Final Report
Technical Use Attainability Analysis
Clear Fork Trinity River
(Stream Segments 0831 and 0833)

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INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ) is leading an effort to assess the water quality of classified segment 0831 (Clear Fork Trinity River below Lake Weatherford) and classified segment 0833 (Clear Fork Trinity River above Lake Weatherford). These segments were contained in the 2000 State of Texas Clean Water Act section 303(d) list as impaired due to depressed dissolved oxygen. The segments make up a portion of the Trinity River Basin and are located mostly within Parker County, west of Fort Worth, Texas.

As contracted by TCEQ, assessments of water quality conditions in segments 0831 and 0833 have been conducted by the Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University. The objectives of the assessments were: 1) to provide data necessary to determine if existing Texas Surface Water Quality Standards applicable to each classified segment are appropriate and, if not, provide sufficient information to develop designated uses and/or criteria adjustments, 2) to provide data necessary to determine if appropriate water quality standards are being met in each classified segment, and 3) if necessary, to acquire data and information needed to support modeling and assessment activities required to allocate pollutant loadings in each of the classified segments.

This report presents the findings of TIAER for assessments of both classified segments. The report is, in essence, two subreports that provide physical, chemical, and biological constituents of the aquatic ecosystems for each segment. The purpose of each subreport is to provide the Texas Commission on Environmental Quality with a ‘stand alone’ document summarizing background information and outlining the findings of the water quality assessments in each segment.

CHAPTER 2

SEGMENT 0831 - CLEAR FORK TRINITY RIVER BELOW LAKE WEATHERFORD

2.1 BACKGROUND

2.1.1 Purpose

The Clear Fork Trinity River below Lake Weatherford, classified segment 0831, is contained on the 2000 State of Texas Clean Water Act Section 303(d) list as impaired due to depressed dissolved oxygen. This chapter summarizes relevant background information on water quality issues for the segment and outlines assessment data collected by TIAER under the approved project monitoring plan and quality assurance project plan.

2.1.2 Description of Segment 0831 and Designated Uses

Classified segment 0831, Clear Fork Trinity River below Lake Weatherford, begins immediately below the Lake Weatherford Dam in Parker County and continues to a point 200 meters downstream of US Highway 377 in Tarrant County. The segment extends approximately 19 miles and contains five incorporated areas: Aledo, Annetta, Hudson Oaks, Weatherford, and Willow Park.

Designated uses of segment 0831 are high aquatic life use, contact recreation, and public water supply. The criteria established to protect the designated uses are provided in the Texas Surface Water Quality Standards (TNRCC, 2000). The dissolved oxygen (DO) criteria to protect a high aquatic life use for the segment is a mean DO concentration of 5.0 mg/L and a minimum DO concentration of 3.0 mg/L. These standards are applicable in all seasons except spring, wherein the criterion for mean DO concentration is 5.5 mg/L and the criterion for minimum DO concentration is 4.5 mg/L.

2.1.3 Environmental Features and Population Characteristics

The watershed of segment 0831 experiences a climate that is subtropical subhumid, which is characterized by hot summers and dry winters. Rainfall in the Clear Fork watershed averages about 30 inches per year, and average gross lake surface evaporation is 68 inches per year (Larkin and Bomar, 1983). The watershed is within the Central Oklahoma-Texas Plains, an ecoregion characterized as containing irregular plains with native vegetation comprised of several oak species and grasses such as bluestem and indiangrass.

Since the majority of the watershed of segment 0831 is within Parker County, population data from that county may be used to characterize basic watershed demography. The 1990

population of Parker County was 64,785 and the 2000 population was 80,435, a 10-year increase of 24 percent. However, urban communities within the watershed are experiencing more rapid growth than the county as a whole (Table 2-1). The increase in urban-community population from 1990 to 2000 was nearly 40 percent, and a similar percentage increase is projected for 2000 to 2010. These substantial population increases are likely the result of urbanization pressures from the City of Fort Worth (year 2000 population of 496,622).

Table 2-1. Historical population and population projections for communities in Clear Fork watershed, segment 0831.

Community	1980	1990	2000	2010
Aledo	1,027	1,169	1,633	2,282
Annetta	205	672	945	1,329
Hudson Oaks	309	711	1,440	2,915
Weatherford	12,049	14,804	20,089	27,262
Willow Park	1,113	2,328	3,252	4,544

[1]Sources of population figures: 1980 data from Alan Plummer and Associates (1988); 1990, 2000, and 2010 data from TWDB (2000).

The watershed of segment 0831 of the Clear Fork is generally rural in nature, though the segment does contain a substantial amount of urban land use (Table 2-2, and Figure 2-1). Combined rural areas (range, wooded, and crop/improved pasture) comprise 93 percent of land cover in the watershed of segment 0831 while urban land cover comprises 6.4 percent of the total area. The land use information in Table 2-2 and Figure 2-1 was obtained from the Texas Gap Analysis Project at Texas Tech University, which used 1993-1994 Landsat Thematic Mapper satellite imagery with 90-meter resolution. More recent land use information readily available to this study were not used because of either inadequate resolution or land use results that were contrary to TIAER's observations during reconnaissance in the watershed.

Though the Texas Gap Analysis Project provided the best land use, certain inconsistencies are apparent. For example, the large areas of pure range around Weatherford, Texas (Figure 2-1). Nonetheless, the land use is sufficiently accurate and recent to provide an indication of conditions in the watershed.

Table 2-2. 1993-1994 land cover for segment 0831. (Source: Texas Gap Analysis Project)

Land Cover Category	Acres	Percent of Total
Urban	6,015	6.4%
Crop/Improved Pasture	15,075	16.1%
Range	44,788	47.9%
Wooded	26,932	28.8%
Water	628	0.7%
Other (barren, etc.)	0	0.0%
Total	93,438	-

2.1.4 Permitted Dischargers

Under the Texas Pollution Discharge Elimination System (TPDES), nine entities hold permits within the Clear Fork Segment 0831 (Table 2-3). The City of Weatherford permit allows the largest discharge of any permit at 4.5 million gallons per day (MGD); however, its discharge point is not directly into the Clear Fork. Only the City of Willow Park Wastewater Treatment Plant (WWTP) and the City of Weatherford drinking water treatment plant discharge directly into the Clear Fork Segment 0831. All facilities permitted to allow discharge, with the exception of Pride Companies, L.P., and the Weatherford drinking water treatment facility are for domestic wastewater, and at least secondary treatment levels are the norm. Two of the permits, Deercreek Waterworks, Inc. and Oak Hill Mobile Home Park, specify no discharge and irrigation of effluent. The Cities of Aledo, Weatherford, and Willow Park have effluent limits that require advanced treatment with common limits on carbonaceous BOD_5 (five-day biochemical oxygen demand) of 10 mg/L, total suspended solids (TSS) of 15 mg/L, and ammonia (NH_3) of 3 mg/L. The City of Weatherford WWTP permit limit on ammonia is seasonal and in place for summer months. Various minimum dissolved oxygen (DO) levels are prescribed in each domestic wastewater discharge permit, undoubtedly to maintain certain minimum in-stream DO concentrations in conjunction with prescribed limits for BOD_5 and in some instances NH_3. A review of permit files was conducted by TIAER staff and results were published along with a review of historical water quality data (Hauck and Tanter, 2001). Recent information indicates that during the summer of 2002 the City of Weatherford Water Purification Plant discharge began to be used by Crown Valley Golf Course (personal communication, March 18, 2003, Dania Drogolewicz and John Mummert, TCEQ). Because diversion of the water plant discharge to the golf course is recent, any impact on Clear Fork Trinity River flow is difficult to assess. Expectations are that a portion, if not all, of the present water treatment plant effluent will no longer be discharged into the Clear Fork, at least during drier times of the year.

Figure 2-1. Segment 0831 land cover.

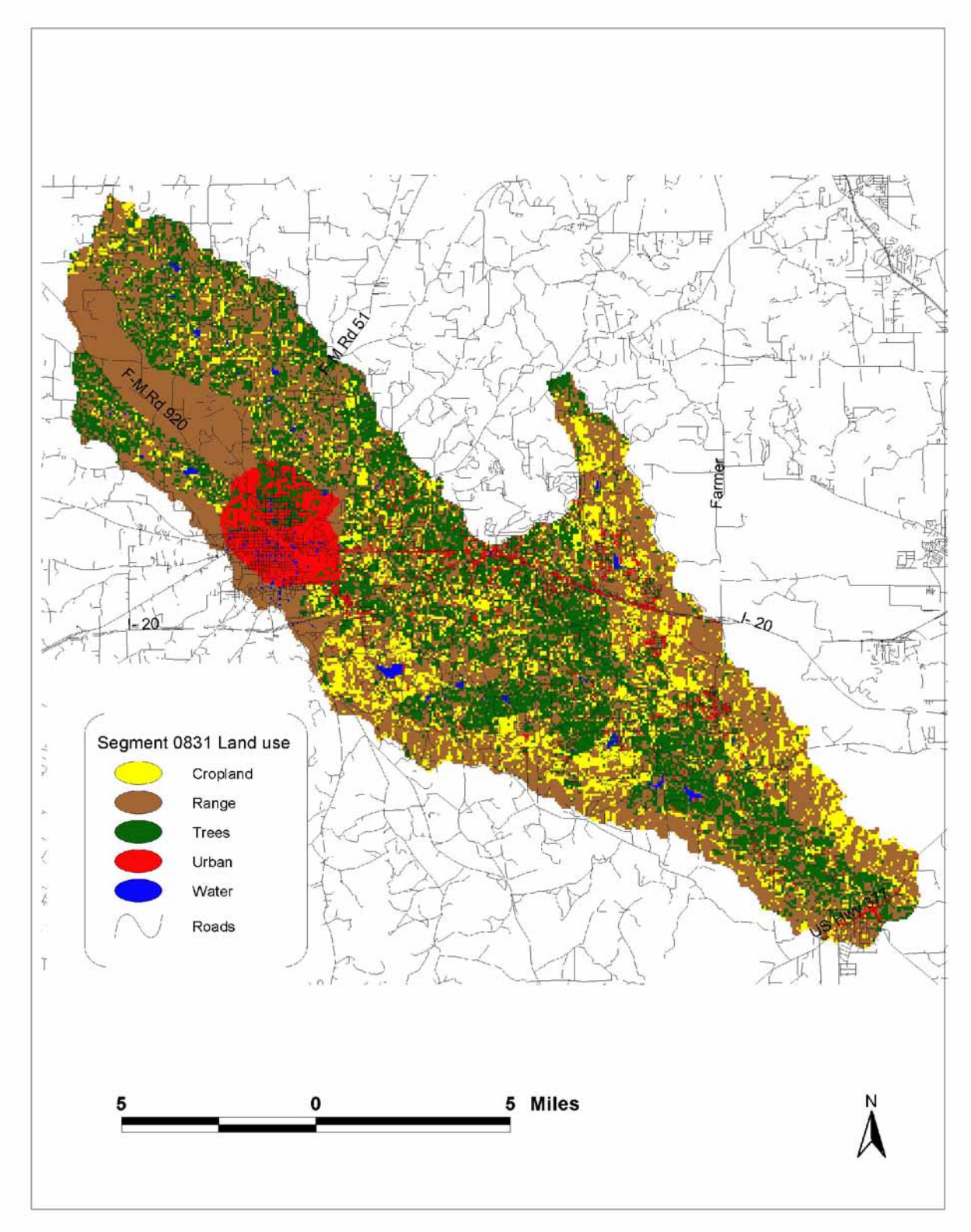

Table 2-3. Information on TPDES permits and permit limits, segment 0831 of the Clear Fork Trinity River.

