Cypress Creek Basin
FY2003

Tankersley Creek Indicator Bacteria Special Study
Upper Big Cypress Creek Watershed

Prepared for
Northeast Texas Municipal Water District
Hughes Springs, Texas

PREPARED IN COOPERATION WITH THE
Texas Commission on Environmental Quality
The preparation of this report was financed through grants from the
Texas Commission on Environmental Quality

by
Paul Price Associates, Inc.
3006 Bee Caves Road, Suite D-230
Austin, Texas 78746

December 16, 2003

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Tankersley Creek, designated as assessment unit 0404b, is an unclassified freshwater stream in the Cypress Creek Basin that extends 8 miles from its confluence with Big Cypress Creek (Segment 0404) to the upstream perennial portion of the stream northwest of Mount Pleasant in Titus County, Texas (Figure 1-1). Indicator bacteria (i.e., fecal coliform) samples taken from Tankersley Creek at FM 899 in the upper 3 miles of the watershed and from two stations in the lower 5 miles of this drainage; at FM 127 southwest of Mount Pleasant and from FM 3417 south of Mount Pleasant sometimes show that fecal coliform levels exceed the state water quality criterion established to assure the safety of contact recreation. As a result, Tankersley Creek was placed on the State's List of Impaired Water Bodies or the 303(d) list.

Tankersley Creek was placed on the TCEQ's 2000 Clean Water Act Section Draft 303(d) List of Texas impaired water bodies with the following segment summary: "Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS) (L – low priority; NS – not supporting designated use)." There was insufficient bacteriological data available for the 2002 assessment to evaluate changes in water quality. No information was available for this segment to include in the Cypress Creek Basin Task 5a Review of the FY2002 TCEQ 305(b) Water Quality Assessment Report submitted to TNRCC on 15 February 2002. An "all station query" to the TNRCC Regulatory Activity and Compliance System (TRACS) conducted on 29 August 2002 disclosed a single sample for each species taken by TCEQ during FY2001 (21 December 2000). Therefore, Tankersley Creek will remain on the 2002 303(d) list of impaired water bodies until sufficient data are available to assess.

The Texas Commission on Environmental Quality (TCEQ) and local Cypress Creek Basin stakeholders have suggested some additional investigation to confirm or challenge those results, and to obtain information on the origin and occurrence of indicator bacteria in this portion of the Big Cypress Creek drainage. Additional study recommendations have included a wider geographical coverage for future sampling, investigation of the relationship between runoff events and bacteria levels and a need to document the comparability of a fecal coliform indicator, which resulted in the 303 (d) listing, with the *Escherichia coli (E. coli)* indicator, which will be the water quality standard in the future.

Appendix H (Tankersley Creek Indicator Bacteria Special Study, Upper Big Cypress Creek Watershed) to the FY2002-2003 Cypress Creek Basin Quality Assurance Project Plan (QAPP) was developed to ensure the reliability of the monitoring data collected under each task description. The goal of this Special Study was to obtain a broader assessment of the bacterial water quality conditions in the two primary streams draining the Mount Pleasant area and of the reach of Big Cypress Creek receiving that drainage. The key objective of this study was to provide and incorporate new information on fecal coliform conditions into the existing database for the reassessment of Tankersley Creek. Two additional objectives of the study included the establishment of comparable fecal coliform and *E. coli* data sets at locations previously sampled only for the former, and to assess the role of rainfall and runoff in determining bacterial numbers in the upper Big Cypress Creek Watershed.

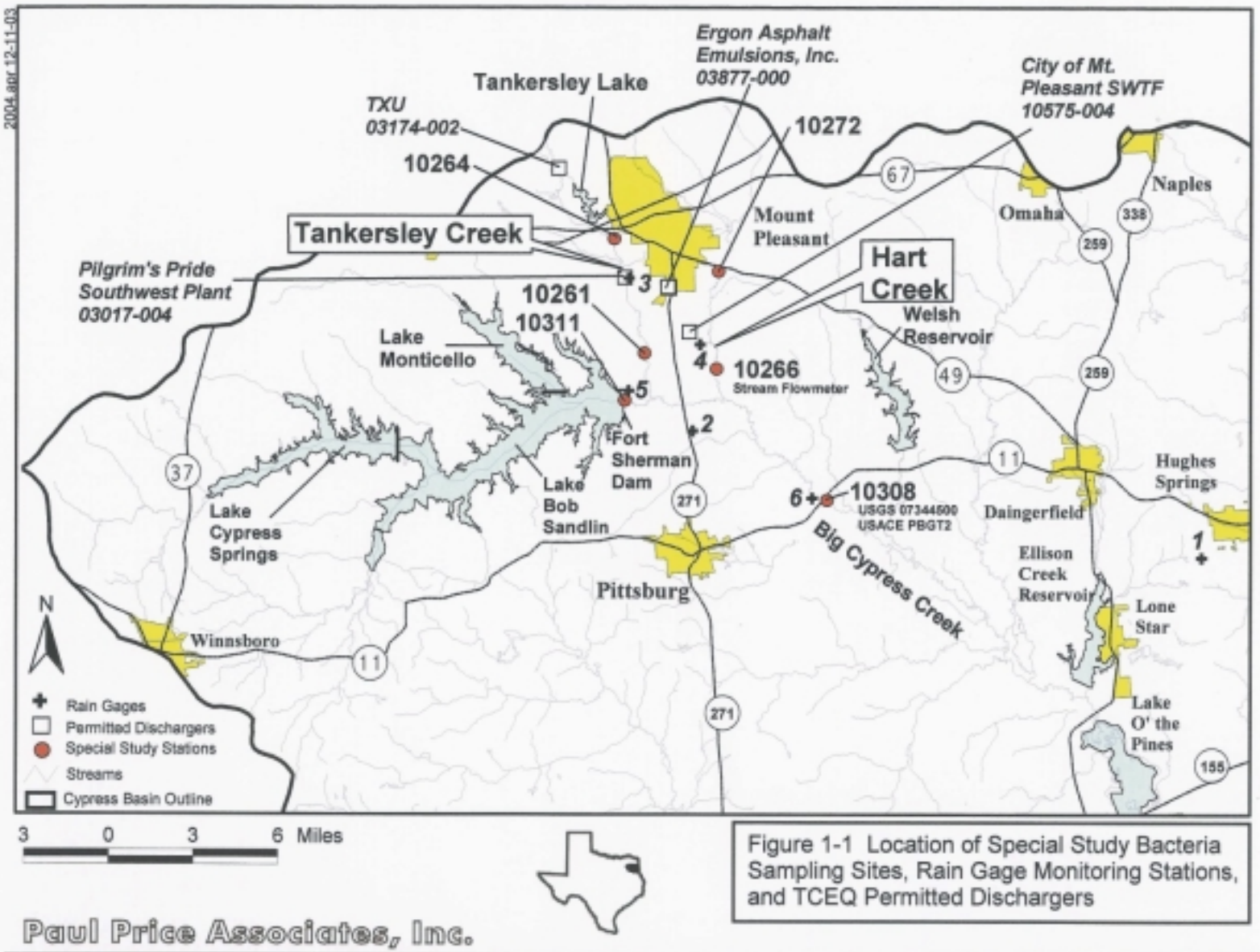


Figure 1-1 Location of Special Study Bacteria Sampling Sites, Rain Gage Monitoring Stations, and TCEQ Permitted Dischargers

2.0 AQUATIC MONITORING

The Tankersley Creek Indicator Bacteria Special Study was designed to include several sampling locations to obtain results that are representative of the Big Cypress Creek Watershed habitat in Titus and Camp Counties. Big Cypress Creek is the largest sub-watershed in the Cypress Creek Basin and forms the Titus-Camp county boundary line. For the purpose of this document, the term "Big Cypress Creek watershed" refers to the entire drainage of Segment 0404 from downstream of Fort Sherman Dam at Lake Bob Sandlin to State Highway 11, which includes the unclassified tributaries; Tankersley Creek and Hart Creek (Figure 1-1).

2.1 AQUATIC HABITATS

2.1.1 General Description

Big Cypress Creek drains much of the western Cypress Creek Basin, a predominantly rural watershed of rolling wooded hills with regional elevations of 200 to 800 feet MSL, but with limited local relief, gentle slopes, and broad, frequently flooded, densely vegetated stream bottoms. Post oak and blackjack oak constitute the dominant climax overstory vegetation, but loblolly and shortleaf pine are also common. The bottomland forest is the most mesic habitat in eastern Texas; the dense vegetation is generally comprised of water oak, willow oak, sweet gum, black gum, and birch primarily vegetated by a mixture of oak woodland and prairie.

The City of Mount Pleasant, Texas in Titus County is the largest urban population center found within the Special Study area. The landscape is drained by Tankersley and Hart creeks, tributaries of Big Cypress Creek, which lie on the western and eastern sides of Mount Pleasant, respectively. Tankersley Creek arises in Titus County northwest of the City of Mount Pleasant. The creek flows in a southeasterly direction for approximately 2 miles before it enters Tankersley Lake, which impounds Tankersley Creek about two miles northwest of Mount Pleasant. Downstream of the spillway of the 150-acre impoundment, stream flow is to the south for a distance of almost 6.5 miles to the confluence of Tankersley Creek with Big Cypress Creek at the Titus-Camp county line.

Hart Creek originates approximately 4.5 miles north of Mount Pleasant in central Titus County. The creek flows in a generally southeast direction and receives surface drainage from Hayes Creek near the eastern city limits of Mount Pleasant and south of New Mount Pleasant Lake. Downstream from this point, Hart Creek carries overland flow for a distance of approximately 6.5 miles before discharging into Big Cypress Creek at the Titus-Camp county line.

The six sampling stations shown on Figure 1-1 were located on Tankersley Creek at FM 889 (TCEQ Station 10264), Tankersley Creek at FM 3417 (TCEQ Station 10261), Hart Creek at State Highway (SH) 49 (TCEQ Station 10272), Hart Creek at SE 12 (TCEQ Station 10266), Big Cypress at SH11 (TCEQ Station 10308), and Big Cypress Creek at a point downstream of Fort Sherman Dam and upstream of the Tankersley Creek confluence (TCEQ Station 10311).

To supplement existing data and further characterize basin conditions, bacteriological samples were collected from six locations. Stations were situated upstream (Station 10264) and downstream (Station 10261) of the large Southwest Treatment Plant outfall on Tankersley Creek, which drains the western side of Mount Pleasant. Stations were positioned upstream (Station 10272) and downstream (Station

10266) of the smaller Southside Treatment Plant outfall on Hart Creek, which drains the eastern side of Mount Pleasant. Big Cypress Creek was sampled at a location (Station 10311) situated downstream of Lake Bob Sandlin and upstream of the confluence of Tankersley and Hart Creeks, and at the State Highway (SH) 11 crossing (Station 10308) downstream of that confluence (Figure 1-1). The Special Study included quarterly sampling at the stations on Tankersley Creek for both fecal coliform bacteria and *E. coli*, and quarterly sampling for *E. coli* only at the Big Cypress Creek and Hart Creek stations. A wet weather sampling program was also initiated at all six stations to document the levels of *E. coli* during and following rainfall/runoff events. Fecal coliform samples were also sampled at the two Tankersley Creek locations during rainfall/runoff events.

2.1.2 Monitoring Locations

Station 10264 is located on Tankersley Creek at FM 899, a paved asphalt road that crosses the creek via a short and narrow concrete box culvert bridge on the west side of Mount Pleasant. This station is bounded on all sides by pastureland and rural residences. The upstream creek segment was pooled behind the concrete floor of the bridge structure. The creek width upstream of the bridge was uniform with an average width of 23-25 feet and depth of 0.2 to1.5 feet. Bottom material consisted of mud and sand. For a distance of 40 feet downstream of the FM 899 bridge, the streambed had a bottom of large rock and broken concrete slabs. Downstream of the riprap area, the floodplain narrowed and forest canopy became dense. During the quarterly site visits, water depth beneath the bridge never exceeded a depth of 0.25 inch and flow was measurable only during October 2002 (3.30 cfs) and April 2003 (0.53 cfs). Stream flow along this length of creek may be regulated by Tankersley Lake that is situated approximately 1.4 miles upstream and north of Interstate Highway 30. This station is about 1.2 miles upstream of the Southwest Wastewater Treatment Plant outfall (Permit No. 03017-004) and downstream of the Texas Utilities Mining Company's storm water flow variable discharge (Permit No. 03174-002) from mining operations north of IH 30 (Figure 1-1). The drainage area of the watershed measured upstream of the monitoring station is approximately 8,637 acres or 13.5 square miles.

Station 10261 is located on Tankersley Creek at FM 3417 approximately 0.9 mi. west of U.S. Highway 271 south of Mount Pleasant, Texas in the south-central portion of Titus County. This sampling site is about 5 miles downstream of Station 10264, about 3.8 miles downstream of Southwest Wastewater Treatment Plant and 2 miles upstream of the confluence with Big Cypress Creek. The approximate drainage area upstream of the FM 3417 crossing is 20,703 acres or 32.4 square miles. The upper reach of Tankersley Creek upstream of Stations 10264 and 10261 receives Texas Utilities Mining Company's storm water flow variable discharge from the Monticello Mine. During the FY2003 survey, the creek flowed underneath a modern heavy-duty concrete structure with a span of over 200 ft. The creek channel varied in width from 10 to 30 feet and exhibited a maximum depth exceeding 6.0 feet over a relatively flat bottom of sediments consisting largely of sand and clay. The base flow of this stream is maintained in large part by treated effluent discharged from the Southwest Wastewater Treatment Plant (Permit No. 03017-004) located at FM 127 (Figure 1-1). This facility is authorized to treat and dispose of 3.0 million gallons per day (MGD) of industrial and domestic wastewater into Tankersley Creek. The creek had measurable flow conditions during 3 of the 4 quarterly field trips with instantaneous readings of total flow ranging from 2.92 cfs to 6.85 cfs. Stream flow was too swift for measurement during January 2003.

