Technical Aquatic Life Use-Attainability Analysis Report:
Atascosa River (Segment 2107)

Atascosa River Station 20773

Prepared for:
Texas Commission on Environmental Quality
Austin Texas

Prepared by:
Texas Institute for Applied Environmental Research
Tarleton State University
Stephenville, Texas

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PR1201

June 2012

Acknowledgements

The Texas Institute for Applied Environmental Research at Tarleton State University developed this report and conducted the supporting field and laboratory investigations through an Inter-Governmental Cooperative Agreement with the Texas Commission on Environmental Quality. Funding for this project is through the Texas Commission on Environmental Quality and source of funds is wholly or in part from the United States Environmental Protection Agency.

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List of Abbreviations and Acronyms

ADCP	Acoustic Doppler Current Profiler
NH_3-N	Ammonia Nitrogen
ALU	Aquatic Life Use
ALUAA	Aquatic Life Use-Attainability Analysis
AU	Assessment Unit
B-IBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
Cl^{-1}	Chloride
Chl-a	Chlorophyll-α
CAP	Cumulative Antecedent Precipitation
cfs	Cubic Feet per Second
DSLP	Days Since Last Precipitation
°C	Degrees Centigrade
°F	Degrees Fahrenheit
DO	Dissolved Oxygen
DO%sat	Dissolved Oxygen Percent Saturation
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
Fixed SS	Fixed Suspended Solids
FFG	Functional Feeding Group
HQI	Habitat Quality Index
IBI	Index of Biotic Integrity
kg	Kilogram
km	Kilometer
m	Meters
µg/L	Micrograms/liter
µs/cm	Microsiemens/centimeter
mg/L	Milligrams/liter
mL	Milliliter
mm	Millimeter
MRLC	Multi-Resolution Land Characteristics Consortium
MS4	Municipal Separate Storm Sewer
MSL	Mean Sea Level
NH_3-N	Total Ammonia Nitrogen
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NO_3-N	Nitrate Nitrogen
NO_{2+3}-N	Nitrite-Nitrate Nitrogen
NM	Non-measurable
PO_4-P	Orthophosphate Phosphorus
Pheo-a	Pheophytin-α

RUAA	Recreational Use-Attainability Analysis
SS QAP	Special Studies Quality Assurance Plan
SC	Specific Conductivity
S.U.	Standard Units
SH	State Highway
SWMP	Stormwater Management Program
SPCW	Stream Physical Characteristics Worksheet
SO_4^{-2}	Sulfate
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TAC	Texas Administrative code
TCEQ	Texas Commission on Environmental Quality
TIAER	Texas Institute for Applied Environmental Research
TPWD	Texas Parks and Wildlife Department
TPDES	Texas Pollutant Discharge Elimination System
TWQB	Texas Water Quality Board
TV	Tolerance Value
Tot-Alk	Total Alkalinity
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TOC	Total Organic Carbon
TON	Total Organic Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USGS	United States Geological Survey
UAA	Use-Attainability Analysis
VSS	Volatile Suspended Solids
WWTF	Wastewater Treatment Facility
T	Water Temperature

Chapter 1
Introduction

Background

The Texas Commission on Environmental Quality (TCEQ) is responsible for administering provisions of the constitution and laws of the State of Texas to promote judicious use and the protection of the water quality in the state. A major aspect of this responsibility is the development of surface water quality standards and the continuous monitoring of the water quality to evaluate compliance with state water quality standards which are established within Texas Water Code §26.023 and Title 30 Texas Administrative Code §§307.1 – 307.10 (TAC, 2010).