Name/ Permit No.	Discharge Route	Flow (MGD)	BOD_5 (mg/L)	TSS (mg/L)	NH_3 (mg/L)	Min. DO (mg/L)
Aledo, City of (10847)	Unnamed trib., thence to Clear Fork (Seg. 0831)	0.121	10	15	3	4
Aledo, Ind. School Dist. (13438)	Unnamed trib., thence to Clear Fork (Seg. 0831)	0.015	20	20	NA	3
Cowtown Enterpr. Inc. (14003)	Natural drain., thence to unnamed trib., thence to Clear Fork (Seg. 0831)	0.0216	20	20	NA	2
Deercreek Waterworks, Inc. (13759)	No discharge, domestic sewage effluent irrigation; Clear Fork (Seg. 0831)	NA	NA	NA	NA	NA
Oak Hill Mobile Home Park (14190)	No discharge, domestic sewage effluent irrigation; Clear Fork (Seg. 0831)	NA	NA	NA	NA	NA
Pride Companies, L.P. (03490)	Unnamed trib., thence to Clear Fork (Seg. 0831)	0.00015	NA	NA	NA	NA
Weatherford, City of WWTP (10380)	Town Cr., thence to South Fork, thence to Clear Fork (Seg. 0831)	4.5	10	15	3[1]	6
Weatherford, City of Water Purification Plant (14198)	Clear Fork (Seg. 0831)	0.636	NA	65	NA	NA
Willow Park, City of (13834)	Six-inch pipe into Clear Fork (Seg. 0831)	0.3	10	15	3	5

[1]City of Weatherford has seasonal permit limits from April-October requiring ammonia effluent of 3 mg/L.

2.1.5 Summary of Historical Data

Hauck and Tanter (2001) reported findings from an analysis of historical water quality and biological data collected in segment 0831 of the Clear Fork Trinity River. Historical water quality monitoring in the segment has occurred at station 13691, located at the junction of the Clear Fork Trinity River and U.S. Highway 377, and station 11060, located at the junction of the Clear Fork Trinity River and Interstate Highway (IH) 20 (Figure 2-2). Station 13691 is the long-term TCEQ monitoring station within the segment where water quality data has been collected since the early 1970s. Station 11060 was sampled monthly between the years of 1980 and 1982, when

sampling was discontinued. Sampling at station 11060 was resumed in the early 1990s and continued through the publication of the historical data report. A survey of fish species occurring in segment 0831 was conducted at two stations within the segment by the Texas Parks and Wildlife Department in the mid-1950s (Lamb, 1957). A second fish survey was conducted by a graduate student from The University of Texas at Arlington from July 1971 through May 1972 (Kelly, Jr., 1975). Sampling for this survey was conducted at the location of TCEQ station 13691 and on Segment 0831 at FM 5 near the community of Annetta.

In addition to the analyses of existing water quality data, Hauck and Tanter (2001) also utilized hydrologic records from two United States Geological Survey (USGS) gauging stations and anecdotal records obtained from a landowner questionnaire in order to characterize historical flow conditions in segment 0831. USGS gauging station 0804600 is located 5.6 km upstream of TCEQ water quality monitoring station 13691, and USGS gauging station 08045850 is located at TCEQ water quality monitoring station 11060. Data from the questionnaire distributed to landowners were used to ascertain landowners' recollections of persistence of streamflow and pools along the portion of the Clear Fork of the Trinity for which they had the greatest familiarity.

The results of the historical data review included the following conclusions regarding water quality and flow regime in segment 0831:

1. Hydrologic streamflow records from two USGS stations that have operated in segment 0831 indicate an intermittent system, though the data and conclusion drawn from the data must be viewed with caution. Most recent data (October 1998 to the present) obtained from the more upstream USGS station and taken after refinement of its low flow rating curve indicate nearly perennial flow even during the drought conditions of 1999 and 2000.[1] This conclusion of likely perennial flow is supported by landowner responses to a questionnaire developed for this study. The respondents indicated a stream that has very low flow (often described as a trickle in the summer months), and most respondents indicated that the stream always had some flow. At a minimum segment 0831 appears to be intermittent with perennial pools; however, the segment is likely to be perennial for most of its length.

2. Existing data on nutrients, chlorophyll-α, and dissolved oxygen concentrations show a general trend of spatial increase from the more upstream station (TCEQ station 11060) to the more downstream station (TCEQ station 13691). The increase in nutrients and chlorophyll-α is likely the result of effluents from municipal wastewater treatment plants. The downstream increase in dissolved oxygen, however, is more difficult to explain, and may be the result of increase in flow from upstream to downstream. Particularly in the upper most reaches of segment 0831, flow during

[1] Interestingly, the USGS streamflow record for this station indicates several days of zero flow in September 2001, including September 12th when TIAER staff measured flow at the location (see Table 2-4 of this report).

certain times of the year is comprised in large part of seepage from the Lake Weatherford dam.

3. Evaluation of dissolved oxygen concentrations from routine grab sampling and intensive studies (diurnal deployments of multi-probe instrumentation), indicate that a high aquatic life use is not being fully supported (i.e., not maintaining a mean dissolved oxygen concentration of 5 mg/L and a minimum dissolved oxygen concentration of 3 mg/L). Dissolved oxygen measurements not supporting the high aquatic life use occur most frequently in late summer, though low concentrations are experienced less frequently in the spring and fall.

2.1.6 Introduction to Technical Use Attainability Analysis

TCEQ contracted with TIAER to conduct the suggested monitoring activities in segment 0831. The 2-year monitoring project consisted of three intensive surveys, two 24-hour dissolved oxygen surveys, and seven supplemental surveys. In addition to the intensive, 24-hour dissolved oxygen, and supplemental surveys conducted in segment 0831, two monitoring events were conducted in support of potential water quality modeling to be conducted for the segment. Specific monitoring efforts conducted in each of these surveys were outlined in the Project Monitoring Plan (Jones and Hauck, 2001) and the Quality Assurance Project (TIAER, 2001) plan, and are described in detail below.

2.2 METHODOLOGIES

Monitoring in segment 0831 was conducted in the index periods (March 15 – October 15) of 2001 and 2002. The monitoring effort was initiated in July 2001 so that it was initiated halfway through the index period and within the critical period (July 1 – September 30) of that year. An intensive survey was conducted in August 2001 and a 24-hour dissolved oxygen survey was conducted in September 2001. Supplemental surveys were conducted on segment 0831 in July and October of 2001 to complete the monitoring effort for that year.

Monitoring was resumed in the index period of 2002. Intensive surveys were conducted in May and July-August, while a 24-hour dissolved oxygen survey was conducted in June. Supplemental surveys were conducted on segment 0831 in March, April, August and September. Collection of model support data occurred two times within the critical period of 2002, once in July and once in August.

Locations of the monitoring stations utilized in the assessments are provided below along with descriptions of each individual site. A summary of the monitoring activities conducted at each station is provided later in the section.

2.2.1 Monitoring Locations and Station Descriptions

The monitoring conducted in segment 0831 occurred at 18 stations (Figure 2-3). Intensive surveys, 24-hour DO surveys, and supplemental surveys were conducted at stations 17446, 11060, 17445, 17454, 17444, and 13691. These stations, along with stations 17450, 17458, 17457, 17449, 17452, 17451, 17453, 17637, 17455, 17456, 17448, and 17447, were monitored during model support surveys. The following information is a detailed list describing monitoring station locations within the segment.

Station 17446 is located on the Clear Fork Trinity River at East Lake Drive immediately below the Lake Weatherford dam and upstream of the Willow Park WWTP discharge. The station location allowed an assessment of stream characteristics prior to the introduction of urban effluents. This station was monitored during intensive, 24-hour DO, and supplemental surveys, as well as, model support surveys.

Station 11060, located at the junction of the Clear Fork Trinity River and Interstate Highway (IH) 20, collocated with USGS streamflow gaging station 08045850. TCEQ routinely collects water quality samples at this station. The station was monitored during intensive, 24-hour DO, and supplemental surveys, as well as, model support surveys.

Station 17445 is located at the junction of the Clear Fork Trinity River and Underwood Road west of Aledo, immediately upstream of the Clear Fork-South Fork confluence. The station was used in conjunction with Station 17444 to assess the impacts of the South Fork inflows on the Clear Fork. This station was monitored during intensive, 24-hour DO, and supplemental surveys, as well as, model support surveys.

Station 17454 is located on the South Fork at the lowest accessible point prior to its confluence with the Clear Fork and allows characterization of South Fork flow immediately before entry into the Clear Fork. This station was monitored during intensive, 24-hour DO, and supplemental surveys, as well as, model support surveys. (Note that biological sampling did not occur at this station during intensive surveys.)

Station 17444 is located at the junction of the Clear Fork Trinity River and Farm to Market Road (FM) 5 southwest of Aledo, Texas. It is located below the confluence of the Clear Fork with the South Fork, which drains the urban area associated with Weatherford, Texas and is the largest tributary of Clear Fork. This station was monitored during intensive, 24-hour DO, and supplemental surveys, as well as, model support surveys.