Station 10272 is located on Hart Creek at State Highway 49 southeast of Mount Pleasant, Texas in Titus County (Figure 1-1). This reach of Hart Creek is relatively wide, without a tree canopy, and with steep

eroded banks up to 6.0 feet high covered with a dense mixture of herbaceous vegetation. The only shading present at this station was that provided by the bridge crossing. The water is turbid and water depth ranged from 0.3 to 4.1 feet. There was no measurable stream flow during the fall, winter and summer field trips. A total flow of 6.80 cfs was recorded during the April 2003 survey. The floodplain upstream and downstream of the bridge opened up to pastureland actively used by livestock. Since October 2002, several trucks have been observed positioned next to a large portable irrigation pump parked on the east bank immediately upstream of the bridge. It appears that the creek is being used as a source of water for local highway expansion activity. The total drainage area upstream of State Highway 49 is about 20,232 acres or 31.6 square miles. Storm water flow variable discharge from Ergon Asphalt (Permit No. 03877-000) to Hart Creek occurs just downstream of Station 10272.

Station 10266 is located on the lower reach of Hart Creek at County Road SE 12 in Titus County near the Mount Pleasant airport (Figure 1-1). A continuous water level recorder was established at this trigger station to document changes in the stream water level prior to a storm event. This instrument, connected by an internal telephone modem notified sampling personnel to prepare for immediate bacteria collection at all locations when programmed alarm conditions (i.e., detection of rising water) had occurred. The creek at this point is 1.4 miles from its confluence with Big Cypress Creek and drains a surface area of approximately 28,356 acres or 44.3 square miles. Pastureland is present on both sides of the narrow, wooded corridor marking the creek banks. The creek banks were gently sloping and densely covered by an understory consisting of herbaceous vegetation and saplings of the overstory species. A small sand and gravel riffle area occurred immediately downstream of the bridge where the channel was constricted by a gravel bar near the right bank. The stream channel upstream was 20 to 24 feet wide and narrowed to 15 to 17 feet downstream of the riffle area. Water depth ranged from 0.3 ft in the riffle area to 2.5 feet in the upstream segment. Within this reach of Hart Creek, the base flow appears to originate primarily from the Southside Wastewater Treatment Plant discharge (Permit No. 10575-004), located approximately 0.8 mile upstream of this station (Figure 1-1). This facility is authorized to treat and dispose of 2.91 MGD of municipal wastes into Hart Creek. Stream flow measurements were obtained during all four quarterly surveys. Total flow ranged from 2.96 cfs in July 2003 to 8.54 in January 2003.

Station 10311 is located on Big Cypress Creek downstream of Fort Sherman Dam (Figure 1-1), which impounds Lake Bob Sandlin on the Titus-Camp county line upstream of the first tributary downstream of Lake Bob Sandlin (Tankersley Creek). The Titus County Freshwater Supply District No. 1 regulates releases of water from Fort Sherman Dam. The total drainage area upstream of the dam is 151,332 acres or 236.5 square miles. An approximate 2,000-ft diversion channel with a uniform width of approximately 150ft has been cleared of riparian vegetation and channelized to transport the released water. This canal runs in a northwest to southeast direction from the spillway to converge with the original Big Cypress Creek channel. Big Cypress Creek continues from this confluence in a generally easterly direction. The creek narrows from 10 to 25 ft in the vicinity of the sample station situated in an open, flat grassy meadow immediately downstream of the confluence. Although no flow was observed here during the 4 quarterly site visits, flow is highly variable and regulated by periodic releases from the lake that have ranged from 150 cfs to 6000 cfs since January 2002.

Station 10308 is located on Big Cypress Creek at the State Highway 11 Bridge east of Pittsburg, Texas in Camp County downstream of the confluences of Tankersley and Hart creeks (Figure 1-1). The U.S. Geologic Survey (USGS) maintains a stream flow monitoring station (USGS station 07344500), also the site of U.S. Army Corps of Engineers (USACE) Station PBGT2, where stage height (ft), stream

flow (cfs) and precipitation (inches) is measured. The creek banks within the bridge right-of-way consist of sandy-clay alluvium covered with herbaceous vegetation but are without a tree canopy. Upstream and downstream of the bridge, the floodplain is heavily wooded but never forms a complete canopy over the creek. The creek channel ranges from 25 to 40 ft wide and the creek banks are cut into sandy clay banks 0.5 to 4 ft high. Mean gage height and stream flows can be found on the USGS website at http://tx.waterdata.usgs.gov. This information in addition to rainfall amount can also be obtained from the USACE website at http:// www.swf-wc.usace.army.mil/reports/PBGT2.TXT. This station receives wastewater discharges from the four treatment facilities in Mount Pleasant and non-point sources that include urban runoff from Mount Pleasant, Pittsburg and other residential concentrations, leakage from on-site treatment facilities, and intensive agricultural activity, including chicken litter disposal, particularly in the area around Pittsburg. The total drainage area is 228,879 acres or 357.6 square miles.

2.2 MATERIALS AND METHODS

The Special Study followed the guidelines and policies set forth in the *CRP Program Guidance & Reference Guide FY 2002-2003* (and Appendices). Sampling methods and measurements of field parameters were consistent with the procedures outlined in the *TNRCC Surface Water Quality Monitoring Procedures Manual* (June 1999).

2.3 FIELD SAMPLING PROCEDURES

2.3.1 Wet Weather Monitoring

Three wet weather events were monitored during the Special Study duration. As a study guideline, an attempt was made to collect wet weather samples during runoff resulting from initial storm events greater than 0.1 inches in magnitude, with delivery rates of 0.25 inches/hour or more, and occurring at least 72 hours from the previously measurable rainfall (>0.10 inches). Each actual wet weather event sampling was initiated in response to a rise in water level detected by an ISCO Model 4230 wet weather monitoring stream flow meter on Hart Creek (Figure 1-1) at Titus County Road SE 12 (Station 10266). The modem-telephone line installation was programmed to notify sample collection personnel. Northeast Texas Municipal Water District (NETMWD) personnel, upon receiving the water level alarm, initiated manual sample collection at all six station locations immediately. To evaluate the role of initial surface runoff as a transporter of *E. coli* in the study watersheds, follow up sampling was conducted approximately 24 hours after the collection of the initial sample, and again at an interval of approximately one week (7 days) from initial sample collection to document the changes in bacterial levels following a runoff event. The collection schedule was maintained regardless of storm duration or the occurrence of multiple storm events to assess the relative importance of initial runoff versus subsequent surface flushing and drainage from tributaries, surface impoundments, and bank storage.

At each sample location, a temporary staff gage was positioned and a cross section recorded during the quarterly survey conducted on 9 October 2002. Water level (ft) on the staff gage and an estimated flow (ft^3/s) was recorded each time the station was visited and/or a sample collected. Additional field information, including flow severity, staff gage readings, and days since last significant rainfall was recorded at each station during each wet weather sampling event.

2.3.2 Rainfall Monitoring

As part of the data collection for the Tankersley Creek Indicator Bacteria Special Study, a total of 4 rain gages (Nos. 1-4 on Figure 1-1) were installed, programmed and activated for continuous recording in November 2002 and maintained by NETMWD staff in the upper Big Cypress Creek Watershed (Table 2-1). Each rain gage consisted of a Campbell Scientific TE 525 Tipping Bucket Rain Gage and an Onset Corporation HOBO Event Logger. All gages and loggers were programmed, set-up, and calibrated according to manufacturers specifications shown in the manufacturer's user manuals. The rain gages are mounted to steel pipes located in open areas so nearby structures do not affect the collection data. Each rain gage was serviced approximately every 30 days by NETMWD staff to offload data and re-launch the unit. As part of this servicing, each unit was cleaned of any debris, bugs, etc., and re-leveled as prescribed by the user's manuals. For consistency, all four gages were inspected on the same day. A maintenance log sheet for each rain gage was filled out during every trip. Only the daily rainfall totals recorded at gage numbers 2, 3, and 4 were used for discussion in Section 3.1. Additionally, monthly precipitation amounts were provided by Titus County Fresh Water Supply District from their rain gage monitoring station (No. 5 on Figure 1-1) located near Fort Sherman Dam at Lake Bob Sandlin and by weekly internet monitoring of the USACE rain gage (No. 6 on Figure 1-1) located at the State Highway 11 bridge crossing over Big Cypress Creek. The six rain gage monitoring station locations are shown on Figure 1-1.

Table 2-1
Rain Gage Monitoring Stations

Segment	Figure 1-1 Number	Location	Latitude	Longitude
0404	1	Northeast Texas Municipal Water District Executive Office Building at HWY 250 South in Hughes Springs, Texas	32°58.890' N	094° 39.193' W
0404	2	Guard Shack near the US 271 crossing of Walkers Creek north of Pittsburg, Texas	33°03.520' N	094° 57.597' W
0404	3	Pilgrim's Pride Southwest WWTP (Permit No. WQ0003017-004)	33°08.317' N	094° 59.700' W
0404	4	City of Mount Pleasant Southside WWTP (Permit No. WQ0010575-004)	33°06.167' N	094° 57.183' W
0404	5	Immediately downstream of Lake Bob Sandlin northeast of Fort Sherman Dam	33°04.955' N	095° 00.053' W
0404	6	Big Cypress Creek at State Highway 11 near Pittsburg, Texas (USGS Sta. No. 07344500 / USACE Sta. No. PBGT2 / TCEQ Sta. No. 10308)	33°01.319' N	094° 52.859' W

2.3.3 Quarterly Monitoring

In addition to the storm runoff sampling, bacterial samples were also collected quarterly during the FY2003 sampling period regardless of rainfall conditions. Field parameters were recorded during the quarterly sampling at all stations in addition to physical stream channel dimensions (width and depth), stream flow, staff gage readings and light penetration. Instantaneous field measurements of water temperature, dissolved oxygen (D.O.), conductivity, and pH readings were obtained with a Yellow Springs Instrument (YSI) 610 DM/600 XLM Minilogger. Measurements of the aforementioned standard field parameters were taken from all stations during each quarterly collection survey. Each data sonde was calibrated according to the manufacturer's recommendations prior to station visits and post-calibrated upon return to the office. Water transparency was measured at each station during the quarterly monitoring using a 20-cm diameter black-and-white Secchi disk.

Instantaneous flow measurements were taken, when feasible, during each quarterly survey to determine stream discharge in cubic feet per second (cfs). The average velocity (ft/s) was determined with a Marsh-McBirney Model 2000 Flo-Mate portable velocity meter and top-setting wading rod. Stream flow discharge (cfs) was calculated by multiplying the section width by the section depth (ft^2) by the velocity (f/s). Stream flow for Big Cypress Creek at State Highway 11 (Station 10308) was monitored on a weekly basis and real-time measurements were obtained from the U.S Geologic Survey (USGS) and U.S. Army Corps of Engineers (USACE) websites.

2.4 FIELD DOCUMENTATION

Field books containing field data collection forms were provided to the field crews for field data recording and record keeping. Entries into the field books included sample date, start time, weather conditions, field personnel present, all field measurements, observations and any other information pertinent to the specific field activity.

2.5 SAMPLE COLLECTION

Sterile, styrene 100 ml Colilert sample bottles purchased from IDEXX Laboratories, Inc. were used for *E. coli* and fecal coliform analysis. Special care was taken to assure that the containers were clean (sterile) and posed no threat of contamination to the bacteria samples. The presterilized Colilert plastic bottle has a clear seal over its cap and contains sodium thiosulfate ($Na_2S_2O_3$). Any sample bottle whose seal was broken was immediately discarded.

For sampling purposes, the seal and cap was removed being careful not to touch the inside of the cap or bottle. At each creek location, *E coli* samples were taken by holding the sample bottle near the base and dipping it, neck downward, below the water surface. The bottle was turned slightly upward and towards the stream current. During the sampling process, the field collector avoided contact with the inside of the container to prevent contamination and made sure the sample was free from any uncharacteristic floating debris. Fecal coliform sample collection from the two Tankersley Creek locations also followed the same protocol.

The bottles were capped tightly and the samples were placed in a pre-cooled ice chest immediately after collection in order for the sample to quickly chill to a temperature of 4°C. Samples were kept on ice during transportation up to the point of delivery and exchange at the East Texas Baptist University (ETBU) laboratory. All samples met the holding time criteria necessary to be considered valid.

2.6 SAMPLE ANALYSIS

Two methods of bacteria sample analysis were utilized in this Special Study effort. The membrane filtration technique was used for the determination of fecal coliform bacteria and the Colilert Quanti-Tray Method was used in the determination of *Escherichia coli* (*E. coli*). Each method requires the collection of a separate100-milliliter (ml) sample of water. In the laboratory, a predetermined portion of water from each sample bottle was taken to incubate and then observed for the presence of the requested bacterial organism.