An aquatic life use-attainability analysis (ALUAA) is needed to evaluate the appropriate aquatic life uses (ALUs) and dissolved oxygen (DO) criteria for the Atascosa River (Segment 2107). Low gradient streams subject to intermittency such as the Atascosa River exhibit more variability in DO dynamics than perennial streams because flow frequently becomes sluggish and broken into disconnected pools. Routine monitoring and special studies commissioned by the TCEQ on the Atascosa River reveal DO concentrations are not meeting state water quality standards. Furthermore, an impairment verification monitoring study by the Ecological Communications Corporation (EComm) done in 2002 – 2004 (EComm, 2005) concluded there were minor to moderate impairments in the fish and aquatic invertebrate populations of the Atascosa River.

The Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University, Stephenville, Texas was contracted by TCEQ to conduct various intensive surveys during 2010 and 2011 at eight stations on the Atascosa River; two stations in each of the four assessment units (AU) comprising Segment 2107. Intensive surveys included ten 24-hour surveys of DO and other physicochemical parameters, streamflow measurements, and routine chemical sampling and analysis performed at the eight fixed TCEQ monitoring stations. In addition, TIAER performed three biological surveys contemporaneously with three of the 24-hour surveys; one during the summer of 2010 the second in the spring of 2011, and the third during the summer of 2011. The objective of this monitoring study was to supply additional information to aid assigning appropriate aquatic life uses and DO criteria in the Atascosa River and to provide a better understanding of the overall oxygen dynamics in similar low gradient, occasionally intermittent streams.

Water Quality Standards

The Atascosa River has been assigned the following designated uses in the Texas Surface Water Quality Standards (TAC, 2010):

- Primary contact recreation
- High aquatic life
- General

Each of these uses is protected by one or more water quality criterion (Table 1-1). The two designated uses of greatest relevance in this report and to the ALUAA are the high aquatic life and general uses.

Table 1-1 Designated uses and criteria for the Atascosa River (Source: TAC, 2010)

Use	Water Quality Parameter	Water Quality Criterion
Primary contract recreation	Geometric mean *E. coli*§	126 colonies / 100 mL
High aquatic life	24-hr. average DO	5.0 mg/L
High aquatic life	24-hr. minimum DO	3.0 mg/L
General	pH range	6.5 – 9.0 S.U.
General	Temperature (maximum; °F)	90
General	Cl^{-1} *	600
General	SO_4^{-2} *	500
General	Total dissolved solids *	1,500

§ *E. coli* is the abbreviation for *Escherichia coli* in this report.

* For chloride (Cl^{-1}), sulfate (SO_4^{-2}) and total dissolved solids, criteria represented by annual average values.

Report Purpose and Organization

The primary purpose of this report is to provide the results of the intensive monitoring program conducted in 2010 and 2011 that resulted in the collection of data for the Atascosa River aquatic life use-attainability analysis project, a project hereafter referred to as ALUAA project. Additionally, the report will provide background information on such characteristics of the watershed as its hydrology, average climatic conditions, ecoregion setting, land use and land cover, and permitted or regulated entities, as well as an analysis of relevant historical water quality collected by Ecomm, TCEQ, its predecessor agencies and, under the Clean Rivers Program, the Nueces River Authority. Collectively the contents of this report, and especially the results of the intensive monitoring program, are intended to inform efforts by the TCEQ to conduct an ALUAA, which evaluates the appropriate aquatic life uses (ALUs) and DO criteria for the Atascosa River.

Chapter 2
Characteristics of Watershed

Description of Watershed and Segments

The main portion of the Atascosa River (Segment 2107) is formed by the union of the North and West Prongs of the river in extreme northwestern Atascosa County, southeast of Lytle, Texas. From its origin, the river continues approximately 103 miles into Live Oak County between Choke Canyon Reservoir and Three Rivers, where it joins the Frio River (Figure 2-1). The Atascosa River watershed includes the cities of Lytle, Poteet, Pleasanton, Jourdanton, and Christine and the communities of Campbellton and Whitsett. The watershed is characterized by level to rolling land dominated by open grasslands, as well as cacti, thorny shrubs, and trees such as mesquite, live oak, and post oak. The watershed is recreationally important for hunting, including large game (Jones et al., 2010). The Atascosa River is divided into four AUs by TCEQ, which are the smallest geographic areas of use support reported in the assessment process (Figure 2-2, TCEQ, 2010a).

