshwater Stream
Water body length / area: 3.5 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in Previous Years Assessment Area	Use	Support Status	Parameter	Category
Entire creek	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5c
Entire creek	Contact Recreation Use	Not Supporting	bacteria	5c

Additional Information: The fish consumption use was not assessed.

This water body was identified on the 2000 303(d) List as not supporting the contact recreation use due to bacteria. Because there were insufficient data available in 2002 to evaluate changes in water quality, this water body will be identified as not meeting the standard for bacteria until sufficient data are available to demonstrate use support.

This water body was also identified on the 2000 303(d) List as not supporting the aquatic life use due to depressed dissolved oxygen. Because an insufficient number of 24-hour dissolved oxygen values were available in 2002 to determine if the criterion is supported, this water body will be identified as not meeting the standard for dissolved oxygen until sufficient 24-hour measurements are available to demonstrate support of the criterion.

Monitoring sites used: Assessment Area	Station ID	Station Description
Entire creek	16049	GUM GULLY AT HALLIBURTON RD 1.1KM UPSTREAM OF CONFL WITH ADAMS BAYOU (1.03 GG)

Segment ID: 0508B **Water body name:** Gum Gully (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 3.5 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Not Assess-Not Represent	Entire creek	3.5	20	8	
Dissolved Oxygen grab minimum	Not Assess-Not Represent	Entire creek	3.5	20	5	
Dissolved Oxygen 24hr average	Not Assessed	Entire creek	3.5	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Entire creek	3.5	0		
Overall Aquatic Life Use	Not Assessed	Entire creek	3.5			
Contact Recreation Use						
E. coli single sample	Not Assessed	Entire creek	3.5	0		
E. coli geometric mean	Not Assessed	Entire creek	3.5	0		
Fecal coliform single sample	Not Assess-Not Represent	Entire creek	3.5	20	11	
Fecal coliform geometric mean	Not Assess-Not Represent	Entire creek	3.5	20		592
Overall Recreation Use	Not Assessed	Entire creek	3.5			
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Entire creek	3.5			
Overall Use Support						
	Not Assessed	Entire creek	3.5			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Entire creek	3.5	3	1	
Nitrite + Nitrate Nitrogen	Not Assessed	Entire creek	3.5	4	0	
Orthophosphorus	Not Assessed	Entire creek	3.5	4	0	

Segment ID: 0508B **Water body name:** Gum Gully (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 3.5 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Nutrient Enrichment Concern (continued)						
Total Phosphorus	Not Assessed	Entire creek	3.5	0		
Overall Nutrient Enrichment Concerns	Not Assessed	Entire creek	3.5			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Entire creek	3.5	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Entire creek	3.5			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Entire creek	3.5			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Entire creek	3.5			
Overall Secondary Concern						
	No Concern	Entire creek	3.5			

(based on data from 03/01/1996 to 02/28/2001)

Adams Bayou Above Tidal (unclassified water body)

Segment: 0508A Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From a point 1.1 km (0.7 miles) upstream of IH 10 in Orange County to the upstream perennial portion of the stream northwest of Orange in Orange County
Water body classification: Unclassified
Water body type: Freshwater Stream
Water body length / area: 8 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
Entire bayou above tidal	Contact Recreation Use	Not Supporting	bacteria	5c

Standards Not Met in Previous Years Assessment Area	Use	Support Status	Parameter	Category
Entire bayou above tidal	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5b

Additional Information: The fish consumption use was not assessed.

This water body was identified on the 2000 303(d) List as not supporting the aquatic life use due to depressed dissolved oxygen. Because an insufficient number of 24-hour dissolved oxygen values were available in 2002 to determine if the criterion is supported, this water body will be identified as not meeting the standard for dissolved oxygen until sufficient 24-hour measurements are available to demonstrate support of the criterion.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
Entire bayou above tidal	Aquatic Life Use	Use Concern	depressed dissolved oxygen

Monitoring sites used: Assessment Area	Station ID	Station Description
Entire bayou above tidal	14964	ADAMS BAYOU AT FM1078 NW OF ORANGE SUBWATERSHED 1.03 (AB8)
Entire bayou above tidal	15742	ADAMS BAYOU AT FM1130 SE OF MAURICEVILLE, TX SUBWATERSHED 1.03 (AB9)

Segment ID: 0508A **Water body name:** Adams Bayou Above Tidal (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Aquatic Life Use						
Dissolved Oxygen grab average	Use Concern	Entire bayou above tidal	8	37	15	
Dissolved Oxygen grab minimum	Use Concern	Entire bayou above tidal	8	37	5	
Dissolved Oxygen 24hr average	Not Assessed	Entire bayou above tidal	8	0		
Dissolved Oxygen 24hr minimum	Not Assessed	Entire bayou above tidal	8	0		
Chronic Toxicity tests in water	Not Assessed	Entire bayou above tidal	8	1	0	
Overall Aquatic Life Use	Fully Supporting	Entire bayou above tidal	8			
Contact Recreation Use						
E. coli single sample	Not Assessed	Entire bayou above tidal	8	0		
E. coli geometric mean	Not Assessed	Entire bayou above tidal	8	0		
Fecal coliform single sample	Not Supporting	Entire bayou above tidal	8	21	10	
Fecal coliform geometric mean	Not Supporting	Entire bayou above tidal	8	21		528
Overall Recreation Use	Not Supporting	Entire bayou above tidal	8			
Fish Consumption Use						
Overall Fish Consumption Use	Not Assessed	Entire bayou above tidal	8			
Overall Use Support						
	Not Supporting	Entire bayou above tidal	8			
Nutrient Enrichment Concern						
Ammonia Nitrogen	Not Assessed	Entire bayou above tidal	8	5	3	
Nitrite + Nitrate Nitrogen	Not Assessed	Entire bayou above tidal	8	9	0	