For each fecal coliform sample collected, two different volumes of water were filtered. The filter was pre-rinsed with sterile distilled water, the sample was filtered, and the filtration funnel was rinsed with

approximately 25 ml of sterile distilled water. Following the filtration, the membrane filter was transferred to a Petri dish with a paper disk saturated with sterile m-FC media. The dishes were incubated in an inverted position for 24 hours in an incubator at 44.5°C. Following incubation of each plate, the number of positive colonies was recorded and the number of colonies per 100 ml calculated. One laboratory quality control sample was run for each sampling event up to 9 samples. If ten or more samples were collected during the sampling event, two laboratory duplicates were run. Each laboratory duplicate container was clearly identified as a duplicate on the bacteriological log sheets. All procedures were conducted as described in the 1999 TNRCC *Surface Water Quality Monitoring Procedures Manual*.

The bacteria analysis for E. coli is an enzyme substrate method called Colilert that is analogous to the commonly used multiple tube method. Bacteria counts are expressed as a most probable number (MPN) per 100 milliliters (ml). Different dilution ratios were prepared for each collection set by adding an aliquot of sample to sterile, deionized/distilled (DI) water to produce 100 ml of liquid. A powdered reagent (Colilert-18) was added to each dilution bottle and the mixture added to a sterile, plastic tray containing 97 wells and incubated for 18 hours at 35°C. The wells produce a yellow color when total coliform is present and fluoresce under ultraviolet light (UV) when E. coli are present. Bacterial results are reported as a most probable number (MPN) because of known uncertainties in the methods used to evaluate the presence of bacteria.

For laboratory duplicate analysis of *E coli*, a 100 ml sample was chosen at random and split into two equal sample test volumes of 50 ml and diluted with 50 ml of sterile deionized water to a 100 ml total volume. Sample dilutions did, however, vary by sample date. Sample dilution for *E. coli* followed guidelines as outlined in the "*E. coli Colilert® Quanti-tray® 2002 Method Standard Operating Procedure (Revised 9/28/01) and "Laboratory Quality Assurance Guidance for Colilert®/Enterolert® Analysis Under the Clean Rivers Program (Revised 10/4/01)* provided by the TCEQ.

2.7 CHAIN-OF-CUSTODY RECORDS

Chain-of-custody procedures were established to ensure sample integrity. The sample custody was properly documented to provide a mechanism for tracking each bacteria sample submitted to the ETBU laboratory for E. coli and fecal coliform analysis. Sample chain-of-custody protocol was maintained through the receipt of the sample containers, sample collection, transfer between personnel, shipment to the ETBU laboratory and final disposal of the sample.

The field crew member(s) were personally responsible for the care and custody of the bacteria samples until the samples were transferred or properly dispatched to the ETBU laboratory. Every bottle was labeled prior to sample collection with an indelible marker in a clear and precise way for proper identification in the field and for tracking in the laboratory. The sample labels contained the station identification number, sample collector's name, date and time of collection, and analytical parameter.

The field crew transported every sample set collected during the Special Study directly to the ETBU laboratory. A properly completed chain-of-custody form accompanied all samples collected during each phase of the Special Study. The TCEQ station identification number and station location was listed on each form. Each time the possession of samples were transferred, the individuals relinquishing and receiving would sign, date and note the time on the record.

This record documented the transfer of custody of samples from the field collector to another person and/or to the ETBU laboratory. The ETBU custodian examined all arriving samples for proper documentation to determine whether or not the samples met the 6-hour holding time constraints. The ETBU custodian accepted delivery of valid samples only by signing the final portion of the chain-of-custody form and retained the original copy. The ETBU custodian monitored the progress of the samples through the analysis stage.

2.8 LAND USE

Currently, land use and permitted discharger information is available on Geographic Information System (GIS) files for the entire Cypress Creek Basin. A description of the various existing land uses surrounding the Tankersley watershed was prepared based on this existing data layer. Additional detail was added to the land use inventory of the Special Study area by identifying and locating agricultural operations, developed water resources, forestry, industrial/commercial, pastureland, recreational, urban development, and undeveloped land. Point source discharges of industrial wastewater, treated sanitary wastewater or storm water associated with industrial or municipal activity identified from GIS information and verified through research conducted at the TCEQ Central Records Department and the Office of the Chief Clerk.

3.0 RESULTS

Appendix A presents the complete results of sampling efforts conducted since October 2002 under dry and wet-weather conditions to determine the presence and concentration of bacterial contaminants at six locations in the upper Big Cypress Creek watershed. Bacterial samples were collected quarterly during Clean Rivers Program routine and systematic station monitoring periods regardless of weather conditions. Wet weather samples were collected without schedule, in response to the rainfall/runoff conditions outlined above in Section 2.3. A logbook for each set of collected bacteria samples (e.g., quarterly event or immediate rainfall - 24-hour - 7-day monitoring) was maintained for each survey. Table 3-1 presents the collection dates of the various CRP FY2003 sampling events that occurred during the duration of the Special Study. An event type designation, in parentheses, was assigned to each sample event by collection date.

Table 3-1
Quarterly Event and Runoff Event Sample Dates

Date	Sample Event
2 October 2002	Dry Weather Baseline (B1)
9 October 2002	FY2003 Fall Quarterly (Q1)
10 October 2002	FY2003 Fall Quarterly (CRP1)
12 November 2002	Dry Weather Baseline (B2)
6 January 2003	FY2003 Winter Quarterly (CRP2)
7 January 2003	FY2003 Winter Quarterly (Q2)
6 February 2003	Storm water Event 1 – Initial (F1)
7 February 2003	Storm water Event 1 – 24-hour (F2)
13 February 2003	Storm water Event 1 – 7-day (F3)
19 April 2003	Storm water Event 2 – Initial (A1)
21 April 2003	Storm water Event 2 – 24-hour (A2)
22 April 2003	FY2003 Spring Quarterly (CRP3)
23 April 2003	FY2003 Spring Quarterly (Q3)
25 April 2003	Storm water Event 2 – 7-day (A3)
21 July 2003	FY2003 Summer Quarterly (Q4)
24 July 2003	FY2003 Summer Quarterly (CRP4)
30 July 2003	Storm water Event 3 – Initial (J1)
1 August 2003	Storm water Event 3 – 24-hour (J2)
6 August 2003	Storm water Event 3 – 7-day (J3)

3.1 RAINFALL DATA

Stream flow information for the stations monitored during the wet weather and quarterly monitoring programs of this special study are summarized in Table 3-2. The staff gages placed at each of the Special Study stations provided little useful information due to loss of the gages due to high water or vandalism, and the prevalence of very low flows. Stream flow and staff gage measurements made during the quarterly samples were useful in estimating stream flow during wet weather events only at the upper Tankersley Creek location (Station 10264). In Table 3-2, where stream flow characteristics are summarized, **bold type** represents flows estimated from stream flow-staff gage correlations and measured flows are shown in standard type. The limited data from Station 10264 suggests little reliability at low flows (<1 cfs). Plots of gage heights versus measured flow at Station 10308 also show substantial scatter below 1 cfs.

Figures 3-1 through 3-3 show daily rainfall totals relative to each applicable event type sample date recorded at the three primary rain gages listed in Table 2-1 at the guard shack near the US271crossing of Walker Creek, at the Pilgrim's Pride Southwest Wastewater Treatment Plant on Tankersley Creek and at the City of Mount Pleasant Southside Wastewater Treatment Plant on Hart Creek, respectively.

Table 3-2
Summary of Stream Flow Information from Special Study Stations
During Dry and Wet Weather Conditions

Station: Tankersley Creek at FM 899						
Event Type	Date	Time	Rainfall*	Gage Ht.	Flow (cfs)	Observations and/or Comments
B1	10/2/02	10:58	19	--	--	Dry weather sample to establish baseline value
Q1	10/9/02	16:21	<1	0.675	**0.7,** 0	Low flow severity; moderate channel flow status; samples taken during rain event
B2	11/12/02	9:58	7	--	--	Dry weather sample
	1/7/03	10:20	8	0.825	**3.1**, 3.3	High flow severity; flow may be regulated by Tankersley Lake north of IH-30
F1	2/6/03	14:16	24	0.8	**2.6**	High flow severity; light rain
F2	2/7/03	13:21	1	0.72	**1.4**	
F3	2/13/03	13:31	7	0.72	**1.4**	Light drizzle
A1	4/19/03	20:37	<1	0.78	**2.3**	
A2	4/21/03	6:54	2	0.6	**0**	
Q3	4/23/03	14:15	4	0.61	**0,** 0.52	Low flow severity w/ no flow
A3	4/25/03	13:56	1.5	0.62	**0**	
Q4	7/21/03	8:56	>7	0.65	**0.3,** 0.0064	Low flow severity; trickle flow w/ one measurement
J1	7/30/03	17:48	<1	3.25	OFF SCALE	High Flow Severity
J2	8/1/03	7:39	2	0.65	**0.3**	Water level much lower
J3	8/6/03	13:26	7	0.68	**0.8**	
Station: Tankersley Creek at FM 3417						
Event Type	Date	Time	Rainfall*	Gage Ht.	Flow	Observations and/or Comments
B1	10/2/02	10:38	19	--	--	Dry weather sample to establish baseline value
Q1	10/9/02	10:51	1	2.626	5.28	Normal flow severity; High channel flow status
CRP1	10/10/02	9:00	<1	2.63	4.29	Normal flow severity; High channel flow status
B2	11/12/02	8:43	7	--	--	Dry weather sample
CRP2	1/6/03	12:34	7	--	--	High flow severity; flow estimated; non-wadeable
Q2	1/7/03	8:32	8	--	--	Normal flow severity; water level down 1 ft from previous day
F1	2/6/03	14:30	24	--	--	Normal flow severity
F2	2/7/03	13:21	1	--	--	Flow not estimated
F3	2/13/03	13:47	7	--	--	Flow not estimated
A1	4/19/03	19:42	<1	--	--	
CRP3	4/22/03	12:09	3	--	5.13	Normal flow severity; High channel flow status
Q3	4/23/03	16:25	4	--	6.85	Normal flow severity; High channel flow status
A3	4/25/03					
Q4	7/21/03	10:23	>7	--	2.92	Normal flow severity; High channel flow status
CRP4	7/24/03	12:36	2	--	6.85	Normal flow severity; High channel flow status
J1	7/30/03	18:35	<1	--	--	Water at top of banks
J2	8/1/03	7:39	2	--	--	Level down 1 ft from storm event sample
J3	8/6/03	13:20	7	--	4.52	Normal flow severity; flow similar to that on 8-5-03

Table 3-2 (Cont'd)

Station: Hart Creek at State Highway 49						
Event Type	Date	Time	Rainfall*	Gage Ht.	Flow (cfs)	Observations and/or Comments
B1	10/2/02	11:13	19	--	--	Dry weather sample to establish baseline value
Q1	10/9/02	13:03	<1	1.1	0	Water rising from overnight rains; used as a water source for highway activity?
B2	11/12/02	10:12	7	--	--	Dry weather sample
Q2	1/7/03	11:02	8	1.35	0	Somewhat higher than normal flow severity; High channel flow status
F1	2/6/03	14:04	24	--	0	Normal flow severity
F2	2/7/03	12:35	1	1.88	0	Cold
F3	2/13/03	13:45	7	1.7	0	Light drizzle
A1	4/19/03	20:47	<1	2.82	--	
A2	4/21/03	7:05	2	1.5	--	
Q3	4/23/03	14:52	4	1.5	--	Higher level than January; high channel flow status
A3	4/25/03	13:45	1.5	1.7	--	
Q4	7/21/03	8:30	>7	0.8	0	Low flow severity; no flow observed
J1	7/30/03	18:00	<1	1.65	--	Raining; normal to high
J2	8/1/03	7:57	2	1.08	--	
J3	8/6/03	13:40	7	1.1	0	No flow observed
Station: Hart Creek at County Road SE 12						
Event Type	Date	Time	Rainfall*	Gage Ht.	Flow	Observations and/or Comments
B1	10/2/02	12:10	19	--	--	Dry weather sample to establish baseline value
Q1	10/9/02	11:51	<1	0.475	5.2	Normal flow severity
B2	11/12/02	10:28	7	--	--	Dry weather sample
Q2	1/7/03	11:39	8	--	8.54	Normal flow severity; moderate channel flow status
F1	2/6/03	14:49	24	--	--	Water rising and turbid
F2	2/7/03	13:00	1	--	--	
F3	2/13/03	13:14	7	--	--	
A1	4/19/03	21:15	<1	--	--	Flow meter 2.46 ft
A2	4/21/03	7:21	2	--	--	Level at 0.5 ft; battery dead
Q3	4/23/03	15:53	4	--	6.97	Normal flow severity; moderate channel flow status
A3	4/25/03	14:00	2	--	--	Flow meter 0.529 ft
Q4	7/21/03	10:55	>7	--	2.96	Normal flow severity; moderate channel flow status
J1	7/30/03	18:21	<1	--	--	Raining; Flow meter 0.643 ft
J2	8/1/03	8:19	2	--	--	Flow meter 0.545 ft
J3	8/6/03	13:35	7	--	--	Flow estimated

Table 3-2 (Concluded)