Station 13691 is located at the junction of the Clear Fork Trinity River and U.S. Highway 377,
near the lower limit of the stream segment. This station is routinely monitored by TCEQ. This station was monitored during intensive, 24-hour DO, and supplemental surveys, as well as, model support surveys.
Figure 2-3. Segment 0831 Survey monitoring stations.

directly into the Clear Fork. This station was monitored in the model support surv

Station 17458 is located at Kings Gate Road near Squaw Creek Downs Racetrack
Creek. This location is the lowest readily accessible point on Squaw Creek, a majo
of the Clear Fork. This station was schedule to be monitored in the model support
however, extremely low flows present during both model support surveys preclude
monitoring.

Station 17457 is located on Town Creek at U.S. Highway 80, upstream of the disc
the City of Weatherford WWTP. The station provides characterization of Town C
quality prior to the WWTP discharge. The station was monitored in the model sup
surveys.

Station 17449 is located at the outfall of the City of Weatherford WWTP. This sta
monitored in the model support surveys.

Station 17452 is located at Bankhead Highway on Willow Creek, the major tributa
South Fork. This station was monitored in the model support surveys.

Station 17451 is located on Town Creek at Center Point Road just south of IH 20
Creek is the receiving water for the City of Weatherford WWTP effluent, and this
the lowest accessible crossing prior to the confluence of Town Creek and Willow C
station was monitored in the model support surveys.

Station 17453 is located at Center Point Road in Annetta, Texas, on the lowest acc
point on Burgess Creek, a major tributary of the South Fork. This station was mo
the model support surveys.

Station 17637 is located at the junction of the Clear Fork and Crown Road upstrea
Willow Park WWTP. This station was added in July 2002 to allow assessment of
constructed dam across the Clear Fork. The station was monitored in the model su
surveys.

Station 17455**,** located approximately mid-reach along the South Fork at FM 5 in A
Texas, is intended to assist in characterizing the influence of the City of Weatherfo
discharge on the South Fork. This station was monitored in the model support surv

Station 17456 is located at Old Annetta Road west of Aledo, Texas, on Rufe Evan
tributary to the South Fork of sufficient size to warrant monitoring when flow is pr
station was monitored in the model support surveys.

Station 17448 is located at the outfall of the City of Aledo WWTP. This station w
monitored in the model support surveys.

Station 17447 is located on the unnamed receiving stream of the City of Aledo WWTP effluent, immediately upstream of the stream's confluence with the Clear Fork. This station was monitored in the model support surveys.

2.2.2 Intensive Surveys

As previously stated, a total of three (3) intensive surveys were conducted in segment 0831 within the index periods of years 2001 and 2002. One intensive survey occurred within the critical period of both 2001 and 2002, while the third intensive survey occurred outside this time frame (though within the index period) in the year 2002. The third intensive survey was desired to occur during the spawning season.[2] All three intensive surveys were conducted at stations 17446, 11060, 17445, 17444, and 13691. Intensive surveys included biological and chemical assessments of stream conditions and water quality, and a 24-hour continuous (15-minute interval) measurement of dissolved oxygen conditions at each station. All assessments conducted during the intensive surveys followed the guidelines established in the State of Texas Receiving Water Assessment Procedures Manual (TNRCC, 1999).

Specific monitoring activities conducted during the biological assessments of the intensive surveys within segment 0831 included: assessments of physical stream habitat, assessments of benthic macroinvertebrate communities, and assessments of fish communities. Data collected in each of these efforts allowed for the determination of an aquatic life use rank based on metric indices established by the State of Texas. The aquatic life use score for physical habitat at a particular station was determined using the Habitat Quality Index available from the State of Texas Receiving Water Assessment Procedures Manual (TNRCC, 1999). Also available in the RWA Procedures Manual are the metric indices used for quantitative biological scoring of fish and benthic macroinvertebrate communities (TNRCC, 1999). The biological scoring was based on Fish Statewide Criteria and Benthic Scoring for Kick Samples, Rapid Bioassessment Protocol.

In addition to the biological assessments, intensive surveys also included measurements of streamflow and diurnal dissolved oxygen concentrations at each station within the segment. Other physical parameters, such as temperature, pH, and conductivity were recorded in conjunction with DO concentration at 15-minute intervals at each station. A single water quality sample was also taken within the 24-hour time period in which the physical measurements were logged. The sample from each station was analyzed for ammonia, chloride, chlorophyll-a, pheophytin-a, nitrate+nitrite nitrogen, orthophosphate phosphorus, total phosphorus, sulfate, total alkalinity, total dissolved solids, total Kjeldahl nitrogen, total organic carbon, total suspended solids, volatile suspended solids, and 5-day carbonaceous biochemical oxygen demand. Anecdotal (Appendix A) and pictorial records were also collected at each station during these surveys.

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[2] During this study, the spawning season intensive survey occurred in early to mid May 2002. A major scour event in March 2002 delayed the intensive survey until the benthic community could have time to reestablish.

Station 17454 on the South Fork immediately above its confluence with the Clear Fork was monitored for streamflow and physical and chemical constituents during each intensive survey, because the South Fork represents a major contribution to flow in the segment. Biological assessments were, however, not conducted at station 17454.

2.2.3 24-hour Water Quality Surveys

TIAER conducted two additional and separate 24-hour surveys of water quality conditions in segment 0831 between the years 2001 and 2002. The initial 24-hour DO survey occurred in September 2001, within the critical period of that calendar year. The second survey occurred in June 2002, outside the critical period but within the index period of that year. The surveys were conducted, in both time periods, at stations 17446, 11060, 17445, 17454, 17444, and 13691. The 24-hour water quality surveys included measurements of streamflow and a diurnal record of DO, water temperature, pH, and conductivity conditions at each station within the segment. All 24-hour measurements were conducted on 15-minute intervals. In addition, a single water quality grab sample was taken at each station within the 24-hour time frame and analyzed for ammonia, chloride, chlorophyll-a, pheophytin-a, nitrate+nitrite nitrogen, orthophosphate phosphorus, total phosphorus, sulfate, total alkalinity, total dissolved solids, total Kjeldahl nitrogen, total organic carbon, total suspended solids, volatile suspended solids, and 5-day carbonaceous biochemical oxygen demand. Anecdotal (Appendix A) and pictorial records were also collected at each station during these surveys.

2.2.4 Supplemental Surveys

Supplemental surveys were conducted on a monthly basis during the index periods of 2001 and 2002 beginning in July 2001. These surveys were conducted at stations 17446, 11060, 17445, 17454, 17444, and 13691. Supplemental surveys consisted of instantaneous measurements of streamflow, DO, water temperature, pH, and conductivity at each water quality monitoring location. Additionally, anecdotal (Appendix A) and pictorial records were collected at each station during these surveys.

2.2.5 Receiving Stream and WWTP Surveys

In support of potential water quality modeling efforts for segment 0831, TIAER conducted receiving stream and WWTP surveys on Segment 0831 in July and August 2002. These surveys were conducted at all water quality monitoring stations in the segment. Receiving stream and WWTP surveys included diurnal measurements of water quality and physical stream conditions. At most stations, a water quality grab sample was taken and physical stream conditions were instantaneously measured on 6-hour intervals over a 24-hour period. At other stations, automated water sampling instrumentation was utilized along side multiprobe sondes capable of logging physical stream conditions. At stations where sondes were deployed for the 24-hour period, measurements were made at 15-minute intervals.

Mean, minimum, and maximum values of DO, water temperature, pH, and conductivity were determined from both the 15-minute interval logged data and the 6-hour interval instantaneous data. The water quality grab samples from stream stations collected over the 24-hour period were time composited into one sample and analyzed for ammonia, chloride, chlorophyll-a, pheophytin-a, nitrate+nitrite nitrogen, orthophosphate phosphorus, total phosphorus, total dissolved solids, total Kjeldahl nitrogen, total suspended solids, volatile suspended solids, 5-day carbonaceous biochemical oxygen demand, and 20-day carbonaceous biochemical oxygen demand. Water quality samples from WWTPs collected over the 24-hour period were flow-weight composited into one sample using discharge records at each facility. Detailed anecdotal records were not required for the model support surveys.

Time of travel dye studies were also conducted in segment 0831 in support of potential modeling efforts. The time of travel studies were conducted along the upper portion of segment 0831, in the South Fork Trinity River, and in the lower portion of the segment. The time of travel studies were designed to provide critical information on flow rate and solute transport within the segment. Rhodamine dye was injected at specified locations within each of these reaches and then sampled at specific predetermined locations downstream. In addition to tracking dye movement through the watercourse, these studies also consisted of flow measurements at critical locations along each stretch and measurements of average stream width and depth at 100 m intervals for 1 kilometer above and below each dye sampling location.

Additionally, estimates of suspended algae productivity were made at station 17444, the Clear Fork Trinity River near Interstate 20 (0.4 kilometers upstream of 11060), and the South Fork of segment 0831 at Interstate 20 near Weatherford. Estimates of plant productivity in these locations were made using a modified light and dark bottle method described in Standard Methods for the Examination of Water and Wastewater (APHA, 1995).

Estimates of sediment oxygen demand (SOD) were made at stations 17446 and 11060. These estimates were made from data collected by the Tarrant Regional Water District (TRWD) using an in-situ modified SOD chamber. Sediment oxygen demand data were collected within the index and critical periods of 2002 at both stations.

Light and dark bottle productivity and sediment oxygen demand data collected during the project study period are secondary data not collected under an approved QAPP.

2.3 RESULTS

2.3.1 Physical Conditions

Streamflow conditions monitored in the index periods of 2001 and 2002 indicate that segment 0831 was perennial during the survey. During the monitoring period, all measured streamflows on the Clear Fork exceeded 0.2 cfs, which is the higher of the two low-flow criteria (7Q2) for segment 0831 as listed in Appendix B of the Texas Surface Water Quality Standards. Flow conditions were measured at each of the major monitoring stations on a monthly basis within the period of July – October 2001 and March – September 2002. Flow measurements were also taken twice (July and August 2002) at additional stations within the segment during the model support surveys. Results of all flow monitoring efforts are provided in Tables 2-4, 2-5, and 2-6. Pictorial records at each station are shown for a period of higher flow (March/April 2002) and lower flow (August/September 2002) in Appendix B.

Time of travel studies were conducted during model support monitoring at three locations within the segment in addition to routine flow measurements. Time of travel rates were specifically characterized for the following reaches: 1) the upper portion of segment 0831 between stations 17450 and 11060, 2) South Fork Trinity River from the City of Weatherford WWTP to station 17451, and 3) the lower portion of segment 0831 between stations 17448 and Clear Fork at Kelly Road. Stream width and depth measurements taken within these reaches are included in Appendix C.