The following draws from TCEQ descriptions of the Atascosa River including associated AUs as found in TCEQ (2010b):

Segment 2107: from the confluence with the Frio River in Live Oak County to the confluence of the West Prong Atascosa River and the North Prong Atascosa River in Atascosa County.

- AU 2107_01: From the downstream end of the segment at the confluence with the Frio River to the confluence with Borrego Creek.
- AU 2107_02: From the confluence with Borrego Creek to the confluence with Galvan Creek.
- AU 2107_03: From the confluence with Galvan Creek to the confluence with Palo Alto Creek. (It includes the City Park in Pleasanton, Texas.)
- AU 2107_04: From the confluence with Palo Alto Creek to the upper end of this segment at the confluence of the West Prong Atascosa River and North Prong Atascosa River.

Climate and Ecoregion Setting

The Atascosa River watershed is in a subtropical-subhumid region of Texas characterized by hot and humid summers and mild and dry winters. Based on National Oceanic and Atmospheric Administration (NOAA) records for the City of Pleasanton, located within the northwest portion of the watershed, the mean annual high and low temperatures are approximately 99° F (37° C) and 40° F (5° C), respectively. Summer high temperatures are consistently above 90° F (32° C). Annual average precipitation is 33 inches (844 mm) and 8 inches (203 mm) of that total falls in May and September when high-intensity rainfall events and flash floods are common. Monthly norms of temperature and precipitation are provided in Figure 2-2.