Station: Big Cypress Creek downstream of Fort Sherman Dam (Lake Bob Sandlin)						
Event Type	Date	Time	Rainfall*	Gage Ht.	Flow (cfs)	Observations and/or Comments
B1	10/2/02	10:05	19	--	--	Dry weather sample to establish baseline value
Q1	10/9/02	9:05	<1	0.85	0	YSI sonde malfunction; rainfall heavy at time of visit; no flow observed; high channel flow status; located ~2000ft downstream of dam; last release was on 5-18-02
B2	11/12/02	9:09	7	--	--	Dry weather sample
Q2	1/7/02	9:32	8	1.85	0	No release from dam; shut down 12 hrs earlier running at 400 cfs; 1 ft higher than observed in October
F1	2/6/03	14:00	24	0.85	--	
F2	2/7/03	13:30	1	0.85	--	
F3	2/13/03	13:30	7	0.6	--	
A1	4/19/03	20:12	<1	0.98	--	
A2	4/21/03	7:30	2	0.8	0	No flow
Q3	4/23/03	13:28	4	1.85	0	Level same as January; normal flow severity; last release on 3-28-03
A3	4/25/03	13:30	2	0.85	--	
Q4	7/21/03	9:58	>7	0	0	Last release on 5-17-03
J1	7/30/03	18:15	<1	-0.25	0	
J2	8/1/03	??	2	-0.25	0	
J3	8/6/03	13:20	7	-0.25	0	
Station: Big Cypress Creek at State Highway 11						
Event Type	Date	Time	Rainfall*	Gage Ht.	Flow	Observations and/or Comments
B1	10/2/02	12:30	19	--	--	Dry weather sample to establish baseline value
Q1	10/9/02	9:29	<1	1.15	23	Normal flow severity; high channel flow status
B2	11/12/02	10:48	7	--	--	Dry weather sample
Q2	1/7/03	8:02	8	4.325	117	High flow severity
F1	2/6/03	15:02	24	1.28	25	
F2	2/7/03	14:16	1	--	45	
F3	2/13/03	14:12	7	--	200	Water over staff gage
A1	4/19/03	21:53	<1	--	22	
A2	4/21/03	20:12	2	0.98	28	
Q3	4/23/03	17:11	4	1.1	20	Normal flow severity; high channel flow status
A3	4/25/03	7:59	2	0.8	34	
Q4	7/21/03	11:45	>7	0.65	12	Low flow severity
J1	7/30/03	19:00	<1	--	7.7	Raining
J2	8/1/03	8:55	2	--	0	
J3	8/6/03	14:00	7	0.7	0	Flow estimated at .13 ft/sec

*Number of days since last significant rainfall

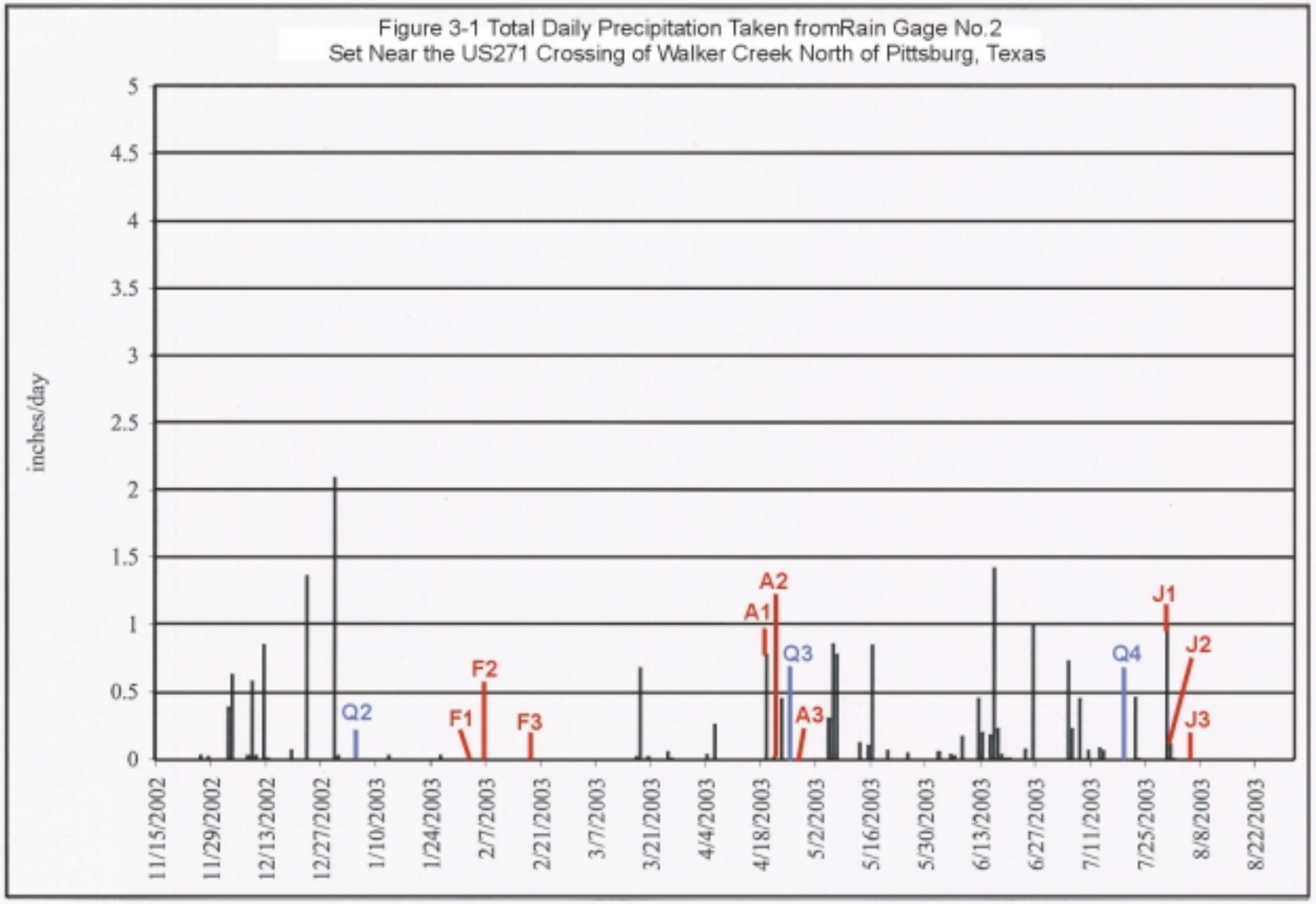


Figure 3-1 Total Daily Precipitation Taken fromRain Gage No.2
Set Near the US271 Crossing of Walker Creek North of Pittsburg, Texas
inches/day
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
A2
A1
J1
Q3
Q4
J2
F2
Q2
F1
F3
A3
J3
11/15/2002
11/29/2002
12/13/2002
12/27/2002
1/10/2003
1/24/2003
2/7/2003
2/21/2003
3/7/2003
3/21/2003
4/4/2003
4/18/2003
5/2/2003
5/16/2003
5/30/2003
6/13/2003
6/27/2003
7/11/2003
7/25/2003
8/8/2003
8/22/2003

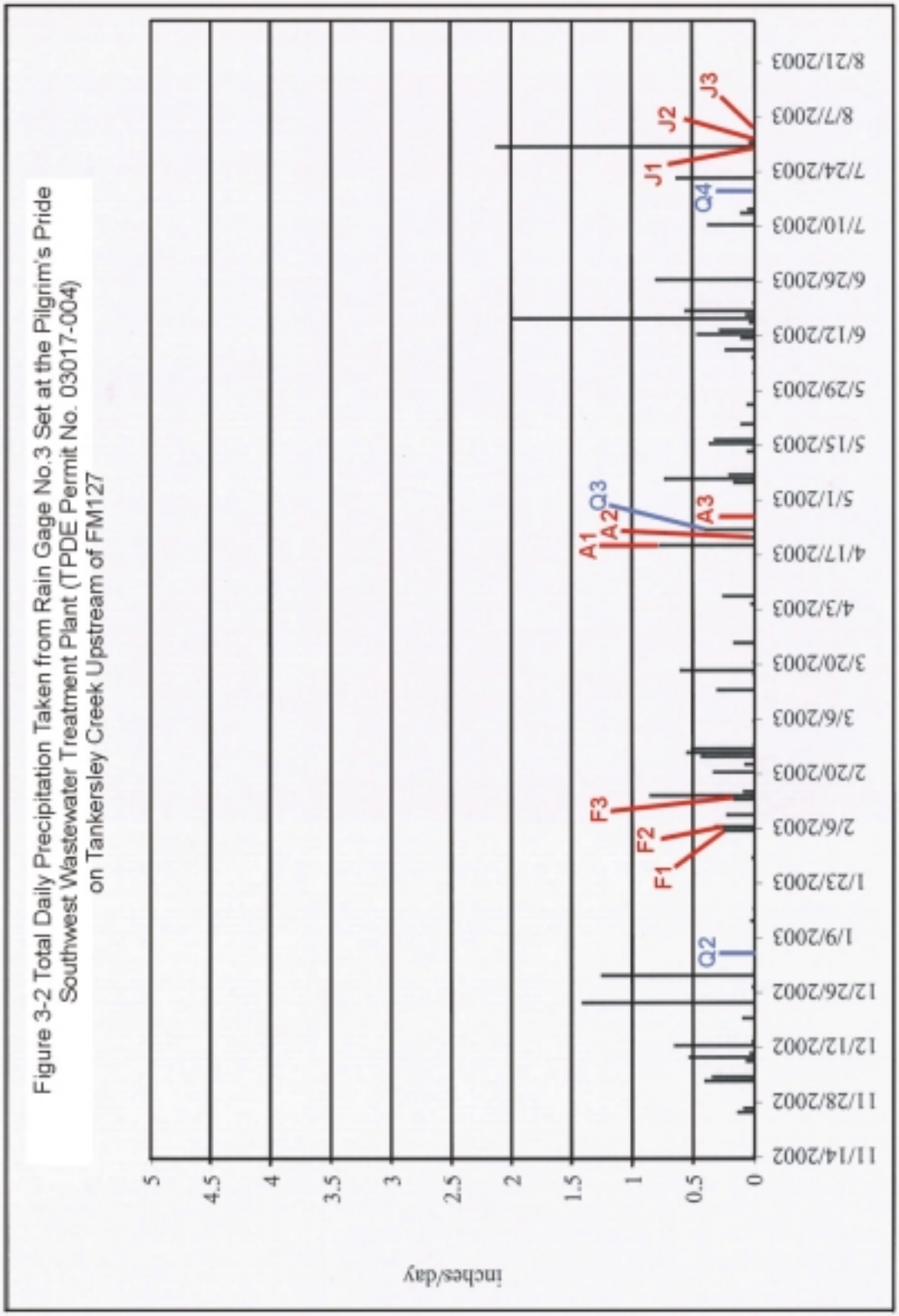


Figure 3-2 Total Daily Precipitation Taken from Rain Gage No.3 Set at the Pilgrim's Pride Southwest Wastewater Treatment Plant (TPDE Permit No. 03017-004) on Tankersley Creek Upstream of FM127
inches/day
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
11/14/2002
11/28/2002
12/12/2002
12/26/2002
1/9/2003
1/23/2003
2/6/2003
2/20/2003
3/6/2003
3/20/2003
4/3/2003
4/17/2003
5/1/2003
5/15/2003
5/29/2003
6/12/2003
6/26/2003
7/10/2003
7/24/2003
8/7/2003
8/21/2003
Q2
F1
F2
F3
A1
A2
Q3
A3
J1
J2
J3
Q4