Flow in segment 0831 is influenced by several factors. The presence of Lake Weatherford above the segment appears to provide a constant, though limited, source of flow as seepage to the segment. Discharges from WWTPs in the segment also provide a continuous source of flow in certain areas of the watercourse. Finally, the South Fork of the segment, which originates several miles above the City of Weatherford, generally provides a significant increase of flow below its confluence with the main stem of segment 0831.

As previously stated, the hydrology of the Clear Fork at station 17446 is highly impacted by the presence of the Lake Weatherford Dam, which is located immediately upstream of the site. Average flow at this station for all assessments was 0.6 cfs with only one measurement (September 2001) exceeding 1.0 cfs. The consistent and relatively small flow appears to be provided by seepage through the dam of Lake Weatherford. In contrast, station 11060, the next downstream station, demonstrated a hydrology with a more typical seasonal trend, which also appears common at most other stations within the segment. Relatively high flows were observed at this station in the spring when rainfall was greater. Decreased flow was generally observed in the summer and fall months at this station with the exception of the significant increase observed in September 2001.

Measured time of travel along the portion of the segment between stations 17450 (outfall of Willow Park WWTP) and 11060 in mid-July 2002 was estimated at 0.040 fps, with a corresponding instantaneous flow rate of 0.9 cfs (measured 0.4 km above station 11060). Time of travel decreased to 0.012 fps for this reach in late August 2002. Similarly, flow at the

location 0.4 km above station 11060 during this study was measured at 0.4 cfs. Time of travel along this reach is likely impacted by the presence of major pools within the segment. Width and depth measurements above and below each sampling station for the time of travel studies (Appendix C) indicate that the reach includes several pools of substantial size.

Flow at station 17445 is representative of flow conditions in segment 0831 prior to the confluence of South Fork with the main stem of the segment. Similar to conditions observed at the upstream station 11060, flow at station 17445 exhibited a highly seasonal pattern of increased flow in the spring months and decreased flow in summer and fall months. Again at this station, the exception is a relatively high value for flow measured in September 2001.

Table 2-4. Segment 0831, 2001 streamflow conditions in units of cfs.

Station	Jul. 26-27, 2001	Aug. 8-10, 2001	Sep. 12, 2001	Oct. 4, 2001
17446	0.5	0.6	1.3	0.4
11060	0.4	0.5	3.1	1.3
17445	0.3	0.6	4.7	1.6
17454	1.7	0.4	9.2	2.8
17444	2.8	1.2	18	4.8
13691	1.7	0.3	17	4.9

Table 2-5. Segment 0831, 2002 streamflow conditions in units of cfs.

Station	Mar. 27, 2002	Apr. 17, 2002	May 7, 8, 15, 2002	Jun. 12, 2002	Jul. 9-10, 2002	Jul. 31 & Aug. 1, 2002	Aug. 20 - 21, 2002	Sep. 23, 2002
17446	0.6	0.5	0.4	0.5	0.7	0.4	0.6	0.4
11060	3.8	5.3	6.6	1.0	2.2	0.2	0.4	0.9
17445	4.5	7.5	9.3	1.9	3.2	0.5	0.3	0.8
17454	26	24	27	6.0	8.3	2.9	1.2	1.5
17444	34	41	29	10	12.3	3.4	2.2	3.6
13691	61	73	43	9.8	10.4	3.5	1.3	3.4

Table 2-6. Segment 0831, 2002 streamflow conditions monitored at additional stations during model support surveys in units of cfs.

Station	Jul. 9-10, 2002	Aug. 20-21, 2002
17457	0.5	0.0
17452	0.1	Dry
17451	3.6	1.7
17453	1.9	Dry
17455	6.9	1.3
17456	0.2	0.1
17447	0.2	0.4

Flow at station 17454 in the South Fork just above the confluence with the Clear Fork was generally greater than the flow in the Clear Fork at station 17445. In fact, flow originating in the watershed of South Fork doubled, and in some cases tripled, the amount of flow in segment 0831. A seasonal pattern similar to that observed at stations 11060 and 17445 in the main stem of the segment was also observed at station 17454 in South Fork.

Time of travel measured on August 14, 2002 in South Fork, from the outfall of the City of Weatherford WWTP to station 17451, was 0.092 fps. The corresponding instantaneous flow rate for the time of travel study, measured at station 17451, was 2.2 cfs. Again, time of travel along this reach is impacted by the presence of major pools within the segment. Width and depth measurements above and below each sampling station for the time of travel studies (Appendix C) indicate that the reach includes several pools of substantial size.

Flow conditions at the two most downstream monitoring stations (17444 and 13691) were usually similar. Flow was greatest at both stations in the spring months and significantly decreased in summer and fall periods, with the exception of elevated flow in September and October of 2001. Time of travel conducted in the area of the downstream stations, from 17448 to the Clear Fork at Kelly Road, was estimated at 0.312 fps July 15, 2002 and at 0.052 fps on August 26, 2002. Instantaneous flow measurements conducted at station 17444 (middle station in reach) during the these time of travel studies were 4.7 cfs and 1.1 cfs for the July and August studies respectively.

2.3.2 Water Quality Assessment Data

A number of 24-hour multiprobe sonde deployments were conducted in segment 0831 in order to monitor diurnal conditions of DO, water temperature, pH, and conductivity. Mean, maximum, and minimum DO values from these deployments are given in Tables 2-7 and 2-8. Plots of diurnal DO conditions from each 24-hour data set are available in Appendix D. Mean, maximum, and minimum values for water temperature, pH, and conductivity are included in the water quality data for segment 0831, provided in Appendix E. Additionally,

24-hour averages for DO, water temperature, pH, and conductivity were calculated from instantaneous measurements taken at 6-hour intervals at various stations in support of potential water quality modeling activities. The five primary stations along the Clear Fork (17446, 11060, 17445, 17444, and 13691) each either had seven or eight 24-hour DO measurements during this study period. (The eighth set of measurements occurred at some stations before an unexpected thunderstorm necessitated scrubbing a model support survey.)

Mean diurnal DO concentrations in segment 0831 were generally greater than the established water quality criteria for the segment (5.0 mg/L). Only the most upstream station (17446) consistently failed to meet both the 24-hour mean and minimum DO criteria. Low DO at this station was initially thought to be impacted by low DO water seeping from Lake Weatherford into the segment; however, secondary instantaneous DO data collected at these seeps in May and August 2002 revealed DO concentrations to be between 7-8 mg/L.

At the four other primary stations (11060, 17495, 17444, and 13691) average and minimum DO concentrations from 24-hour data failed to meet criteria less frequently. Station 11060 failed to meet the numeric criterion for mean concentration of DO on June 24-25, 2002; July 30-31, 2002; and August 20-21, 2002 deployments, when 24-hour mean concentrations of 4.9, 3.2, and 4.1 mg/L were recorded respectively.

Relatively large diurnal swings in DO concentrations in segment 0831 below station 17446 caused minimum DO levels to fall below the minimum numeric criterion even though mean concentrations during these time periods met the established mean DO criterion. Such was the case for the August 2001 deployments at stations 11060 and 13691. Low minimum DO concentrations results were also noted for the July 30-31, 2002 deployments at stations 11060 and 17445.

Table 2-7. Segment 0831 24-hour DO deployment data collected in intensive and 24-hour water quality surveys (basic statistics).

Station	Dates	24-hour DO (mg/L)		
		Mean	Maximum	Minimum
17446	August 7-8, 2001	3.4	4.4	2.2
11060	August 7-8, 2001	5.6	11.1	1.6
17445	August 8-9, 2001	6.5	9.4	4.6
17444	August 9-10, 2001	5.6	7.5	3.9
13691	August 9-10, 2001	5.6	8.7	2.9
17454*	August 9-10, 2001	7.0	9.9	5.2
17446	September 11-12, 2001	3.9	4.9	2.4
11060	September 11-12, 2001	5.7	7.0	4.9
17445	September 11-12, 2001	7.9	11.1	6.3
17444	September 12-13, 2001	7.6	8.5	7.2
13691	September 12-13, 2001	7.9	9.6	6.7
17446	May 7-8, 2002	1.1	2.5	0.2
11060	May 7-8, 2002	6.3	6.7	5.9
17445	May 7-8, 2002	7.2	7.8	7.0
17444	May 15-16, 2002	8.5	9.2	8.1
13691	May 15-16, 2002	9.3	10.7	8.3
17454*	May 7-8, 2002	7.5	7.8	7.3
17446	June 12-13, 2002	4.1	5.1	2.4
11060	June 12-13, 2002	6.5	9.9	4.5
17445	June 12-13, 2002	7.7	11.4	5.5
17444	June 12-13, 2002	7.0	8.5	6.0
13691	June 12-13, 2002	7.6	9.4	6.3
17446	July 30-31, 2002	3.8	4.7	2.3
11060	July 30-31, 2002	3.2	4.7	1.9

Table 2-7 continued on next page

17445	July 30-31, 2002	5.5	8.2	2.8

Table 2-7. Segment 0831 24-hour DO deployment data collected in intensive and 24-hour water quality surveys (basic statistics).

Station	Dates	24-hour DO (mg/L)		
		Mean	Maximum	Minimum
17444	August 1-2, 2002	6.2	7.6	5.3
13691	August 1-2, 2002	8.6	12.5	6.1
17454*	July 30-31, 2002	4.2	5.0	2.7

*South Fork immediately above influence with Clear Fork.

Table 2-8. Segment 0831 24-hour DO deployment data collected at stations in model support surveys (basic statistics).

Station	Dates	24-hour DO (mg/L)		
		Mean	Maximum	Minimum
17446**	June 24-25, 2002	4.5	5.5	3.3
11060**	June 24-25, 2002	4.9	5.7	3.8
17447**	June 24-25, 2002	5.4	6.0	4.5
17444**	June 24-25, 2002	7.6	9.2	6.6
13691**	June 24-25, 2002	8.7	12.3	6.4
17446	July 9-10, 2002	5.1	6.0	3.6
17450*	July 9-10, 2002	8.3	8.4	8.0
11060	July 9-10, 2002	7.3	11.1	4.6
17445*	July 9-10, 2002	7.9	9.9	6.2
17456*	July 9-10, 2002	5.8	5.9	5.6
17454	July 9-10, 2002	7.1	8.5	6.4
17448*	July 9-10, 2002	6.8	7.0	6.7
17447	July 9-10, 2002	5.6	6.3	3.7
17637*	July 9-10, 2002	6.3	8.2	4.2
17444	July 10-11, 2002	7.1	8.0	6.6

Table 2-8 continued on next page

17457*	July 10-11, 2002	5.0	6.2	4.1

Table 2-8. Segment 0831 24-hour DO deployment data collected at stations in model support surveys (basic statistics).