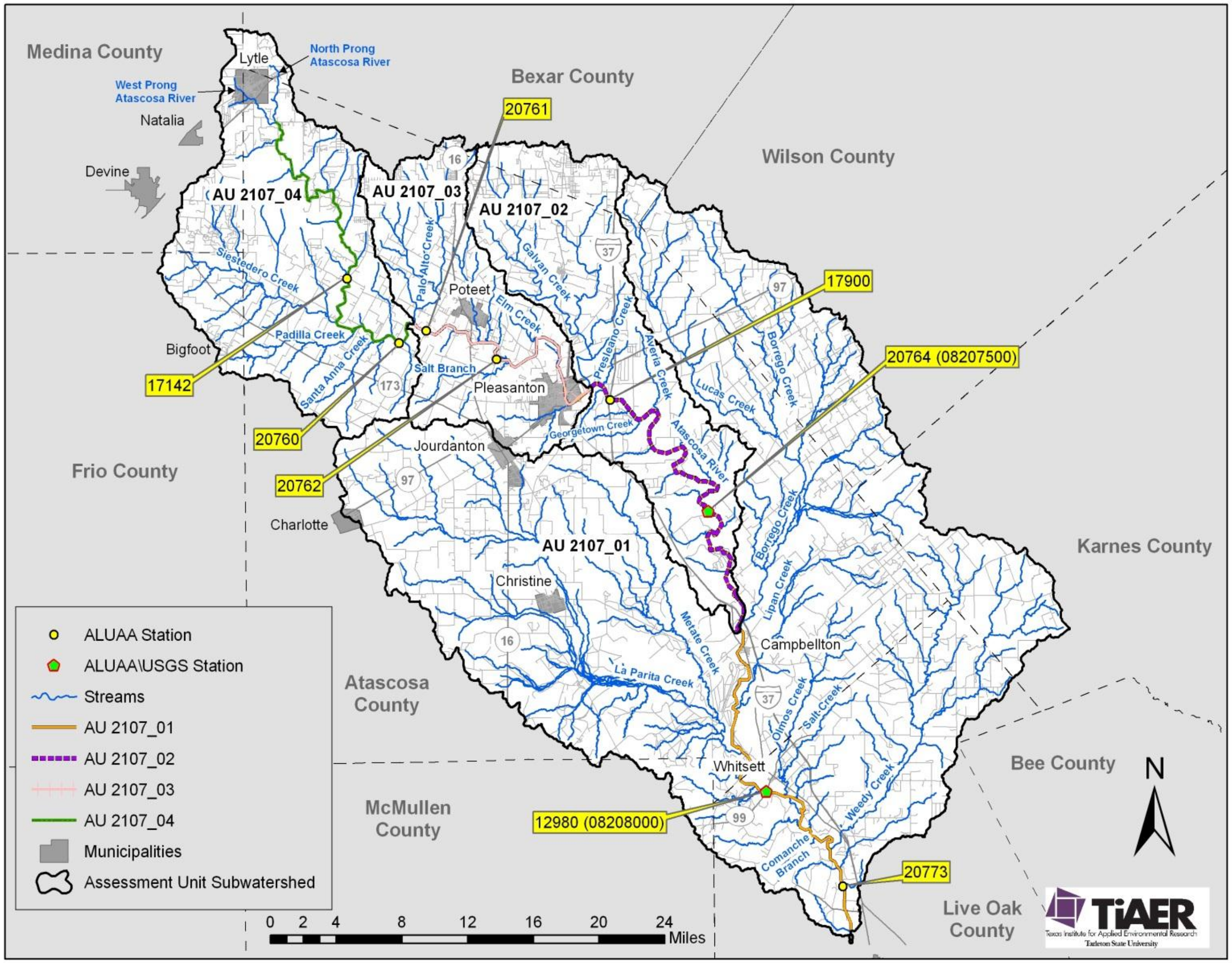

Figure 2-1 Atascosa River watershed depicting AUs and stations of the ALUAA project