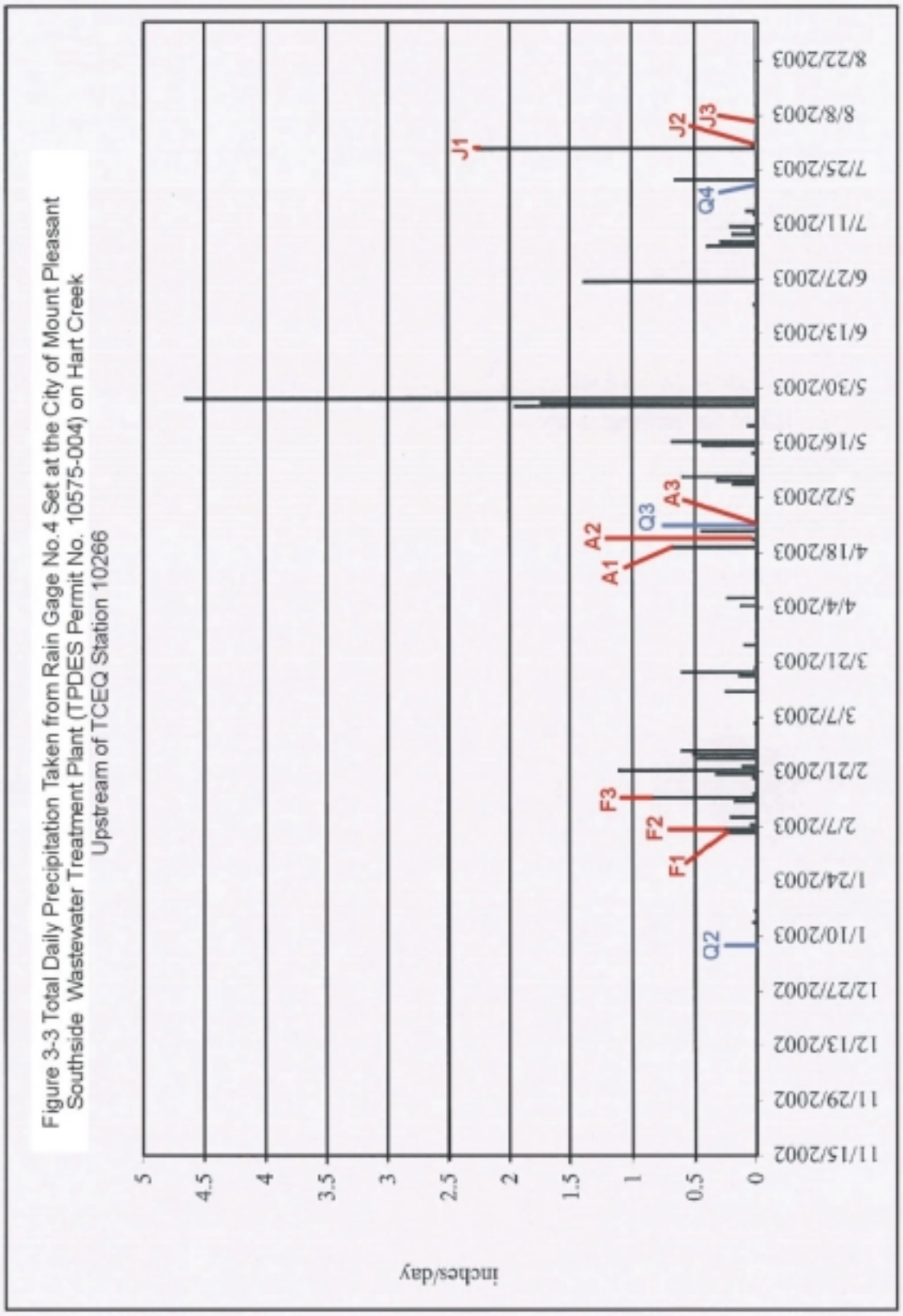


Figure 3-3 Total Daily Precipitation Taken from Rain Gage No.4 Set at the City of Mount Pleasant Southside Wastewater Treatment Plant (TPDES Permit No. 10575-004) on Hart Creek Upstream of TCEQ Station 10266
inches/day
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
11/15/2002
11/29/2002
12/13/2002
12/27/2002
1/10/2003
1/24/2003
2/7/2003
2/21/2003
3/7/2003
3/21/2003
4/4/2003
4/18/2003
5/2/2003
5/16/2003
5/30/2003
6/13/2003
6/27/2003
7/11/2003
7/25/2003
8/8/2003
8/22/2003
J1
J2
J3
Q4
A1
A2
A3
Q3
F1
F2
F3
Q2

Rain Gage No. 5 (Figure 3-3) was near the ISCO flow meter at Station 10266 used for wet weather sampling initiation during the Special Study (Figure 1-1).

Substantial differences in rainfall amounts and distributions are evident among the three primary locations used to monitor rainfall in the study watershed (Figure 1-1). For example, rainfall totals during the special study ranged from 18.83 inches at Walker Creek, 21.75 inches at Hart Creek, to 23.6 inches at Tankersley Creek. While substantial rain fell at the Walker Creek and Tankersley locations during December 2002 (Figures 3-1 and 3-2), none was recorded at the Hart Creek sample site (Figure 3-3) during that period. Conversely, the large event recorded on Hart Creek May 25-27 2003 had no counterpart at the other stations. This is of interest in that wet weather monitoring was initiated in response to an increase in water level (not rainfall amount) in Hart Creek alone. Therefore, we cannot expect the results from the sample events listed in Table 3-1 to represent identical climatic and hydrologic conditions at all sample locations. However, figures 3-2 and 3-3 show that the rainfall regime during all three wet weather events was very similar at the Tankersley and Hart Creek locations, although little precipitation occurred at the Walker Creek location, suggesting that rainfall on the adjacent floodplain areas may not have been an important contributor to runoff flows at the Stations downstream of Fort Sherman Dam on Big Cypress Creek (10311) and on Big Cypress Creek (10308) near Pittsburg.

3.2 LAND USE DISTRIBUTION

The distribution of land use and vegetative cover in the study watershed was based on existing TCEQ Geographic Information System (GIS) layers supplemented with additional information, such as permitted outfall locations. Table 3-3 lists land use types and the approximate acreages and proportions of each land use category identified upstream of each station on Tankersley and Hart creeks. Figure 3-4 shows the general distribution of land use features within the Special Study area.

Land use proportions in the Tankersley and Hart Creek watersheds are very similar, as are the spatial distributions of land use categories. Agriculture is the primary land use for the majority of the Special Study area; pasturage of livestock and cropland account for two thirds to three quarters of the areas monitored in the Tankersley and Hart Creek watersheds (Tables 3-3 and 3-4). Extensive wooded areas, particularly on floodplains occur primarily in the southern portion of each of these two watersheds (Figure 3-4). About 18% of the Hart Creek drainage upstream of Stations 10272 and 10266 consists of built up areas (residential, commercial, industrial, urban, and transportation in and around the City of Mount Pleasant), substantially more than the approximately 9% of the Tankersley Creek watershed (Table 3-3).

Upstream of stations 10308 and 10311 on Big Cypress Creek mixed forestland (primarily floodplain forest) is more important, occupying 29% and 33%, respectively, of those watersheds, with nearly all the remainder consisting of pastureland. Aside from the Monticello Steam Electric Station upstream of Fort Sherman Dam, there is little urban or developed area in the Big Cypress Creek watershed upstream of State Highway 11. The length of Big Cypress Creek from Fort Sherman Dam to State Highway 11 east of Pittsburg, Texas receives treated effluent from four permitted wastewater discharge systems. The approximate location of the four point source dischargers is illustrated in Figure 1-1.

The largest of the four dischargers, the Southwest Wastewater Treatment Plant (TPDES Permit No. 03017-004 and EPA ID #TX00629361), is located southwest of the City of Mount Pleasant on the north

Table 3-3

Land Use Types and Approximate Acreages By Upper and Lower Watershed
Tankersley Creek and Hart Creek

Land Use Description	**Tankersley Creek at FM 899 Station 10264**	**Tankersley Creek At FM 3417 Station 10261**	**Hart Creek at State Highway 49 Station 10272**	**Hart Creek at SE 12 Station 10266**
Unknown Land Type	--	4.69	1.35	1.35
Residential	372.17	916.56	2,706.52	3,181.52
Commercial Services	65.89	65.89	505.58	559.85
Industrial	--	143.65	--	--
Transportation, Communications	127.16	277.47	287.52	298.79
Mixed Urban, or Built-Up Land	46.33	136.02	232.62	316.90
Other Urban, or Built-Up Land	173.40	173.40	301.35	374.95
Cropland and Pasture	6,224.92	13,837.98	13,681.67	18,143.09
Confined Feeding Operations	10.66	60.44	152.32	170.43
Other Agricultural Land	--	95.90	48.56	48.56
Deciduous Forest Land	576.07	1,900.09	1,533.68	1,851.53
Evergreen Forest Land	--	--	59.59	532.19
Mixed Forest Land	273.07	1,991.16	571.67	2,690.08
Reservoirs	181.92	202.80	150.02	185.23
Non-Forested Wetlands	56.93	56.93	--	--
Strip Mines, Quarries and Gravel Pits	528.69	840.13	--	--
Transitional Areas	--	--	--	1.68
TOTAL	8,637.22	20,703.09	20,232.45	28,356.13

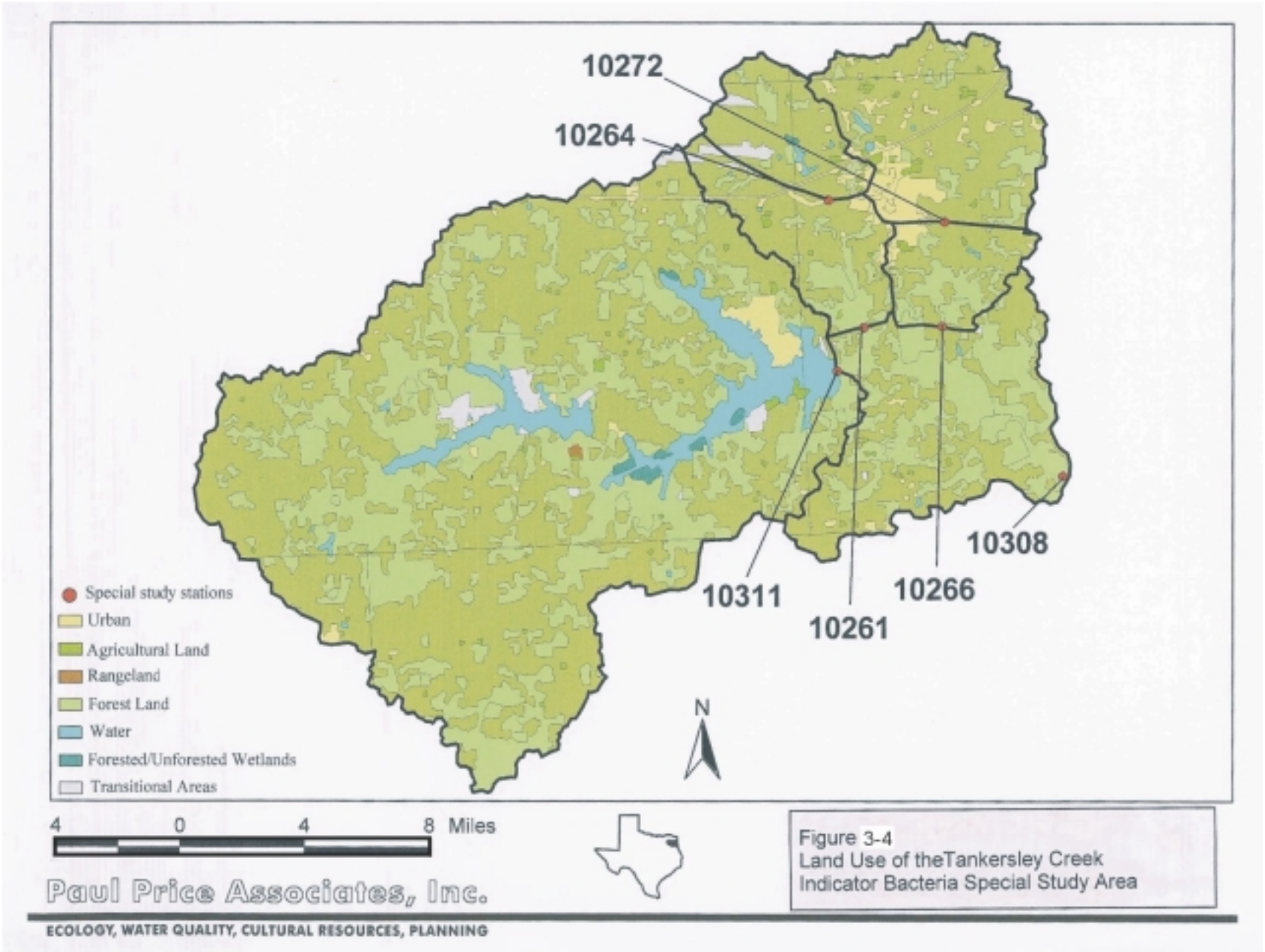


Figure 3-4
Land Use of theTankersley Creek
Indicator Bacteria Special Study Area

Table 3-4

Percentage of Land Use By Upper and Lower Watershed
Tankersley Creek and Hart Creek

Land Use Description	**Tankersley Creek at FM 899 Station 10264**	**Tankersley Creek At FM 3417 Station 10261**	**Hart Creek at State Highway 49 Station 10272**	**Hart Creek at SE 12 Station 10266**
Unknown Land Type	--	0.02	0.01	0
Residential	4.31	4.43	13.38	11.22
Commercial Services	0.76	0.32	2.50	1.97
Industrial	--	0.69	--	--
Transportation, Communications	1.47	1.34	1.42	1.05
Mixed Urban, or Built-Up Land	0.54	0.66	1.15	1.12
Other Urban, or Built-Up Land	2.01	0.84	1.49	1.32
Cropland and Pasture	72.07	66.84	67.62	63.98
Confined Feeding Operations	0.12	0.29	0.75	0.60
Other Agricultural Land	--	0.46	0.24	0.17
Deciduous Forest Land	6.67	9.18	7.58	6.53
Evergreen Forest Land	--	--	0.29	1.88
Mixed Forest Land	3.16	9.62	2.83	9.49
Reservoirs	2.11	0.98	0.74	0.65
Non-Forested Wetlands	0.66	0.27	--	--
Strip Mines, Quarries and Gravel Pits	6.12	4.06	--	--
Transitional Areas	--	--	--	0.01
TOTAL	100	100	100	100

side of FM 127 and approximately 500 feet east of Tankersley Creek.). This facility is authorized to treat and dispose of 3.0 million gallons per day (MGD) of industrial and domestic wastewater into Tankersley Creek. Since 1982, Pilgrims Pride Corporation has operated the city-owned treatment plant facility that receives industrial waste from their poultry processing operation.

The City of Mount Pleasant owns and operates the Southside Wastewater Treatment Plant (TPDES Permit No. 10575-004 and EPA ID #TX0105171). This facility is authorized to treat and dispose of 2.91 million gallons per day (MGD) of municipal wastes into Hart Creek. This outfall is upstream of Station 10266 and downstream of Station 10272.

Ergon Asphalt and Emulsions, Inc. (TPDES Permit No. 03877-000 and EPA I.D. #TX0106194) is located south of Mount Pleasant and has an industrial flow variable storm water permit to discharge into Hart Creek. This discharge is situated between stations 10272 and 10266 and upstream of the City of Mount Pleasant Southside Wastewater Treatment Plant.

TXU Mining Company is authorized to treat and dispose of wastes at variable rates from lignite mines located north and south of IH30. The outfalls are located north and west of Mount Pleasant, discharging into tributaries of both Tankersley and Hart creeks, and eventually Big Cypress Creek. The effluent that is generated from surface mining activity discharges upstream of both Hart Creek sampling locations (Stations 10272 and 10266). At least one tributary carrying mine drainage enters Tankersley Creek Between Stations 10264 and 10261.