Station	Dates	24-hour DO (mg/L)		
		Mean	Maximum	Minimum
17449	July 11-12, 2002	7.1	7.2	6.9
17452*	July 10-11, 2002	6.5	7.8	5.8
17451	July 10-11, 2002	7.0	9.1	5.8
17453*	July 10-11, 2002	7.1	8.2	6.5
17455	July 10-11, 2002	6.5	7.6	6.0
13691*	July 9-10, 2002	7.9	9.2	6.5
17446	August 20-21, 2002	3.9	4.9	2.3
17450*	August 20-21, 2002	7.6	7.9	7.2
11060	August 20-21, 2002	4.1	5.7	3.2
17445*	August 20-21, 2002	6.4	9.0	4.9
17454	August 20-21, 2002	5.6	6.8	4.7
17448*	August 20-21, 2002	6.4	6.6	6.3
17447***	August 20-21, 2002	5.1	5.8	4.1
17444	August 20-21, 2002	5.7	7.0	4.4
17457*	August 21-22, 2002	4.3	5.2	3.7
17449	August 21-22, 2002	7.3	7.6	6.7
17455	August 21-22, 2002	5.7	7.0	4.7
17451	August 21-22, 2002	6.7	9.2	5.6
17456*	August 21-22, 2002	3.9	4.9	3.4
13691*	August 20-21, 2002	7.9	10.1	4.9
17637*	August 20-21, 2002	5.6	7.5	3.5

*Calculated from instantaneous measurements taken at 6-hour intervals over a 24-hour period.
**Unforecast rains caused the discontinuation of this model support survey; however, these 24-hour DO deployments occurred prior to rainfall.
***Calculated from three instantaneous measurements taken over a 23-hour period.

In support of potential modeling efforts sediment oxygen demand was measured by TRWD at stations 17446 and 11060 in June and July 2002. As previously stated, the measurements were conducted by the TRWD using an in-situ chamber method and must be considered as

secondary data not collected under this project's QAPP. Sediment oxygen demand at station 17446 on June 27, 2002 was 0.995 g DO/m^2/day (20 ºC corrected value 0.723 g DO/m^2/day). A SOD value of 1.356 g DO/m^2/day (20 ºC corrected value 0.932 g DO/m^2/day) was measured at the same station on July 24, 2002. Measurements of SOD at station 11060 on June 26, 2002 and July 10, 2002 were 0.899 g DO/m^2/day (20 ºC corrected value 0.676 g DO/m^2/day) and 1.104 g DO/m^2/day (20 ºC corrected value 0.713 g DO/m^2/day) respectively. A SOD value of -0.04 g DO/m^2/day (20 ºC) was also recorded at station 11060 on June 26, 2002. TRWD notes that contamination of control bottles may have compromised this measurement.

Grab water quality samples were collected and analyzed during all 24-hour multiprobe sonde deployments to provide an indication of stream water chemistry (see Appendix E). The average by station of each water quality constituent is provided in Table 2-9 for the five primary stations along the Clear Fork (17446, 11060, 17445, 17444, and 13691) and for the South Fork near its confluence with the Clear Fork (17454). The spatial pattern reflected in the water quality data appears to be in response to the inflow of the South Fork, which in turn is highly influenced by the effluent from the City of Weatherford WWTP. (The City of Weatherford WWTP effluent was monitored as station 17449 in the model support surveys, see Appendix E.) In the Clear Fork above its confluence with the South Fork, soluble nutrient forms are well below TCEQ screening levels; however, at the first station below this confluence (station 17444), all nutrient concentrations increase and orthophosphate phosphorus concentrations are in the range of the screening level of 0.5 mg/L (TNRCC, 2002). The City of Aledo WWTP effluent enters the Clear Fork through a tributary just above station 17444, and undoubtably adds to instream concentrations; however, its flow contribution is relatively minor compared to that of the South Fork.

Suspended algae concentrations, as measured by chlorophyll-a, were indicated to be low at all stations, except station 11060. The fairly large 24-hour DO variations at some stations (Tables 2-7 and 2-8 and Appendix D), which followed the expected pattern indicative of plant photosynthesis/respiration influences (i.e., maximum DO in afternoon and minimum DO at approximately sunrise), provide an expectation of higher chlorophyll-a concentrations than were observed. High densities of attached (periphytic) algae and some macrophytes periodically observed at some stations provide an alternative explanation of the large DO diel fluctuations (see Anecdotal Record, Appendix A).

2.3.3 Habitat and Biological Assessment Data

Metric scores for segment 0831 were calculated from physical stream habitat data, benthic macroinvertebrate data, and fish data using the Habitat Quality Index and the Indices of Biotic Integrity for Benthic Macroinvertebrates and Fish respectively (TNRCC, 1999). The total score of each calculated index and the resulting aquatic life use designations are shown in Tables 2-10, 2-11, and 2-12 for the August 2001, May 2002, and July 2002 assessments respectively. The complete metric scores for habitat, benthic macroinvertebrates, and fish from every station monitored in each assessment period are available in Appendices F, G, and

H.

Table 2-9. Segment 0831 average water quality during intensive, 24-hour DO and model support surveys.

Station	Temp (C)	pH (SU)	Cond (µs/cm)	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	$CBOD_5$ (mg/L)	$CBOD_{20}$ (mg/L)	TOC (mg/L)
17446	25.5	7.5	593	15	3.8	361	<2.20	<2.20	2.6
11060	26.2	7.7	666	21	5.0	389	<2.20	4.0	3.8
17445	27.4	8.0	643	9.0	<4.0	392	<2.20	<2.20	3.4
17444	25.4	8.0	780	34	6.3	523	<2.20	2.70	4.3
13691	26.3	8.3	732	19	4.1	413	<2.20	<2.20	4.3
17454	26.8	8.2	836	37	7.2	483	<2.20	3.7	5.7

Station	CHLA (µg/L)	PHEO (µg/L)	NH_3 (mg/L)	NO_2+NO_3 (mg/L)	TKN (mg/L)	OPO_4 (mg/L)	Total-P (mg/L)	Chloride (mg/L)	SO_4 (mg/L)	Total Alk (mg/L)
17446	6.7	1.14	0.038	0.029	0.34	<0.004	0.063	42	18	251
11060	12.8	3.18	0.061	0.185	0.62	0.047	0.13	40	43	240
17445	2.7	<1.55	0.028	0.090	0.42	0.014	0.076	38	65	216
17444	3.6	1.78	0.070	0.994	0.61	0.831	0.92	80	55	246
13691	2.8	1.11	0.038	0.295	0.53	0.344	0.40	44	48	228
17454	4.1	1.67	0.067	1.30	0.87	1.25	1.32	83	51	231

Due to the lack of suitable habitat (i.e., riffles favorable for kicknet sampling) within segment 0831 during the assessment period of August 2001, multiple methods for sampling the benthic macroinvertebrate community were utilized. Traditional kicknet sampling was conducted in conjunction with the leaf pack method, which utilizes coarse particulate organic matter as a substrate for sampling, and the root sweep method, which is performed by sweeping sampling nets in undercut banks around the roots of riparian vegetation. Station 17444 was sampled with the leaf pack and root sweep methodologies only for this time period. All other stations were sampled with the traditional kicknet methodology. Kicknet sampling was utilized at all monitoring locations in the other assessment periods. Data collected from each sampling technique were analyzed individually using the TCEQ draft index for kicknet sampling (TNRCC, 1999).

Data from station 17446 consistently demonstrated an intermediate rank for aquatic life use, with the exception of high aquatic use designations from benthic macroinvertebrate data in

May and July 2002, and from fish data in July 2002. Generally, an intermediate aquatic life or high aquatic life use designation was assigned to station 11060. Scores for individual indices from each biological assessment at this station indicate a similar trend of values bordering between the intermediate and high designations. Likewise, an intermediate or high designation was assigned to station 17445, where scores from all assessments were in the range of the break between the two designations. Aquatic life use at station 17444 was generally designated as intermediate, though some variability in aquatic life use was present. The benthic macroinvertebrate data from the May 2002 assessment at station 17444 resulted in a high aquatic life use designation, while the fish data from the May assessment resulted in a limited rank and the July 2002 fish assessment ranked as limited to intermediate. Station 13691 was classified as having either intermediate or high aquatic life use for habitat, benthics, and fish.

Table 2-10. Segment 0831 metric scores and resulting aquatic life use rank from August 2001 assessments.

Station	Habitat		Benthic Macroinvertebrate		Nekton	
	Score	ALU[1]	Score	ALU[1]	Score	ALU[1]
17446	18	Intermediate	24	Intermediate	40	Intermediate
11060	24	High	30	High	48	High
17445	17	Intermediate	29	High	42	Intermediate
17444	17	Intermediate	25[2]	Intermediate	42	Intermediate
13691	18	Intermediate	30	High	50	High

[1]ALU - Aquatic Life Use
[2]Average metric score from leaf pack sample and root sweep sample

Table 2-11. Segment 0831 metric scores and resulting aquatic life use rank from May 2002 assessments.

Station	Habitat		Benthic Macroinvertebrate		Nekton	
	Score	ALU[1]	Score	ALU[1]	Score	ALU[1]
17446	17	Intermediate	32	High	42	Intermediate
11060	24	High	26	Intermediate	44	Intermediate
17445	23	High	31	High	46	Intermediate to High
17444	19	Intermediate	30	High	34	Limited to Intermediate
13691	18	Intermediate	25	Intermediate	42	Intermediate

[1]ALU - Aquatic Life Use

Table 2-12. Segment 0831 metric scores and resulting aquatic life use rank from July/August 2002 assessments.

Station	Habitat		Benthic Macroinvertebrate		Nekton	
	Score	ALU[1]	Score	ALU[1]	Score	ALU[1]
17446	17	Intermediate	30	High	50	High
11060	21	High	29	High	46	Intermediate to High
17445	22	High	31	High	46	Intermediate to High
17444	17	Intermediate	23	Intermediate	38	Limited to Intermediate
13691	21	High	34	High	44	Intermediate

[1]ALU - Aquatic Life Use

The results of primary productivity measurements made at station 17444, the Clear Fork Trinity River near Interstate 20 (0.4 kilometers upstream of 11060), and the South Fork Trinity River at Interstate 20 near Weatherford are included in Table 2-13. Chlorophyll-a concentrations from a single grab sample taken during each primary productivity trial are also included in the table.