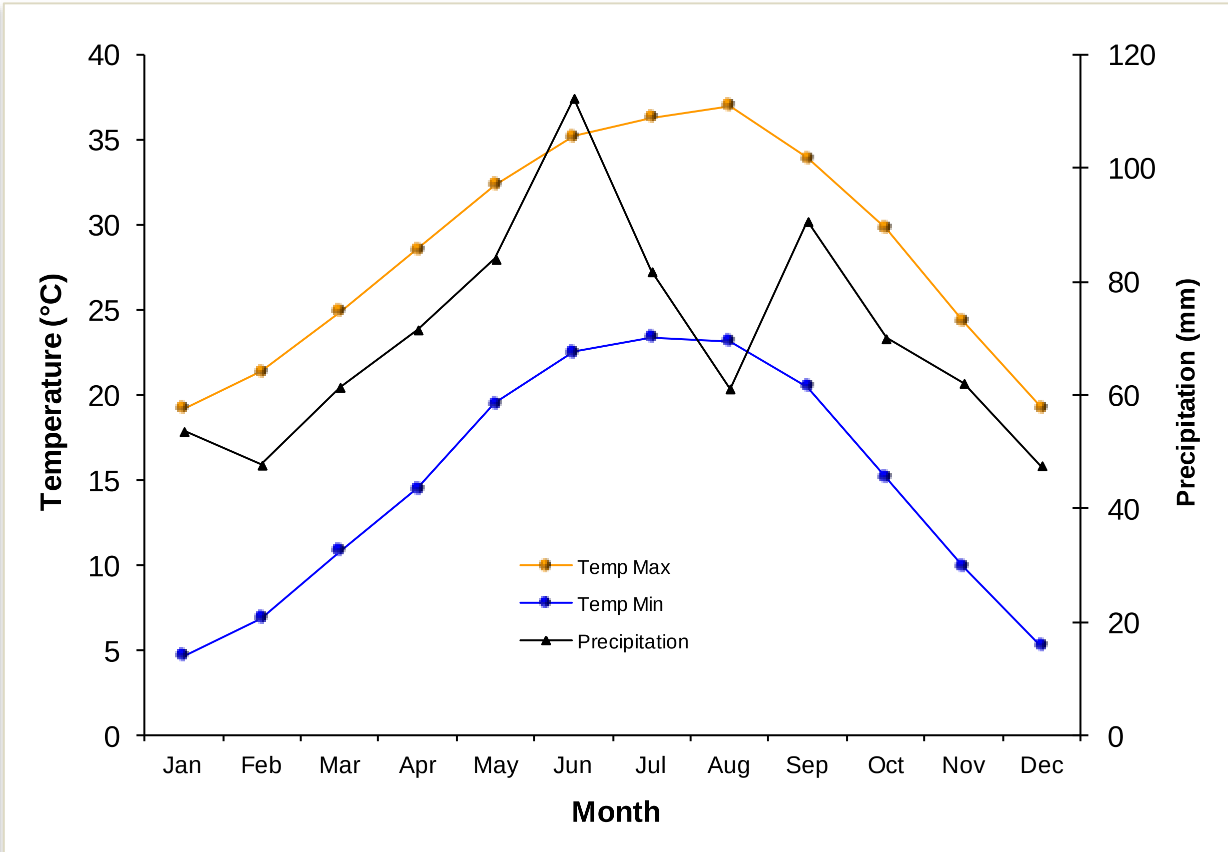

Figure 2-2 20-year temperature and precipitation norms (1991-2010) for City of Pleasanton, Atascosa County, Texas (NOAA, 2012)

The Atascosa River roughly marks the boundary between two Level III ecoregions: the Southern Texas Plains (31) to the southwest and the East Central Texas Plains (33) to the northeast (Figure 2-3). Distinguishing characteristics of the Southern Texas Plains and more specifically, the Level IV Texas-Tamaulipan Thornscrub (31c), include relatively flat to gently rolling topography with mostly thorny brush, such as mesquite, dominating the vegetation. Soils are generally alkaline and sandy or clay, clay-loam, and sandy clay-loam (Griffin et al., 2007). The northeastern half of the watershed lies in the Level IV ecoregion called the Southern Post Oak Savanna (33b), distinguished from surrounding ecoregions by the dominance of hardwoods, improved pasture and rangeland. Soils in the Southern Post Oak Savanna tend to be sandy and sandy-loam. Hunting of birds and larger game occurs in the watershed (Jones et al., 2010). Geologically, the Atascosa River is located in the Eagle Ford Shale formation and since 2009 dozens of oil and gas permits have been issued in the downstream half of the watershed (Railroad Commission, 2012).