3.3 INDICATOR BACTERIA MONITORING

Contact recreation use is protected by criteria for fecal coliform and *E. coli*. Support of contact (and non-contact) recreation water quality is determined by a long-term geometric mean in addition to exceedences of single sample criteria. Criteria for water designated suitable for contact recreation are long-term geometric means not exceeding 200/100 ml and no single value exceeding 400/100 ml for fecal coliform, and geometric means not exceeding 126/100 ml and no single value exceeding 394/100 ml for *E. coli*.

3.3.1 Baseline Sampling

Special Study monitoring was initiated when samples were collected from all six locations on 2 October 2002 (B1) to establish dry weather (baseline) bacterial concentrations after an extended dry period of 19 days (Table 3-5). A second set of samples was collected for dry weather bacterial levels on 12 November 2002 (B2) after a rainless period of 7 days. The results of *E. coli* and fecal coliform samples collected during October were below the screening criteria, while in November *E. coli* abundance at Tankersley Creek Station 10261 (FM 3417) and at Big Cypress Creek Station 10308 (State Highway 11) exceeded the single value criterion (525 /100 ml and 899 /100 ml, respectively). With a single exception (Station 10266), bacterial abundances were greater in the November than in the October sample (Table 3-5)

3.3.2 Quarterly Event Sampling

All four seasonal collections (Q1, Q2, Q3, and Q4) were combined with their respective quarterly Clean Rivers Program Routine/Systematic sampling during October 2002 (CRP) and January (CRP2), April

(CRP3) and July 2003 (CRP4). Field parameter measurements made during the four quarterly sampling efforts are summarized in Table 3-6. With a few exceptions, field parameters at all six stations exhibited appropriate seasonal changes and similar annual ranges. The most upstream stations on Tankersley and Hart Creeks (10264 and 10272) had the widest ranges in dissolved oxygen concentrations, with significant undersaturation evident during October and the following July sample periods. Conductivities tended to be elevated in lower Tankersley Creek (Station 10261), at SH11 on Big Cypress Creek (Station 10308), and to a lesser extent in lower Hart Creek (Station 10266), most likely due to the wastewater discharges from the two Mount Pleasant facilities.

Table 3-5
Baseline Samples Taken During Dry Weather Conditions on 2 October and 12 November2002

Station ID	Site Description	*E. coli* Bacteria mpn/100mL		Fecal Coliform Bacteria org/100mL	
		2 October (B1)	12 November (B2)	2 October (B1)	12 November (B2)
10264	Tankersley Creek at FM 899	25	175	110	140
10261	Tankersley Creek at FM 3417	291	525*	190	340
10266	Hart Creek at SE 12	166	124	--	--
10272	Hart Creek at SH 49	125	152	--	--
10311	Big Cypress Creek downstream of Lake Bob Sandlin	6	102	--	--
10308	Big Cypress Creek at Hwy. 11	225	899*	--	--

* Exceeded the 394 MPN/100 ml single grab criterion

Table 3-6
Physico-Chemical and Stream Flow Characteristics of Indicator Bacteria Special Study Stations
Measured During Quarterly Sampling of Special Study and CRP Events

Event Type	Date	Time	Stream Flow		Field Data			
			Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	D.O. (mg/l)	Cond. (µmhos)	pH (SU)
Station 10264: Tankersley Creek at FM 899								
Q1	10/9/02	16:21	0.675	0	19.9	1.32	449	7.06
Q2	1/7/03	10:20	0.825	3.3	7.6	13.2	248	7.10
Q3	4/23/03	14:15	0.61	0.52	16.8	5.7	573	7.10
Q4	7/21/03	8:56	0.65	0.0064	26.3	3.8	456	6.70
Station 10261: Tankersley Creek at FM 3417								
Q1	10/9/02	10:51	2.626	5.28	20.5	5.74	1558	7.05
CRP1	10/10/02	9:00	2.63	4.29	17.59	7.73	585	7.10
CRP2	1/6/03	12:34	**	--	8.5	13.2	530	7.20
Q2	1/7/03	8:32	**	--	8.6	12.7	816	6.80
CRP3	4/22/03	12:09	**	5.13	19.6	7.3	1208	7.30
Q3	4/23/03	16:25	**	6.85	19.1	7.91	1398	7.39
Q4	7/21/03	10:23	**	2.92	28.6	7.9	1686	6.90
CRP4	7/24/03	12:36	**	6.85	27.6	6.2	1296	7.20
Station 10272: Hart Creek at State Highway 49								
Q1	10/9/02	13:03	1.1	0	19.1	3.95	199	7.11
Q2	1/7/03	11:02	1.35	0	6.3	13.5	245	7.10
Q3	4/21/03	7:05	1.5	--	--	--	--	--
Q4	7/21/03	8:30	0.8	0	27	2.3	298	6.30
Station 10266: Hart Creek at SE 12								
Q1	10/9/02	11:51	0.475	5.2	19.1	6.7	367	7.11
Q2	1/7/03	11:39	**	8.54	7.5	13.4	380	7.10
Q3	4/23/03	15:53	**	6.97	17.7	7.6	435	7.10
Q4	7/21/03	10:55	**	2.96	26.9	8.5	529	7.00
Station 10311: Big Cypress Creek below Fort Sherman Dam (Lake Bob Sandlin)								
Q1	10/9/02	9:05	0.85	0	--	--	--	--
Q2	1/7/02	9:32	1.85	0	9.3	13.7	164	7.20
Q3	4/23/03	13:28	1.85	0	19.4	8.5	242	6.90
Q4	7/21/03	9:58	0	0	29.6	10.9	151	7.30
Station 10308: Big Cypress Creek at State Highway 11								
Q1	10/9/02	9:29	1.15	23	19.9	6.8	1282	7.25
Q2	1/7/03	8:02	4.325	117	7.6	12.3	385	6.40
Q3	4/23/03	17:11	1.1	20	18.1	8.1	654	7.30
Q4	7/21/03	11:45	0.65	12	27.4	10.1	1238	7.10

-- Data not collected
** Staff gage lost during runoff event in December 2002

Table 3-7 presents the quarterly event fecal coliform and *E. coli* results by sample date and geometric mean by station. On 9 October 2002, a total of 6 *E. coli* (one at each site) and 2 fecal coliform samples (Tankersley Creek at FM 899 and FM 3417) were taken during a rainfall event that lasted from the evening of 8 October through the late afternoon of 9 October 2002. Only 0.02 inches of rain was recorded from the Highway 11 rain gage as none of the other rain gages had been installed and/or calibrated. Fecal coliform and *E. coli* levels were significantly elevated at all locations except at the minimally impacted reference site downstream of Lake Bob Sandlin. Maximum concentrations of both bacterial indicators were highest at the FM 3417 site.

Table 3-7
Quarterly Event Sample Results for October 2002, January, April and July 2003

Station ID	Site Description	*E. coli* Bacteria MPN/100ml					Fecal Coliform Bacteria org/100ml				
		9 October (Q1)	7 January (Q2)	23 April (Q3)	21 July (Q4)	GM	9 October (Q1)	7 January (Q2)	23 April (Q3)	21 July (Q4)	GM
10264	Tankersley Creek at FM899	1986*	420*	219	37	287+	1700^	340	77	43	209±
10261	Tankersley Creek at FM 3417	>4838*	472*	774*	1659 *	1309+	2180^	270	165	1400^	623±
10266	Hart Creek at SE 12	>2419*	134	265	87	294+	--	--	--	--	--
10272	Hart Creek at SH 49	>2419*	256	268	6	178+	--	--	--	--	--
10311	Big Cypress Creek downstream of Lake Bob Sandlin	39	70	21	87	24	--	--	--	--	--
10308	Big Cypress Creek at Hwy. 11	1120*	210	173	13	227+	--	--	--	--	--

* Exceeded the 394 MPN/100 ml single grab criterion ^Exceeded the 400 org/100 ml single grab criterion
\+ Exceeded the 126 MPN/100 ml geometric mean (GM) criterion ±Exceeded the 200 org/100ml geometric mean (GM) criterion

On 7 January 2003, a total of 6 *E. coli* and 2 fecal coliform samples were collected under dry weather conditions (i.e., 8 days after a significant rain). Water levels were high at all stations during the winter sampling event, and significant stream flow was present at all locations except at Station 10311 (Big Cypress Creek downstream of Lake Bob Sandlin) at the time of our visit. Titus County Freshwater Supply District No. 1, the controlling authority of Lake Bob Sandlin, had shut down water release from the dam approximately 12 hours earlier from a rate of 400 cubic ft per second (cfs). In January, only Stations 10264 and 10261 on Tankersley Creek exhibited *E. coli* abundances exceeding the single value criterion (Table 3-7). Fecal coliform counts were high but still fell below the screening limit.

A total of 6 E. coli and 2 fecal coliform samples were collected in the spring on 23 April 2003 under dry weather conditions (i.e., 4 days after a significant rain). Water levels were down from January and flow severity varied from low to normal at all sites. Total flow (discharge) was calculated from measurements taken from the two Tankersley and Hart creek locations. There was again no flow noted during the site visit to Big Cypress Creek downstream of Lake Bob Sandlin. Concentrations of *E. coli* were below the single value criterion for all stations except in the lower reach of Tankersley Creek where Station 10261 yielded a concentration of 774 /100 ml. *E. coli* test results at the other five sites and the fecal coliform counts at both Tankersley Creek sites were within the allowable single sample levels.

On 21 July 2003, a total of 6 E. coli and 2 fecal coliform samples were collected under dry weather conditions (i.e., greater than 7 days following a significant rain). The amount of available water was down from the levels observed in April and flow severity ranged from low to normal at all locations. Measurable flow was present at all stations except Hart Creek at 10272 and Big Cypress Creek at 10311. Tankersley Creek at FM 3417, Station 10261, was again the only location with bacterial abundances (both *E. coli* and fecal coliform) exceeding their respective single value criteria while the remaining stations generally exhibited the lowest bacterial numbers observed in the quarterly monitoring series (Table 3-7).

Of the 27 samples collected during the Special Study Quarterly Event Program, 9 or 33% of the samples violated the single value criterion for *E. coli*. The majority of exceedences were observed on 9 October during a rainfall event. In contrast to the results from all the other stations, only Tankersley Creek at FM 3417 (Station 10261) consistently exhibited high levels of *E. coli* throughout the quarterly monitoring program by exceeding the single grab criterion 75% of the time (Table 3-7). Geometric means calculated for all stations in the quarterly sampling program except 10311 exceeded the *E. coli* mean criterion of 126 MPN/100 ml. Both Tankersley Creek stations also exhibited geometric means in excess of the Fecal Coliform mean criterion of 200 MPN/100 ml.

3.3.3 Runoff Event Sampling

In order to fulfill the runoff event collection criteria of four storm events as specified in the Tankersley Creek Indicator Bacteria Special Study QAPP, an extension was requested from 1 September through 31 October 2003. Weather conditions during this period were generally drier than previous years as no significant storm events had occurred in the study watershed up to the deadline date. It was decided that data provided by an additional storm event would probably not be much different than the results seen during the preceding wet weather collections, thus the study was terminated.

The first of three wet-weather collections (Event 1) was taken during the afternoon of February 6, 2003. The 24-hour collections were sampled on February 7, 2003 and the 7-day samples were collected on February 13, 2003. The second of three wet-weather collections (Event 2) was taken on the evening of 19 April 2003. Since the following day was Easter Sunday, the 24-hour collections were not taken until the morning of 21 April 2003 or approximately 36-hours after the initial collection. The 7-day samples were taken on Friday 25 April or 6 days after the initial collection due to the weekend unavailability of field and laboratory staff. The third wet-weather collections (Event 3) were taken in the late afternoon-early evening of 30 July 2003. Due to the unavailability of the Laboratory Coordinator/Analyst on the evening of 31 July 2003, bacteria samples were taken during the early morning hours of 1 August or approximately 38 hours after the initial collection. The 7-day samples were taken as planned on 6 August 2003.

Bacterial abundance during the three-monitored rainfall events showed very high levels of fecal coliform and *E. coli* bacteria to be present at all stations. Table 3-8 summarizes the results obtained from sampling the six study locations for *E. coli* during and following significant rainfall events. Of the initial samples collected during each of the three wet weather events, the *E. coli* single value criterion was exceeded in every instance except two, stations 10308 and 10311 on Big Cypress Creek during the February 2003 event. As noted in Section 3-1 (compare Figures 3-1 through 3-3), rain gage data suggests that little or no rain fell in the immediate vicinity of these stations during the February event, while runoff from the Tankersley and Hart Creek watersheds had not yet reached Station 10308. The

second set of samples collected approximately 24 hours following the initial February event, 10311 continued to exhibit low *E. coli* numbers, while *E. coli* abundance at 10308 had roughly doubled to a level in excess of the single value criterion, presumably as a result of the arrival of Tankersley and Hart Creek water.