A significant positive value for gross primary productivity on July 15, 2002 was observed on the Clear Fork at IH20. A relatively high chlorophyll-a concentration was also documented for the site on this date. The remaining stations showed no significant value for primary productivity or chlorophyll-a concentrations during the trials.

Table 2-13. Results of primary productivity trials in Segment 0831.

Location	Date	Begin/ End Time	Avg Photo-synthesis (mg/L DO)	Avg Respiration (mg/L DO)	Gross Primary Productivity (mg/L DO)	Chlorophyll-a (µg/L)
Station 17444	August 26, 2002	11:50-16:50	0.00	0.13	-0.13	2.52
Clear Fork @ IH20	July 15, 2002	12:00-17:00	3.02	0.27	2.75	43.54
South Fork @ IH20	August 14, 2002	10:58-15:58	0.00	0.48	-0.48	1.03

CHAPTER 3

SEGMENT 0833 - CLEAR FORK TRINITY RIVER ABOVE LAKE WEATHERFORD

3.1 BACKGROUND

3.1.1 Purpose

The Clear Fork Trinity River above Lake Weatherford, classified segment 0833, is contained on the 2000 State of Texas Clean Water Act Section 303(d) list as impaired due to depressed dissolved oxygen. This chapter summarizes relevant background information on water quality issues for the segment and outlines assessment data collected by TIAER under the approved project monitoring plan and quality assurance project plan.

3.1.2 Description of Segment 0833 and Designated Uses

Classified segment 0833, Clear Fork Trinity River above Lake Weatherford, is located northwest of the City of Weatherford, Texas in northern Parker County. As described in the Texas Surface Water Quality Standards (TNRCC, 2000), the segment begins near FM 3107 and continues downstream to a point 1.9 miles above FM 730. TIAER staff with GPS instrumentation visually located the transition area between segment 0833 and Lake Weatherford (segment 0832) at 0.90 miles above FM 730 (32º48'50.05080" N, 97º42'28.49185" W). The segment extends approximately nine miles through the northern portion of the county. Poolville is the only incorporated area within the watershed of this segment.

Designated uses of segment 0833 are high aquatic life use, contact recreation, and public water supply. The criteria established to protect the designated uses are defined in the Texas Surface Water Quality Standards (TNRCC, 2000). The dissolved oxygen criteria to protect a high aquatic life use for the segment is a 24-hour mean DO concentration of 5.0 mg/L and a 24-hour minimum DO concentration of 3.0 mg/L. These standards are applicable in all seasons except spring, wherein the criterion for 24-hour mean DO concentration is 5.5 mg/L and the criterion for 24-hour minimum DO concentration is 4.5 mg/L.

3.1.3 Environmental Features and Population Characteristics

The Clear Fork Trinity River watershed experiences a climate that is subtropical subhumid, which is characterized by hot summers and dry winters. Rainfall in the Clear Fork watershed averages about 30 inches per year, and average gross lake surface evaporation is 68 inches per year (Larkin and Bomar, 1983). The watershed is located within the Central Oklahoma-Texas Plains, an ecoregion characterized as containing irregular plains with native vegetation comprised of several oak species and grasses such as bluestem and indiangrass.

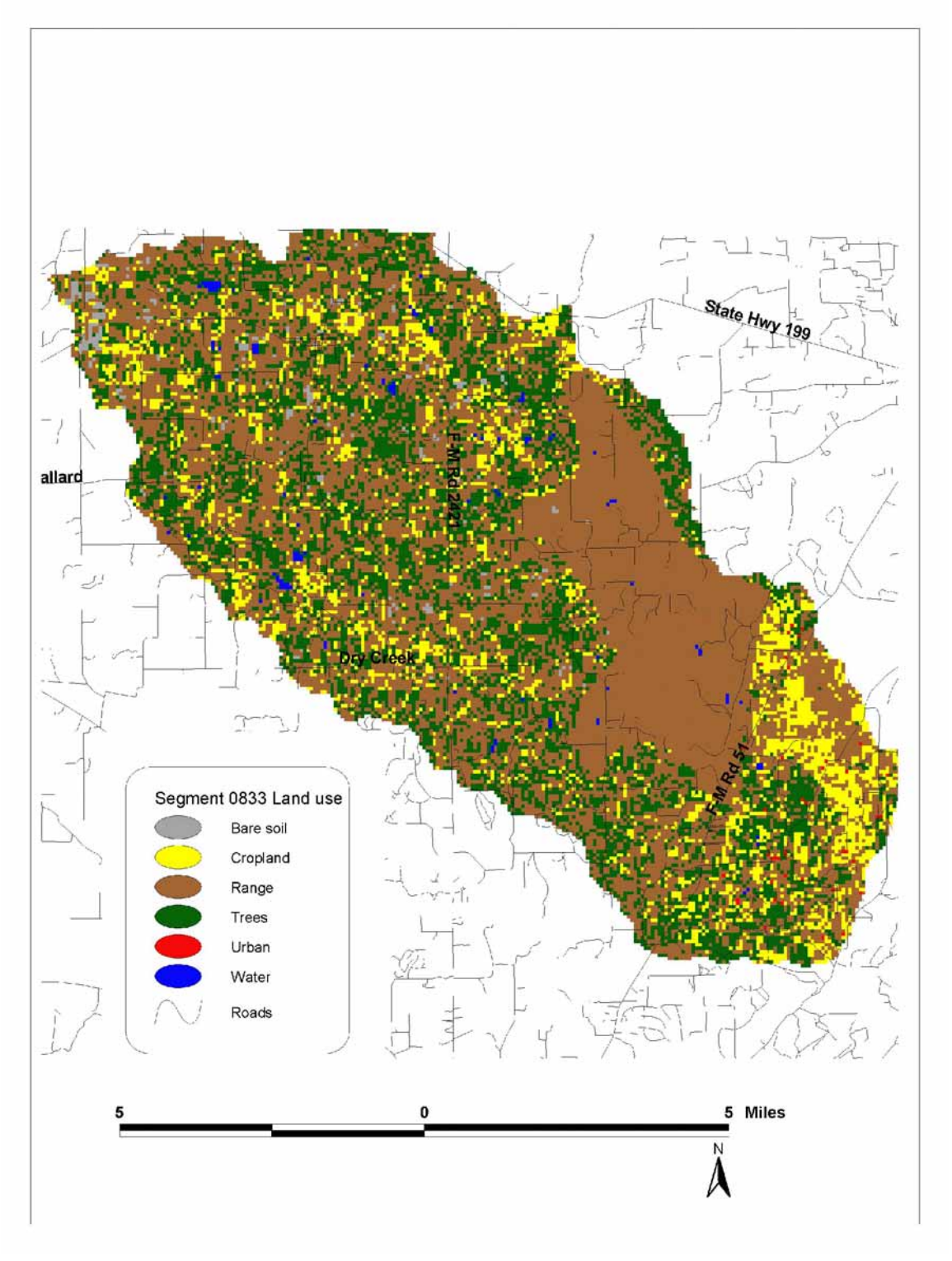
The watershed of segment 0833 is completely within Parker County. Historical county population estimates and future county population projections have been documented; however, these data are highly influenced by urban populations within the county (Hauck and Tanter, 2001). As previously stated, the community of Poolville is the only incorporated area that lies within the watershed of segment 0833. Additionally, this community comprised less than 0.4 percent of the total county population in the year 2000. Although the county as a whole is currently experiencing a population increase, the area surrounding segment 0833 remains relatively rural.

Land cover data generally support the characterization of segment 0833 as a rural area (Table 3-1 and Figure 3-1). Land cover categories of range, wooded, and crop/improved pasture comprise 98 percent of the total land area in the segment 0833 watershed. The land use information in Table 3-1 and Figure 3-1 were obtained from the Texas Gap Analysis Project at Texas Tech University, which used 1993-1994 Landsat Thematic Mapper satellite imagery with 90-meter resolution. More recent land use information readily available to this study were not used because of either inadequate resolution or land use results that were contrary to TIAER's observations during reconnaissance in the watershed.

Table 3-1. 1993-1994 land for segment 0833. (Source: Texas Gap Analysis Project)

Land Cover Category	Acres	Percent of Total
Urban	86	0.2%
Crop/Improved Pasture	7,498	13.4%
Range	32,717	58.3%
Wooded	14,967	26.7%
Water	248	0.4%
Other (barren, etc.)	562	1.0%
Total	56,078	-

Figure 3-1. Segment 0833 land cover.



3.1.4 Permitted Dischargers

Under the Texas Pollution Discharge Elimination System (TPDES), Poolville Independent School District WWTP was granted a no-discharge permit in December 2002. No other facilities are permitted in segment 0833. Hauck and Tanter (2001) reported a permit for a concentrated animal feeding operation occurring in the watershed; however, the permit for the Bendora Dairy was canceled at the request of the facility in August 2002.

3.1.5 Summary of Historical Data

Hauck and Tanter (2001) reported findings from an analysis of historical water quality and biological data collected in segment 0833 of the Clear Fork Trinity River. Historical water quality monitoring in the segment has been limited to station 11062, located at the junction of the Clear Fork Trinity River and FM 51 northeast of Weatherford, and station 16415, located at FM 920 in Poolville (Figure 3-2). Station 11062 is the long-term TCEQ monitoring station within the segment where water quality data has been intermittently collected since the early 1970s. Both station 11062 and station 16415 were monitored by the Tarrant Regional Water District (TRWD) from March 1999 through February 2000 for diurnal DO concentrations and other supporting physical parameters. A survey of fish species occurring in segment 0833 was conducted from July 1971 through May 1972 by a graduate student from The University of Texas at Arlington (Kelly, Jr., 1975). Sampling locations for the fish survey were similar to the locations of historical water quality data collection (TCEQ stations 11062 and 16415).

In addition to the examination of existing biological and water quality data, Hauck and Tanter (2001) also utilized anecdotal records obtained from a landowner questionnaire. This questionnaire was distributed to property owners in the area surrounding segment 0833 in order to ascertain landowners' recollections of persistence of streamflow and pools along the portion of the Clear Fork for which they had the greatest familiarity.

The results of the historical data review included the following conclusions regarding water quality and flow regime in segment 0833:

- No streamflow records exist for segment 0833; however, landowner responses to the study's questionnaire indicate that the segment is intermittent without pools in its uppermost reach, intermittent with pools for most of its length, and has a small reach below FM 51 that is spring fed and perennial. The perennial reach was not, however, indicated to extend to the lower terminus of the segment.

Figure 3-2. Segment 0833 Historical water quality monitoring locations.

Assessment of these data indicated no concerns from nutrients or chlorophyll-α.