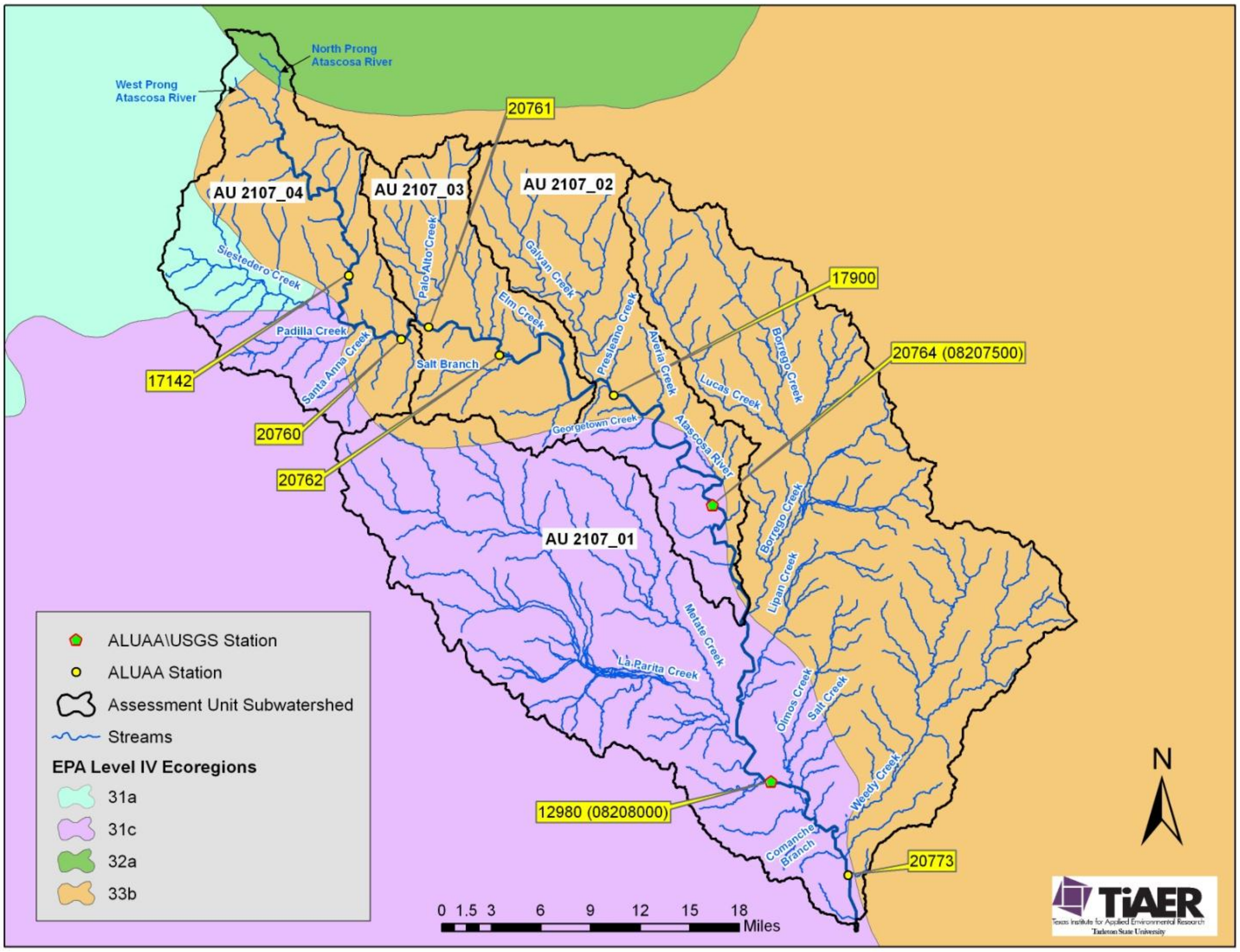

Figure 2-3 EPA Level IV Ecoregions and the Atascosa River Watershed (EPA, 2010)

Land Use/Land Cover and Population

Based on 2006 land use data, the 892,905 acre (1395.2 mi^2) Atascosa River watershed has a land use that is predominately rangeland (54.0%) and pasture/hay (24.3%) (Figure 2-4; Table 2-1). Barren land, wetlands, and open water combine for 2.3% of the land use in the watershed. Only in AU 2107_04 were cultivated crops a major component (20.2%). Since 2009 the Atascosa River watershed has seen a dramatic increase in the number of oil and gas operations, especially in areas downstream of Pleasanton, and this has no doubt increased the percentage of barren and developed land which was last evaluated in 2006.