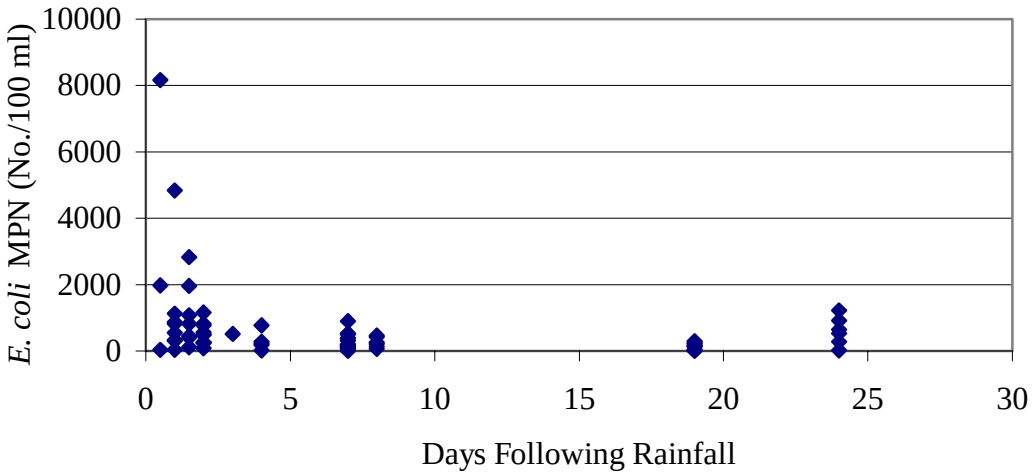
Table 3-8
Escherichia coli Concentrations (MPN/100 ml) in Water Samples Collected During the Tankersley Creek Special Study

Event Type	Date	Tankersley Creek		Hart Creek		Big Cypress Creek	
		FM899 10264	FM3417 10261	SH49 10272	SE12 10266	Below Dam 10311	SH 11 10308
F1	2/6/03	1226	651	523	922	10	271
F2	2/7/03	302	870	821	323	26	546
F3	2/13/03	313	54	82	186.5	39	190
A1	4/19/03	>2419	2419	>2419	>4838	770	1120
A2	4/21/03	819	1954	405	525	106	445
A3	4/25/03	2827	775	821	265	21	173
J1	7/30/03	>2419	>2419	>2419	>4858	411	517
J2	8/1/03	484	500	568	245	257	1074
J3	8/6/03	496	391	115	96	2	158
Geometric Mean		897	703	548	546	54	391

Examination of Table 3-8 shows that second day samples during all three rainfall events resulted in *E. coli* abundances that always exceeded the single value criterion at the lower station on Tankersley Creek (10261), the upper station on Hart Creek (10272) and on Big Cypress Creek at SH 11 (10308). While the other Big Cypress Creek station (10311) always exhibited *E. coli* values less than the single value criterion in second day samples, the remaining Tankersley and Hart Creek stations (10264 and 10266) produced variable results.

Sampling on day seven of each rainfall event resulted in estimates of E. coli abundances that were generally below the single value criterion, except where a substantial intervening rain event (April, 2003) apparently produced elevated values in the Tankersley and Hart Creek watersheds (Table 3-8). Geometric means calculated using the wet weather sample set shows that the criterion for contact recreation (126/100ml) was exceeded (substantially) at all stations except at Station 10311 (Table 3-8). If the dry weather, wet weather, and quarterly sample set results are combined to use all the *E. coli* data available at the six stations, geometric means calculated for *E. coli* samples collected four or more days following significant rainfall show both stations on Tankersley Creek and Station 10308 on Big Cypress Creek to substantially exceed the criterion, while the upper station on Hart Creek exceeds it only marginally (128/100 ml) and the lower station exhibits an *E. coli* abundance of 108 MPN/100 ml. Figure 3-5 is a plot of *E. coli* abundances versus the length of time since significant rainfall at the six study stations. Aside from a cluster of very high *E. coli* values for samples collected within two days following rainfall events, little or no trend is evident in the remaining results.

Figure 3-5
Decline of *E. coli* Abundance Following Rainfall-Runoff Events in the Big Cypress Creek Watershed



3.3.3 *E. coli* – Fecal Coliform Comparison

Figure 3-6 is a plot of all paired fecal coliform and *E. coli* results on samples collected from Tankersley Creek showing that substantial scatter exists in the relationship, particularly at the higher abundances where several censored values (i.e., larger than…) are included at their respective limits. However, an unweighted least squares regression on this data is highly significant ($P<0.0001$), and exhibits an adjusted R^2 of 0.6962. Table 3-9 presents summary statistics for the paired *E. coli* and fecal coliform data sets. Of the two data sets, the *E. coli* results gave consistently higher numbers and exhibited the larger mean error.

Mean Fecal Coliform abundance for samples collected from the two Tankersley Creek stations less than four days following rainfall are only slightly less than the means for those collected four or more days since last rainfall. No significant difference could be detected between those means from either station ($P>0.05$, T-test, equal variances). Plotting Fecal Coliform abundance against days since last rainfall results in a scatter of points without evident trend. While *E. coli* results from the upper station (10264) exhibited a substantial difference in mean abundance between those samples collected less than four days following rainfall (1283 MPN/100 ml) and those collected four or more days after rainfall (775 MPN/100 ml), those differences were also not statistically significant ($P>0.05$, T-test, equal variances). In contrast, the same comparison at the lower station (10261), results in a significant difference in means ($P>0.05$, T-test, unequal variances).

Figure 3-6
Escherichia coli Versus Fecal Coliform Concentrations (MPN/100 ml)
Tankersley Creek

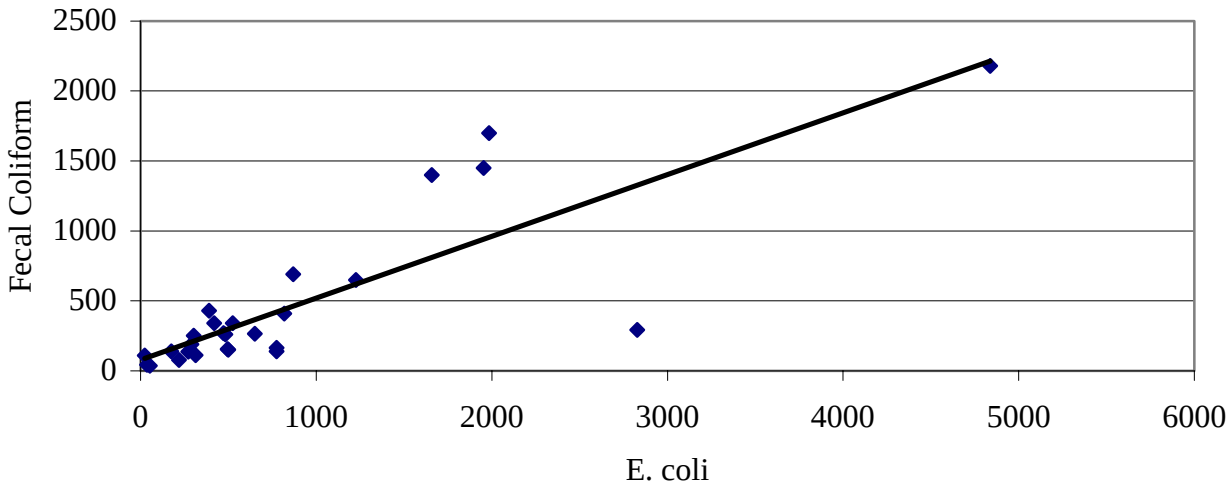


Table 3-9

Bacteriology Descriptive Statistics, Paired Value Data Set, Censored Values Excluded

	E. coli	Fecal Coliform
N	27	27
Lo 95% CI	452.52	238.17
Mean	864.88	458.56
Up 95% CI	1277.2	678.94
Variance	1.087E+06	310359
SE Mean	200.61	107.21
Geometric Mean	476.99	265.00
Minimum	25.000	36.000
Median	496.00	260.00
Maximum	4838.0	2180.0

4.0 DISCUSSION

Fecal coliform bacteria are members of the family Enterobacteriaceae defined (and tested for) by their ability to ferment lactose (milk sugar) with the production of CO_2 at a temperature of 37 ^{o}C (human body temperature). *Escherichia coli* is one species of this group. These organisms grow and reproduce in the intestinal tracts of all warm-blooded animals, including birds, and feces are believed to be the primary source of these bacteria in water. The coliform bacteria are not necessarily pathogenic, but are indicators of the probable presence of animal feces, which may also be the source of disease-causing bacteria.

Bacterial criteria for evaluating the suitability of fresh waters for contact recreation (defined as activities, such as swimming or water skiing, in which there is a substantial probability of ingesting water) were developed through statistical studies conducted at public swimming beaches. These studies involved collecting water samples during periods of recreational activity, then comparing the results of a variety of bacterial analyses with responses to questionnaires about the incidence of gastro-intestinal tract illness. This studies, and many others, have generally found that coliform bacteria levels rise sharply following rainfall events, then tend to decline over a scale of days or weeks, depending on factors that include bacterial source, season and water body type (e.g., streams versus standing water).

Evaluation of the combined *Escherichia coli* results collected in the dry weather, quarterly and wet weather programs indicate that these bacteria are consistently present at levels above the single value criterion (394/100ml)used to evaluate contact recreation use support in the study area streams within 1-2 days of significant local rainfall. Only in samples collected following four or more days of dry weather, do a majority of samples yield *E. coli* numbers below the single value criterion, and two stations, Hart Creek at County Road 12 (10266) and Big Cypress Creek downstream of Fort Sherman Dam (10311), exhibit geometric means less than the mean criterion for contact recreation (126/100 ml) under that definition of dry weather. However, these declines in bacterial abundance with increasing time following rainfall events were only exhibited in some of the *E. coli* results and the phenomenon is certainly not a reliable enough basis on which to assume that dry weather conditions in any of these streams will allow contact recreation.

Of the streams sampled during this study, only Big Cypress Creek could be considered large enough to support contact recreation, but accessibility is limited and the aesthetic aspects of this stream (steep banks, muddy water, abundant woody debris, snakes) do not make it particularly attractive for such uses. However, in spite of their small size and relatively unattractive character, the suburban nature of Tankersley and Hart Creeks suggests that some level of exposure, especially among children, may be occurring. Even under prevailing dry weather conditions, Tankersley Creek and Big Cypress Creek downstream of the Tankersley Creek confluence exhibit coliform levels considered excessive for contact recreational use, and Hart Creek appears only marginally suitable.

Combined sampling for Fecal Coliform and *E. coli* at the two Tankersley Creek stations showed that both procedures indicated that the stream had bacterial abundances consistently too high to be supportive of contact recreation. The cause(s) of the higher numbers and larger variance seen in the *E. coli* data set is not evident from the results of this study, but as indicators of contact recreational suitability the *E. coli* procedure tends to be substantially more protective. Considering the quarterly sampling results alone, both Tankersley Creek stations exhibit geometric means in excess of the respective *E. coli* and fecal coliform criteria. However, the *E. coli* geometric means at both stations

exceeded their mean criterion by far more than did the fecal coliform means (Table 3-7). When the data is inspected, we see that only 50% of individual *E. coli* values were below the single value criterion at the upper station, while none were below that criterion at the lower station. The corresponding results for the fecal coliform samples were 75% and 50% for the upper and lower stations, respectively. Similar results are obtained when all the data collected at the Tankersley Creek stations are used; more than half of all fecal coliform values were less than their single value criterion (60% and 53% at upper and lower stations, respectively), while a smaller proportion of *E. coli* values below the corresponding single value criterion were observed at these stations (40% and 19%).

Although the spatial distribution and correlation of *E. coli* abundance with rainfall indicates an important non-point source component, dry and wet weather results considered together suggest that bacterial contamination may be resulting from continuing sources, particularly in Tankersley Creek, which exhibits the largest bacterial abundances observed in this study at all conditions. Alternatively, mobile non-point sources (e.g., cows) may be delivering sufficient waste material to the streams to maintain at least sporadically high levels of *E. coli* without the benefit of surface runoff. Other possible sources include overflowing septic systems, the dumping of animal waste into catchment basins, sanitary and combined sewer overflows, wastewater, illicit connections to the storm drain system, and sewage sludge disposal.

5.0 RECOMMENDATIONS

Based on the results of this Special Study, it appears that the 303(d) listing of Tankersley Creek is appropriate. Additional monthly characterization of bacterial counts in the upper Tankersley Creek watershed over a 12-month period is recommended. Additional sampling at the twelve monitoring sites listed below will help define the importance of contributing non-point sources found in the tributary subwatersheds of Tankersley Creek upstream of FM 127 compared with downstream locations at and downstream of the Southwest Wastewater Treatment Plant. The specific siting of the sampling locations listed below would be dictated by accessibility and the availability of public right of way.

1) Tributary to Tankersley Lake that drains the Monticello B-2 Mine Area
2) Outlet from Tankersley Lake at IH-30
3) Unnamed tributary draining the Winfield area between Dragoo Creek and Tankersley Lake upstream of IH-30
4) Tankersley Creek at FM 899
5) Dragoo Creek at FM 899
6) Dragoo Creek's confluence with Tankersley Creek
7) Tankersley Creek at FM 127
8) Unnamed tributary that drains land area between FM 899 and SW24 and enters Tankersley Creek downstream of FM 127
9) Tankersley Creek at FM 3417
10, 11 and 12) Three additional tributaries of Tankersley Creek that are representative of different land types will be selected upstream of FM 127

6.0 REFERENCES

Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture. 1983. *Soil Survey of Camp, Franklin, Morris, and Titus Counties, Texas.*

Texas Natural Resource Conservation Commission (TNRCC). 1999. *Receiving water assessment procedures manual*. Water Quality Division, Surface Water Quality Monitoring Program, Texas Natural Resource Conservation Commission, Austin.