- Assessment of dissolved oxygen was conducted using instantaneous data collected by TCEQ and diurnal data collected by TRWD at the long-term monitoring station (TCEQ station 11062) in the segment. Diurnal data collected by TRWD at station 16415 was also evaluated for the assessment. Comparison of measured dissolved oxygen concentrations to criteria indicate that the high aquatic life use is not being fully supported in segment 0833. Dissolved oxygen measurements not supporting the high aquatic life use occur most frequently during late summer in segment 0833, though low concentrations are experienced less frequently during spring and fall.

3.1.6 Introduction to Technical Use Attainability Analysis

TCEQ contracted with TIAER to conduct two years of monitoring activities in segment 0833. The two-year monitoring project consisted of three intensive surveys, two 24-hour DO surveys, and seven supplemental surveys. Monitoring activities conducted in each of these surveys were outlined in the Project Monitoring Plan (Jones and Hauck, 2001) and the Quality Assurance Project Plan (TIAER, 2001), and are described in detail below.

3.2 METHODOLOGIES

Monitoring in segment 0833 was conducted during the index periods (March 15 – October 15) of 2001 and 2002. The monitoring effort was initiated in July 2001 so that it was begun halfway through the index period and within the critical period (July 1 – September 30) of that year. An intensive survey was conducted in August 2001 and a 24-hour DO survey was conducted in September 2001. Supplemental surveys were conducted on segment 0833 in July and October of 2001 to complete the monitoring effort for that year.

Monitoring was resumed in the index period of 2002. Intensive surveys were conducted in May and July, while a 24-hour DO survey was conducted in June. Supplemental surveys were conducted on segment 0833 in March, April, August, and September 2002.

17459 and 17460, and these surveys occurred whenever intensive, 24-hour DO, and supplemental surveys were conducted at the other 5 stations. The following information describes monitoring station locations within the segment.

Station 17459 is located at the junction of the Clear Fork Trinity River and Turpin Lake Road west of Poolville. Only supplemental observations occurred at this station.

Station 16415**,** located at FM 920 in Poolville, Texas, was monitored by Tarrant Regional Water District (TRWD) during an intensive DO survey performed for the Trinity River Authority (TRA) and was included in the fish survey study performed by Kelly (1975). The station was monitored by TIAER during intensive surveys, 24-hour DO surveys, and supplemental surveys.

Station 17460 is located at the junction of the Clear Fork Trinity River and Erwin Road. Only supplemental observations occurred at this station.

Station 17463, located at the junction of the Clear Fork Trinity River and Sarra Road, is approximately midway between the two existing TCEQ stations (16415 and 11062) on segment 0833. Inclusion of this station provided necessary spatial resolution, because of the relatively great stream length between the two existing TCEQ stations. The station was monitored by TIAER during intensive surveys, 24-hour DO surveys, and supplemental surveys.

Station 11062, located at the junction of the Clear Fork Trinity River and FM 51 northeast of Weatherford, Texas, is routinely monitored by the TCEQ and was included in the fish survey performed by Kelly (1975). The station was monitored by TIAER during intensive surveys, 24-hour DO surveys, and supplemental surveys.

Station 17461**,** situated at the junction of the Clear Fork Trinity River and Old Springtown Road, appears to be a transition area between a perennially flowing section and an area described as intermittent with pools (Hauck and Tanter, 2001). The station was monitored by TIAER during intensive surveys, 24-hour DO surveys, and supplemental surveys.

3.2.2 Intensive Surveys

As previously stated, a total of three intensive surveys were conducted in segment 0833 within the index periods of years 2001 and 2002. One intensive survey occurred within the critical period of both 2001 (August 2001) and 2002 (July 2002), while the third intensive survey occurred outside the critical period, but within the index period of year 2002. The third intensive survey was conducted in May 2002 and was desired to occur during the spawning season.[3] All three intensive surveys were conducted at stations 16415, 17463, 11062, 17461, and 17462. Intensive surveys included biological and chemical assessments of stream conditions and water quality, and a 24-hour continuous (15- or 30-minute interval) measurement of dissolved oxygen conditions at each station. All assessments conducted during the intensive surveys followed the guidelines established in the State of Texas Receiving Water Assessment Procedures Manual (TNRCC, 1999).

Specific monitoring activities conducted during the biological assessment portion of the intensive surveys on segment 0833 included: assessments of physical stream habitat, assessments of benthic macroinvertebrate communities, and assessments of fish communities. Data collected in each of these efforts allowed for the determination of an aquatic life use rank based on metric indices established by the State of Texas. The aquatic life use score for physical habitat at a particular station was determined using the Habitat Quality Index available from the State of Texas Receiving Water Assessment Procedures Manual (TNRCC, 1999). Also available in the RWA Procedures Manual are the metric indices used for quantitative biological scoring of fish and benthic macroinvertebrate communities (TNRCC, 1999). The biological scoring was based on Fish Statewide Criteria and Benthic Scoring for Kick Samples, Rapid Bioassessment Protocol.

In addition to the biological assessments, intensive surveys also included measurements of streamflow and diurnal dissolved oxygen concentrations at each station within the segment. Other physical parameters, such as temperature, pH, and conductivity were logged in conjunction with DO concentration at 15- or 30- minute intervals at each station. A single water quality sample was taken at each station within the 24-hour time period in which the physical constituents were measured. This sample was analyzed for ammonia, chloride, chlorophyll-a, pheophytin-a, nitrate+nitrite nitrogen, orthophosphate phosphorus, total phosphorus, sulfate, total alkalinity, total dissolved solids, total Kjeldahl nitrogen, total organic carbon, total suspended solids, volatile suspended solids, and 5-day carbonaceous biochemical oxygen demand. Anecdotal and pictorial records were also collected at each station during these surveys. The anecdotal record is available in Appendix I.

[3] During this study, the spawning season intensive survey occurred in early to mid May 2002. A major scour event in March 2002 delayed the intensive survey until the benthic community could have time to reestablish.

3.2.3 24-hour Water Quality Surveys

TIAER conducted two additional and separate 24-hour surveys of DO and corresponding water quality conditions in segment 0833 between the years 2001 and 2002. The initial 24-hour DO survey occurred in September 2001, within the critical period of that calendar year. The second survey occurred in June 2002, outside the critical period but within the index period. The surveys were conducted at stations 16415, 17463, 11062, 17461, and 17462. Twenty-four hour water quality surveys included measurements of streamflow and a diurnal record of DO, temperature, pH, and conductivity conditions at each station within the segment. All 24-hour measurements were conducted on 15- or 30-minute intervals. In addition, a single water quality grab was taken within the 24-hour time frame and analyzed for ammonia, chloride, chlorophyll-a, nitrate+nitrite nitrogen, pheophytin-a, orthophosphate phosphorus, total phosphorus, sulfate, total alkalinity, total dissolved solids, total Kjeldahl nitrogen, total organic carbon, total suspended solids, volatile suspended solids, and 5-day carbonaceous biochemical oxygen demand. Anecdotal (Appendix I) and pictorial records were also collected at each station during these surveys.

3.2.4 Supplemental Surveys

Supplemental surveys were conducted in July and October 2001, and March, April, August, and September 2002. These surveys were conducted at all seven monitoring stations in segment 0833. Supplemental surveys consisted of instantaneous measurements of streamflow, DO, temperature, pH, and conductivity at each water quality monitoring location. Additionally, anecdotal (Appendix I) and pictorial records were collected at each station during these surveys. As stated in the station descriptions, supplemental survey information was also collected at stations 17459 and 17460 during the time intensive and 24-hour water quality surveys were performed at the other five monitoring stations within the segment.

3.3 RESULTS

3.3.1 Physical Conditions

Streamflow conditions monitored in the index periods of 2001 and 2002 in segment 0833 indicate that the system is intermittent except for the reach containing stations 11062 and 17461, which was perennial. Flow conditions were measured at each of the major monitoring stations on a monthly basis within the critical period of 2001 and within the index and critical periods of 2002. Results of these monitoring efforts are provided in Tables 3-2 and 3-3.

Flow was absent during portions of the monitoring period at the most upstream stations (17459, 16415, 17460, and 17463). Stations 17459, 16415, and 17460 were completely dry (i.e., absence of pools) in July through September 2001. Small flows persisted at these stations the following spring through May 2002; however, a series of pools accounted for the only

water present at 16415 during the July, August, and September 2002 monitoring events while stations 17459 and 17460 were completely dry during this time period. Similarly, flow at station 17463 was consistently measured below 0.1 cfs except in March through June of 2002. Station 17463 was also dry in September 2002.

Table 3-2. Segment 0833, 2001 streamflow conditions in units of cfs.

Station	Jul. 26, 2001	Aug. 23, 2001	Sep. 19, 2001	Oct. 4, 2001
17459	Dry	Dry	Dry	Dry
16415	Dry	Dry	Dry	Dry
17460	Dry	Dry	Dry	Dry
17463	0.0	0.0	0.0	0.0
11062	0.1	0.1	0.1	0.1
17461	0.4	0.4	0.9	0.5
17462	0.2	0.2	0.5	0.5

Table 3-3. Segment 0833, 2002 streamflow conditions in units of cfs.

Station	Mar. 26, 2002	Apr. 16, 2002	Apr. 30 & May 1-2, 2002	Jun. 4, 2002	Jul. 23-25, 2002	Aug. 22, 2002	Sep. 23, 2002
17459	0.8	0.8	0.1	0.2	Dry	Dry	Dry
16415	0.3	0.8	0.3	0.1	0.0	0.0	0.0
17460	1.5	1.5	0.2	0.1	Dry	Dry	Dry
17463	2.1	2.4	0.5	0.2	0.0	0.0	Dry
11062	8.3	8.0	0.6	2.4	0.2	0.0	0.1
17461	8.4	9.8	2.7	3.8	0.7	0.2	0.1
17462	10	14	1.3	4.0	1.0	0.0	0.0

Downstream stations (11062, 17461, and 17462) generally exhibited higher flow rates than did the upstream stations. A high flow of 8.3 cfs was measured in March 2002 at station 11062 while a low of 0.0 cfs was measured at the station in August 2002. Similar trends were observed at the two most downstream stations. Although dry conditions were never noted at station 17461, flow at this station did not exceed 1.0 cfs in the summer or fall of either year. Flow was completely absent (less than 0.0 cfs) at station 17462 in August and September 2002, and flows were consistently measured at and below 0.5 cfs at this station in the late summer and fall of both years. The consistent presence of higher flow at station 17461 than at station 17462 during the dry summer months (July-September) may be explained by the

presence of natural springs above station 17461, which were identified from the landowner questionnaire described in the historical data report (Hauck and Tanter, 2001). Pictorial records at each station are shown for the period of higher flow (April 2002) and lower flow (August 2001) in Appendix J.