Segment ID: 0508A **Water body name:** Adams Bayou Above Tidal (unclassified water body)

Freshwater Stream | Sabine River Basin | Total size: 8 Miles

Assessment Method	Status of Use Support or Concern	Location	Location size	# of samples	# of exceedances	Mean
Nutrient Enrichment Concern (continued)						
Orthophosphorus	Not Assessed	Entire bayou above tidal	8	9	0	
Total Phosphorus	Not Assessed	Entire bayou above tidal	8	0		
Overall Nutrient Enrichment Concerns	Not Assessed	Entire bayou above tidal	8			
Algal Growth Concern						
Chlorophyll a	Not Assessed	Entire bayou above tidal	8	0		
Sediment Contaminants Concern						
Overall Sediment Contaminant Concerns	Not Assessed	Entire bayou above tidal	8			
Fish Tissue Contaminants Concern						
Overall Fish Tissue Contaminant Concerns	Not Assessed	Entire bayou above tidal	8			
Narrative Criteria Concern						
Overall Narrative Criteria Concerns	No Concern	Entire bayou above tidal	8			
Overall Secondary Concern						
	No Concern	Entire bayou above tidal	8			

(based on data from 03/01/1996 to 02/28/2001)

Adams Bayou Tidal

Segment: 0508 Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence with the Sabine River in Orange County to a point 1.1 km (0.7 miles) upstream of IH 10 in Orange County
Water body classification: Classified
Water body type: Tidal Stream
Water body length / area: 8 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, General Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
1 mile reach near Green Avenue	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5c
1 mile reach near Green Avenue	Contact Recreation Use	Not Supporting	bacteria	5c
2 mile reach near Western Avenue	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5c
2 mile reach near Western Avenue	Contact Recreation Use	Not Supporting	bacteria	5a
Lower 3 miles of segment	Aquatic Life Use	Partially Supporting	depressed dissolved oxygen	5c
Upper 2 miles of segment	Aquatic Life Use	Not Supporting	depressed dissolved oxygen	5c
Upper 2 miles of segment	Contact Recreation Use	Not Supporting	bacteria	5c

Additional Information: General uses are fully supported. The fish consumption use was not assessed.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
1 mile reach near Green Avenue	Aquatic Life Use	Use Concern	depressed dissolved oxygen
2 mile reach near Western Avenue	Aquatic Life Use	Use Concern	depressed dissolved oxygen
Lower 3 miles of segment	Aquatic Life Use	Use Concern	depressed dissolved oxygen
Lower 3 miles of segment	Contact Recreation Use	Use Concern	bacteria
Upper 2 miles of segment	Aquatic Life Use	Use Concern	depressed dissolved oxygen
Upper 2 miles of segment	General Use	Use Concern	low and high pH

Monitoring sites used: Assessment Area	Station ID	Station Description
1 mile reach near Green Avenue	16059	ADAMS BAYOU AT GREEN AVE. IN ORANGE (1.03 AB4)
2 mile reach near Western Avenue	10442	ADAMS BAYOU AT WESTERN AVE. IN ORANGE, TX, SUBWATERSHED 1.03 (AB3)
Lower 3 miles of segment	10441	ADAMS BAYOU AT FM1006 IN ORANGE, TX, SUBWATERSHED 1.03 (AB2)

(based on data from 03/01/1996 to 02/28/2001)

Monitoring sites used: Assessment Area	Station ID	Station Description
Upper 2 miles of segment	14990	ADAMS BAYOU AT PARK AVE. IN PINEHURST, TX, 1.4 KM DOWNSTREAM OF IH 10 SUBWATERSHED 1.03 (AB5)

Published studies: Publication	Date	Author
IMS 14 Adams Bayou	June 1974	Twidwell, S.
IS 65 Adams Bayou	Sept. 1982	Werkenthin, F.

(based on data from 03/01/1996 to 02/28/2001)

Terry Gully (unclassified water body)

Segment: 0511E Sabine River Basin

Basin number: 5
Basin group: A
Water body description: From the confluence with Cow Bayou in Orange County to the headwaters northeast of Vidor in Orange County
Water body classification: Unclassified
Water body type: Freshwater Stream
Water body length / area: 8.6 Miles
Water body uses: Aquatic Life Use, Contact Recreation Use, Fish Consumption Use

Standards Not Met in 2002 Assessment Area	Use	Support Status	Parameter	Category
Entire creek	Contact Recreation Use	Not Supporting	bacteria	5c

Additional Information: The aquatic life use is fully supported. The fish consumption use was not assessed.

2002 Concerns: Assessment Area	Use or Concern	Concern Status	Description of Concern
Entire creek	Aquatic Life Use	Use Concern	depressed dissolved oxygen

Monitoring sites used: Assessment Area	Station ID	Station Description
Entire creek	16040	TERRY GULLY AT IH10, 9KM UPSTM OF THE CONFL WITH COW BAYOU AND 8.3KM E. OF THE INTERS OF IH10 AND SH12 IN VIDOR (SUBWATERSHED 1.02 TG)