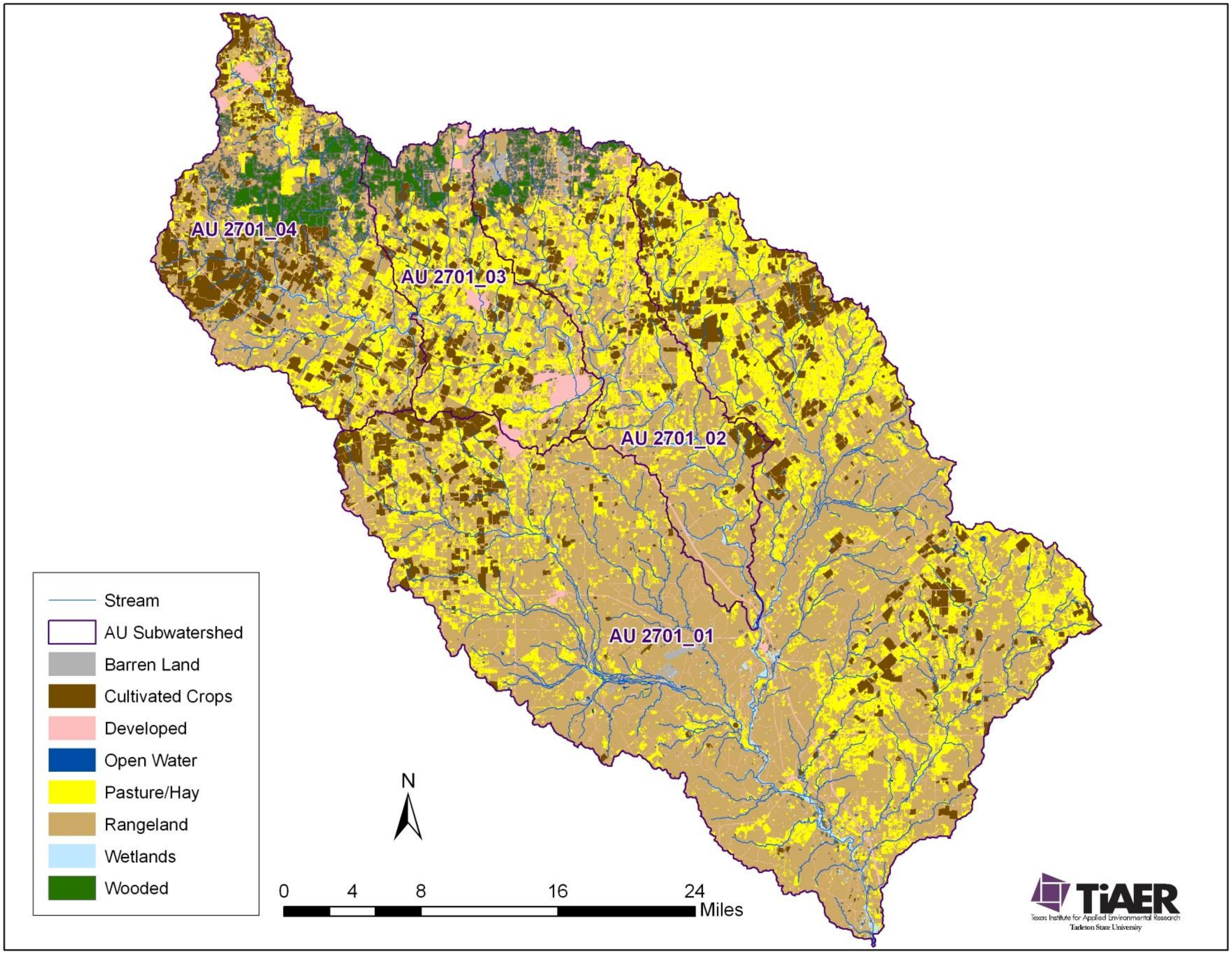

Figure 2-4 Land use and land cover for the Atascosa River watershed, Segment 2107 (Fry et al., 2011)

Table 2-1 Land use in the Atascosa River watershed, Segment 2107 (Source: Fry et al., 2011)