3.3.2 Water Quality Assessment Data

A total of five, 24-hour DO surveys were conducted at intensively surveyed monitoring locations within segment 0833 during the index and critical periods of 2001 and 2002. However, lack of flow at station 16415 prohibited monitoring at this location in August and September 2001. Twenty-four hour mean, maximum, and minimum DO concentrations were calculated from diurnal DO data collected (Table 3-4). Plots of diurnal DO data from each monitoring event are available in Appendix K. In addition to DO conditions, diurnal data from each site also included measurements of water temperature, pH, and conductivity. Twenty-four hour mean concentrations of these constituents are provided with water quality data in Appendix L.

Generally, the most upstream survey stations in the segment demonstrated lower DO concentrations than stations further downstream. Mean DO at 16415 ranged from a low of 0.1 mg/L in July 2002 to a high of only 2.1 in May 2002. Mean and minimum DO concentrations for all deployments at 16415 failed to meet high aquatic life use criteria for the segment (5.0 and 3.0 mg/L respectively). Although station 17463 demonstrated slightly higher mean DO values than 16415, only the May 2002 deployment resulted in mean and minimum DO conditions higher than the current water quality criteria. At station 11062 only the May and June 2002 deployments resulted in mean and minimum DO concentrations meeting water quality criteria. Mean DO concentrations at station 17461 met the water quality criteria for all deployments; however, minimum concentrations in August 2001 (2.6 mg/L) and July 2002 (2.9 mg/L) failed to meet the minimum 24-hour DO criteria for the segment. Only station 17642 consistently demonstrated 24-hour mean and minimum DO levels above the numeric criteria during the two-year monitoring period.

Grab water quality samples were collected and analyzed during all 24-hour multiprobe sonde deployments to provide an indication of stream water chemistry (see Appendix L). The average by station of each water quality constituent is provided in Table 3-5. The spatial pattern reflected in the water quality data appears to be in response to the hydrology of the system. Poorer average water quality, as measured by higher concentrations of salts, nutrients, and chlorophyll-a, occurred at the two most upstream stations (16415 and 17463) where flow was often very low. The lower three stations generally had higher and more persistent flow than the upper stations and commensurately water quality was better and generally met appropriate criteria and screening levels of TCEQ. Throughout the segment, oxygen demand or organic load was indicated to be low as reflected by the low $CBOD_5$ concentrations at all stations.

Table 3-4. Segment 0833 24-hour DO deployment data (basic statistics).

Station	Dates	24-hour DO (mg/L)		
		Mean	Maximum	Minimum
16415	August 22-23, 2001	NA	NA	NA
17463	August 22-23, 2001	2.0	7.2	0.2
11062	August 23-24, 2001	1.6	2.1	0.9
17461	August 21-22, 2001	6.7	11.9	2.6
17462	August 21-22, 2001	5.8	8.1	4.3
16415	September 18-19, 2001	NA	NA	NA
17463	September 18-19, 2001	3.0	4.3	1.9
11062	September 18-19, 2001	2.8	3.3	2.2
17461	September 18-19, 2001	7.7	12.3	4.3
17462	September 19-20, 2001	6.8	8.6	5.9
16415	May 2-3, 2002	2.1	4.0	0.9
17463	May 2-3, 2002	7.4	8.6	5.4
11062	May 2-3, 2002	6.1	7.6	4.7
17461	May 1-2, 2002	6.5	11.1	4.9
17462	May 1-2, 2002	7.0	8.8	6.3
16415	June 3-4, 2002	0.9	2.9	0.2
17463	June 3-4, 2002	4.0	7.3	2.5
11062	June 3-4, 2002	6.3	7.3	5.4
17461	June 3-4, 2002	8.1	13.5	5.1
17462	June 3-4, 2002	7.5	10.4	5.9
16415*	July 24-25, 2002	0.1	0.2	0.0
17463	July 24-25, 2002	0.8	3.3	0.2
11062	July 24-25, 2002	2.3	3.0	1.7
17461	July 23-24, 2002	6.8	12.5	2.9
17462	July 23-24, 2002	6.8	10.2	4.8

* No streamflow, pool present.

Table 3-5. Segment 0833 average water quality during 24-hour multiprobe sonde deployments.

Station	Temp (C)	pH (SU)	Cond (µs/cm)	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	$CBOD_5$ (mg/L)	TOC (mg/L)
16415	26.0	7.9	1294	78	14.7	691	2.7	8.2
17463	26.9	7.8	1140	17	6.2	702	3.5	6.9
11062	26.0	7.8	915	33	5.0	560	<2.20	4.4
17461	27.1	7.9	818	17	<4	547	<2.20	3.8
17462	25.7	8.1	783	6.0	<4	514	<2.20	3.4

Station	CHLA (µg/L)	PHEO (µg/L)	NH_3 (mg/L)	NO_2+NO_3 (mg/L)	TKN (mg/L)	OPO_4 (mg/L)	Total-P (mg/L)	Chloride (mg/L)	SO_4 (mg/L)	Total Alk (mg/L)
16415	42.7	9.47	0.100	0.040	1.40	0.046	0.300	173	71	380
17463	57.5	<1.5	0.285	0.023	1.32	0.094	0.344	112	62	411
11062	8.4	<1.5	0.055	<0.024	0.45	0.048	0.140	79	62	331
17461	8.6	1.5	0.032	0.114	0.43	0.024	0.082	65	66	291
17462	2.7	<1.5	0.042	0.097	0.40	0.032	0.082	64	62	277

3.3.3 Habitat and Biological Assessment Data

Scores were calculated from physical stream habitat categories, benthic macroinvertebrate metrics, and fish metrics using the Habitat Quality Index and the Indices of Biotic Integrity for Benthic Macroinvertebrates and Fish, respectively (TNRCC, 1999). The total score of each calculated index and the resulting aquatic life use designations are shown in Tables 3-6, 3-7 and 3-8 for each of the three intensive surveys in August 2001, May 2002, and July 2002 respectively. The complete habitat category scores, and benthic macroinvertebrates and fish metric scores for each intensive survey are available in Appendices M, N, and O respectively.

Due to the lack of flow in the upper portion of segment 0833 in the late summer of 2001, biological assessments were not conducted at station 16415 in August 2001. Additionally, the lack of flow and corresponding lack of suitable habitat (i.e., riffles favorable for kicknet sampling) at other stations within the segment during this time period resulted in the use of a variety of methods for sampling the benthic macroinvertebrate community. Traditional kicknet sampling was conducted in conjunction with the leaf pack method, which utilizes coarse particulate organic matter as a substrate for sampling, and the root sweep method, which is performed by sweeping sampling nets in undercut banks around the roots of riparian vegetation. Station 17463 was evaluated using a leaf pack sampling technique only. A kicknet and root sweep sample were both collected at station 11062. Station 17461 was sampled using kicknet, leaf pack, and root sweep methods, while station 17462 was sampled

using only the leaf pack and root sweep methodologies. The kicknet method was used exclusively in the other two intensive surveys in May and July 2002. Data collected from each sampling technique were analyzed individually using the TCEQ draft index for kicknet sampling (TNRCC, 1999).

Habitat, fish, and benthic macroinvertebrate data from station 16415 consistently demonstrated a limited to intermediate rank for aquatic life use. Scores for individual indices from each biological assessment category at this station indicate a similar trend of values bordering both the limited and intermediate aquatic life use designations. An intermediate designation was assigned to station 17463 from all biological assessments, with the exceptions of a limited designation from benthic macroinvertebrate data in August 2001 and limited to intermediate designation for nekton data in July 2002. Aquatic life use at station 11062 was generally designated as limited to intermediate. Values calculated for individual indices from each biological assessment at station 11062 were often in the range very near the break between the limited and intermediate ranks. Station 17461 was generally classified as having an intermediate aquatic life use, although the majority of individual index scores were very near, or even within, the range of a high aquatic life use designation. Finally, with the exceptions of the limited Habitat Quality Index scores from May and July 2002 monitoring and the high benthic aquatic life use in August 2001, station 17462 was consistently designated as having an intermediate aquatic life use.

Table 3-6. Segment 0833 cumulative index scores and resulting aquatic life use rank from August 2001 assessments.

Station	Habitat		Benthic Macroinvertebrate		Nekton	
	Score	ALU[1]	Score	ALU[1]	Score	ALU[1]
16415	NA	NA	NA	NA	NA	NA
17463	16	Intermediate	20[2]	Limited	42	Intermediate
11062	15	Intermediate	27[3]	Intermediate	40	Intermediate[6]
17461	17	Intermediate	25[4]	Intermediate	44	Intermediate
17462	14	Intermediate	29[5]	High	42	Intermediate

[1]ALU - Aquatic Life Use
[2]Metric score from leaf pack sample
[3]Average metric score from root sweep sample and kicknet sample
[4]Average metric score from leaf pack sample, root sweep sample, and kicknet sample
[5]Average metric score from leaf pack sample and root sweep sample
[6]Station 11062 fish survey was re-sampled September 19, 2001 due to field problems with August sampling

Table 3-7. Segment 0833 cumulative index scores and resulting aquatic life use rank from May 2002 assessments.

Station	Habitat		Benthic Macroinvertebrate		Nekton	
	Score	ALU[1]	Score	ALU[1]	Score	ALU[1]
16415	13	Limited	22	Intermediate	34	Limited to Intermediate
17463	15	Intermediate	22	Intermediate	40	Intermediate
11062	13	Limited	20	Limited	40	Intermediate
17461	19	Intermediate	32	High	42	Intermediate
17462	12	Limited	27	Intermediate	42	Intermediate

[1]ALU - Aquatic Life Use

Table 3-8. Segment 0833 cumulative index scores and resulting aquatic life use rank from July 2002 assessments.

Station	Habitat		Benthic Macroinvertebrate		Nekton	
	Score	ALU[1]	Score	ALU[1]	Score	ALU[1]
16415	13	Limited	17	Limited	36	Limited to Intermediate
17463	16	Intermediate	28	Intermediate	38	Limited to Intermediate
11062	17	Intermediate	28	Intermediate	44	Intermediate
17461	19	Intermediate	30	High	40	Intermediate
17462	12	Limited	26	Intermediate	42	Intermediate

[1]ALU - Aquatic Life Use

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