_____. 1999. *Surface water quality monitoring procedures manual*. Water Quality Division, Surface Water Quality Monitoring Program, Texas Natural Resource Conservation Commission, Austin.

_____. 2001. *Program Guidance and Reference Guide FY2002-2003*. The Texas Clean Rivers Program, Texas Natural Resource Conservation Commission, Austin.

APPENDIX A

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results By Date

TABLE A-1

Field and Laboratory Results by Sample Date

Station 10264: Tankersley Creek at FM 899

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
B1	10-2-02	10:58	19	--	--	--	--	--	--	25	110	Baseline samples
Q1	10-9-02	16:21	<1	0.675	0.00	19.9	1.32	449	7.06	1984	1700	Low flow severity; moderate channel flow status; samples taken during rain event
B2	11-12-02	09:58	7	--	--	--	--	--	--	174.8	140	Baseline; Fecal lab duplicate
Q2	1-7-03	10:20	8	0.825	3.30	7.6	13.2	248	7.1	420	340	High flow severity; flow may be regulated by Tankersley Lake north of IH-30
F1	2-6-03	14:16	24	0.80	none	--	--	--	--	1226	650	High flow severity; light rain
F2	2-7-03	13:21	1	0.72	none	--	--	--	--	302	250	Lab duplicates for both bacteria samples
F3	2-13-03	13:31	7	0.72	none	--	--	--	--	313	112	Light drizzle; lab duplicates taken for fecals
A1	4-19-03	20:37	13	0.78	none	--	--	--	--	>2419	1450	
A2	4-21-03	06:54	1.5	0.60	none	--	--	--	--	819	408	E. coli lab duplicates
Q3	4-23-03	14:15	4	0.610	0.52	16.8	5.7	573	7.0	219	77	Low flow severity w/ no flow
A3	4-25-03	13:56	1.5	0.62	none	--	--	--	--	2827	293	
Q4	7-21-03	08:56	>7	0.65	0.0064	26.3	3.8	456	6.7	37	43	Low flow severity; trickle flow w/ one measurement
J1	7-30-03	17:48	8	3.25	1 ft/sec	--	--	--	--	>2419	TNC	High flow severity; TNC assigned a count of 3000
J2	8-1-03	07:39	2	0.65	>.1 ft/sec	--	--	--	--	484	260	Level much lower
J3	8-6-03	13:26	7	0.68	>.1 ft/sec	--	--	--	--	496	156	

Data Collected By: HLP; RMB; WPM; RGD; DJT TNC = Too numerous to count *Days since last significant rainfall

TABLE A-1 (Cont'd)

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results by Sample Date

Station 10261: Tankersley Creek at FM 3417

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
B1	10-2-02	10:38	19	--	--	--	--	--	--	291	190	Baseline samples
Q1	10-9-02	10:51	1	2.626	5.28	20.5	5.74	1558	7.05	4838	2180	Normal flow severity; High channel flow status
CRP 1	10-10-02	09:00	<1	2.630	4.29	17.59	7.73	585	7.10	8164	--	Normal flow severity; High channel flow status
B2	11-12-02	08:43	7	--	--	--	--	--	--	525	340	Baseline samples
CRP 2	1-6-03	12:34	7	**	0.5 ft/sec	8.5	13.2	530	7.20	384	--	High flow severity; flow estimated; non-wadeable conditions
Q2	1-7-03	08:32	8	**	0.5 ft/sec	8.6	12.7	816	6.80	472	270	Normal flow severity; water level down 1 ft from previous day
F1	2-6-03	14:30	24	**	2.2 ft/sec	--	--	--	--	651	265	Normal flow severity; fecal lab duplicates
F2	2-7-03	13:21	1	**	none	--	--	--	--	870	690	Flow not estimated
F3	2-13-03	13:47	7	**	none	--	--	--	--	54	36	Flow not estimated
A1	4-19-03	19:42	13	**	.85 ft/sec	--	--	--	--	2419	TNC	
A2	4-21-03	06:34	1.5	**	.25 ft/sec	--	--	--	--	1954	1450	Fecal lab duplicate
CRP 3	4-22-03	12:09	3	**	5.13	19.6	7.30	1208	7.30	520	--	Normal flow severity; High channel flow status
Q3	4-23-03	16:25	4	**	6.85	19.1	7.91	1398	7.39	774	165	Normal flow severity; High channel flow status
A3	4-25-03	13:56	2	**	none	--	--	--	--	775	140	Flow not estimated; Fecal lab duplicate
Q4	7-21-03	10:23	>7	**	2.92	28.6	7.9	1686	6.90	1659	1400	Normal flow severity; High channel flow status
CRP 4	7-24-03	12:36	2	**	6.85	27.6	6.20	12.96	7.20	1159	--	Normal flow severity; High channel flow status

TABLE A-1 (Cont'd)

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results by Sample Date

Station 10261: Tankersley Creek at FM 3417 (Concluded)

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
J1	7-30-03	18:35	8	**	1 ft/sec	--	--	--	--	>2419	1300	Water at top of banks; fecal lab duplicates
J2	8-1-03	07:39	2	**	0.4 ft/sec	--	--	--	--	500	150	Level down 1 ft from storm event sample; fecal lab duplicates
J3	8-6-03	13:20	7	**	4.52	--	--	--	--	391	430	Normal flow severity; flow similar to that on 8-5-03; fecal lab duplicates

Data Collected By: HLP; RMB; WPM; RGD; DJT **Staff gage lost after heavy rain event during Christmas holidays
*Days since last significant rainfall

TABLE A-1 (Cont'd)

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results by Sample Date

Station 10266: Hart Creek at SE 12

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
B1	10-2-02	12:10	19	--	--	--	--	--	--	166	--	Baseline samples
Q1	10-9-02	11:51	1	0.475	5.20	19.1	6.7	367	7.11	>2419	--	Normal flow severity
B2	11-12-02	10:28	7	--	--	--	--	--	--	124	--	Baseline samples
Q2	1-7-03	11:39	8	**	8.54	7.5	13.4	380	7.1	134	--	Normal flow severity; moderate channel flow status
F1	2-6-03	14:49	24	**	--	--	--	--	--	922	--	Water rising and turbid
F2	2-7-03	13:00	1	**	--	--	--	--	--	323	--	
F3	2-13-03	13:14	7	**	--	--	--	--	--	186.5	--	Lab duplicates
A1	4-19-03	21:15	13	**	--	--	--	--	--	>4834	--	Flow meter 2.46 ft
A2	4-21-03	07:21	1.5	**	--	--	--	--	--	525	--	Level at 0.5 ft; battery dead
Q3	4-23-03	15:53	4	**	6.97	17.7	7.6	435	7.10	265	--	Normal flow severity; moderate channel flow status
A3	4-25-03	14:00	2	**	--	--	--	--	--	332	--	Flow meter 0.529 ft
Q4	7-21-03	10:55	>7	**	2.96	26.9	8.5	529	7.0	87	--	Normal flow severity; moderate channel flow status
J1	7-30-03	18:21	8	*	--	--	--	--	--	>4858	--	Raining; Flow meter 0.643 ft
J2	8-1-03	08:19	2	*	--	--	--	--	--	245	--	Flow meter 0.545 ft
J3	8-6-03	13:35	7	*	0.5 ft/sec	--	--	--	--	96	--	Flow estimated

Data Collected By: HLP; RMB; WPM; RGD; DJT **Staff gage lost after heavy rain event during Christmas holidays
*Days since last significant rainfall

TABLE A-1 (Cont'd)

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results by Sample Date

Station 10272: Hart Creek at SH 49

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
B1	10-2-02	11:13	19	--	--	--	--	--	--	125	--	Baseline samples
Q1	10-9-02	13:03	1	1.10	0.00	19.1	3.95	199	7.11	>2419	--	Water rising from overnight rains; used as a water source for highway activity?
B2	11-12-02	10:12	7	--	--	--	--	--	--	152	--	Baseline; E.C. lab duplicates
Q2	1-7-03	11:02	8	1.35	0.00	6.3	13.5	245	7.1	256	--	Somewhat higher than normal flow severity; High channel flow status
F1	2-6-03	14:04	24	?	0.00	--	--	--	--	523	--	Normal flow severity
F2	2-7-03	12:35	1	1.88	0.00	--	--	--	--	821	--	Cold
F3	2-13-03	13:45	7	1.70	0.00	--	--	--	--	82.0	--	Light drizzle
A1	4-19-03	20:47	13	2.82	--	--	--	--	--	>2419	--	
A2	4-21-03	07:05	1.5	1.50	--	--	--	--	--	405	--	
Q3	4-23-03	14:52	4	1.50	--	--	--	--	--	268	--	Higher level than January; high channel flow status
A3	4-25-03	13:45	2	1.70	--	--	--	--	--	821	--	
Q4	7-21-03	08:30	>7	0.80	0.00	27.0	2.3	298	6.30	6	--	Low flow severity; no flow observed
J1	7-30-03	18:00	8	1.65	.5 ft/sec	--	--	--	--	>2419	--	Raining; normal to high
J2	8-1-03	07:57	2	1.08	1 ft/sec	--	--	--	--	568	--	
J3	8-6-03	13:40	7	1.10	0.00	--	--	--	--	115	--	No flow observed; lab duplicates

Data Collected By: HLP; RMB; WPM; RGD; DJT *Days since last significant rainfall

TABLE A-1 (Cont'd)

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results by Sample Date

Station 10311: Big Cypress Creek downstream of Fort Sherman Dam (Lake Bob Sandlin)

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
B1	10-2-02	10:05	19	--	--	--	--	--	--	6	--	Baseline samples
Q1	10-9-02	09:05	<1	0.85	0.00	--	--	--	--	39	--	YSI sonde malfunction; rainfall heavy at time of visit; no flow observed; high channel flow status; located ~2000ft below dam; last release was on 5-18-02
B2	11-12-02	09:09	7	--	--	--	--	--	--	102	--	Baseline samples
Q2	1-7-02	09:32	8	1.85	0.00	9.3	13.7	164	7.2	70	--	No release from dam; shut down 12 hrs earlier running at 400 cfs; 1 ft higher than observed in October
F1	2-6-03	14:00	24	0.85	.24 ft/sec	--	--	--	--	10	--	
F2	2-7-03	13:30	1	0.85	.2 ft/sec	--	--	--	--	26	--	
F3	2-13-03	13:30	7	0.60	--	--	--	--	--	39	--	
A1	4-19-03	20:12	13	0.98	.98 ft/sec	--	--	--	--	770	--	
A2	4-21-03	07:30	1.5	0.80	0.00	--	--	--	--	106	--	No flow
Q3	4-23-03	13:28	4	1.85	0.00	19.4	8.5	242	6.9	21.	--	Level same as January; normal flow severity; last release on 3-28-03
A3	4-25-03	13:30	2	0.85	.33 ft/ sec	--	--	--	--	88	--	
Q4	7-21-03	09:58	>7	0.00	0.00	29.6	10.9	151	7.3	13	--	Last release on 5-17-03
J1	7-30-03	18:15	8	-0.25	0.00	--	--	--	--	411	--	
J2	8-1-03	??	2	-0.25	0.00	--	--	--	--	257	--	Lab duplicates
J3	8-6-03	13:20	7	-0.25	0.00	--	--	--	--	2	--	

Data Collected By: HLP; RMB; WPM; RGD; DJT *Days since last significant rainfall

TABLE A-1 (Concluded)

TANKERSLEY CREEK INDICATOR BACTERIA SPECIAL STUDY
Field and Laboratory Results by Sample Date

Station: Big Cypress Creek at SH 11

Event Type	Date	Time	Rainfall *	Stream Flow		Field Data				Bacteria		Observations and/or Comments
				Gage Ht. (ft)	Flow (cfs)	Temp. (°C)	DO (mg/l)	Cond. (umhos)	pH (SU)	E. C. (mpn/100ml)	F. C. (org/100ml)	
B1	10-2-02	12:30	19	--	--	--	--	--	--	225	--	Baseline samples
Q1	10-9-02	09:29	1	1.15	23.0	19.9	6.8	1282	7.25	1120	--	Normal flow severity; high channel flow status
B2	11-12-02	10:48	7	--	--	--	--	--	--	899	--	Baseline samples
Q2	1-7-03	08:02	8	4.325	117	7.6	12.3	385	6.40	210	--	High flow severity
F1	2-6-03	15:02	24	1.28	25	--	--	--	--	271	136	E. coli lab duplicates
F2	2-7-03	14:16	1	--	45	--	--	--	--	546	--	
F3	2-13-03	14:12	7	--	200	--	--	--	--	190	--	Water over staff gage
A1	4-19-03	21:53	13	--	22	--	--	--	--	1120	--	
A2	4-21-03	20:12	1.5	0.98	28	--	--	--	--	445	--	
Q3	4-23-03	17:11	4	1.1	20.0	18.1	8.1	654	7.30	173.0	--	Normal flow severity; high channel flow status
A3	4-25-03	07:59	2	0.80	34	--	--	--	--	255	--	Lab duplicates
Q4	7-21-03	11:45	>7	0.65	12	27.4	10.1	1238	7.10	87	--	Low flow severity
J1	7-30-03	19:00	8	--	7.70	--	--	--	--	517	--	Raining
J2	8-1-03	08:55	1.5	--	0	--	--	--	--	1074	--	Lab duplicates
J3	8-6-03	14:00	7	0.70	0	--	--	--	--	158	--	Flow estimated at .13 ft/sec

Data Collected By: HLP; RMB; WPM; RGD; DJT *Days since last significant rainfall