Land Use Category	2107_01		2107_02		2107_03		2107_04		Total Acres	% of Watershed
	Acres	% of AU	Acres	% of AU	Acres	% of AU	Acres	% of AU		
Rangeland	335,485	61.0	59,736	50.0	30,320	35.2	56,756	41.2	482,296	54.0
Pasture/Hay	131,392	23.9	31,254	26.2	28,113	32.7	26,586	19.3	217,344	24.3
Cultivated Crops	45,617	8.3	8,107	6.8	9,898	11.5	27,771	20.2	91,393	10.2
Developed	24,905	4.5	8,194	6.9	8,911	10.4	8,715	6.3	50,726	5.7
Wooded	1,437	0.3	7,488	6.3	6,691	7.8	15,540	11.3	31,157	3.5
Wetlands	8,652	1.6	2,591	2.2	1,463	1.7	2,038	1.5	14,744	1.7
Barren Land	1,227	0.2	1,925	1.6	541	0.6	126	0.1	3,819	0.4
Open Water	1,028	0.2	133	0.1	104	0.1	161	0.1	1,426	0.2
Total Acres	549,742		119,428		86043		137693		***892,905***	***100***
% of Watershed	61.6		13.4		9.6		15.4			

The land use/land cover provided in Figure 2-4 and Table 2-1 is a product of the cooperative mapping effort of the Multi-Resolution Land Characteristics Consortium (MRLC), and the presented geographic information layer (GIS) is commonly referred to as the National Land Cover Database 2006 (NLCD2006; Fry et al., 2011). Below are descriptions of the land use / land cover categories derived from NLCD2006:

- **Rangeland** – includes shrub/scrubland (areas dominated by shrubs less than 5 meters tall) and grassland (areas dominated by gramanoid or herbaceous vegetation not subject to intensive management but available for grazing).

- **Pasture/Hay** – areas of grasses and legumes planted for livestock grazing or the production of seed or hay crops.

- **Cultivated Crops** – areas used for the production of annual crops, such as corn, and perennial woody crops such as orchards and vineyards. This class also includes all land being actively tilled.

- **Developed** – areas of both low and high intensity development including impervious surfaces, residential and commercial buildings, parks, and golf courses.

- **Wooded** – areas dominated by deciduous and/or evergreen trees generally greater than 5 meters tall.

- **Wetlands** – areas where trees, shrubs, and/or perennial herbaceous vegetation dominates and the soil or substrate is periodically saturated with or covered with water.

- **Barren Land** – areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation; lichen cover may be extensive.

- **Barren Land** – areas of open water, generally with less than 25% cover of vegetation or soil.

The Atascosa River watershed is generally sparsely populated, especially the southern half of the watershed, with pockets of more dense population in the cities and townships. There are no readily available population estimates for the study watershed; however, a rough picture of the population can be drawn based on county and census tract estimates. The majority of the watershed and the watershed’s population are located in Atascosa County (Figure 2-1) which had a 2010 population of 44,911 (U.S. Census, 2011). The census tract for northern Live Oak County which encompasses the southern portion of the Atascosa River watershed and is largely rural had a 2010 population of 4,615. Pleasanton is the largest city in the watershed by population (8,934).

Regulated Sources

Pollution sources that are regulated have permits under the Texas Pollutant Discharge Elimination System (TPDES) and the National Pollution Discharge Elimination System (NPDES). Examples of regulated sources are wastewater treatment facility (WWTF) discharges and storm water discharges from industries, construction, and municipal separate storm sewer systems (MS4s) of cities. There are a number of TPDES/NPDES permitted WWTFs in the Atascosa River watershed (Figure 2-5; Table 2-2).

The TPDES/NPDES Municipal Separate Storm Sewer (MS4) Phase I and II rules require municipalities and certain other entities in urban areas to obtain permits for their stormwater systems. Both the Phase I and II permits include any conveyance, such as ditches, curbs, gutters, and storm sewers, that do not connect to a wastewater collection system or treatment facility. Phase I permits are individual permits for large and medium sized communities with populations exceeding 100,000, whereas Phase II permits are for smaller communities with populations less than 100,000 located within an Urbanized Area as defined by the 2000 Census.

There are no urbanized areas in the Atascosa River watershed according to the 2000 Census and thus no MS4 permits.

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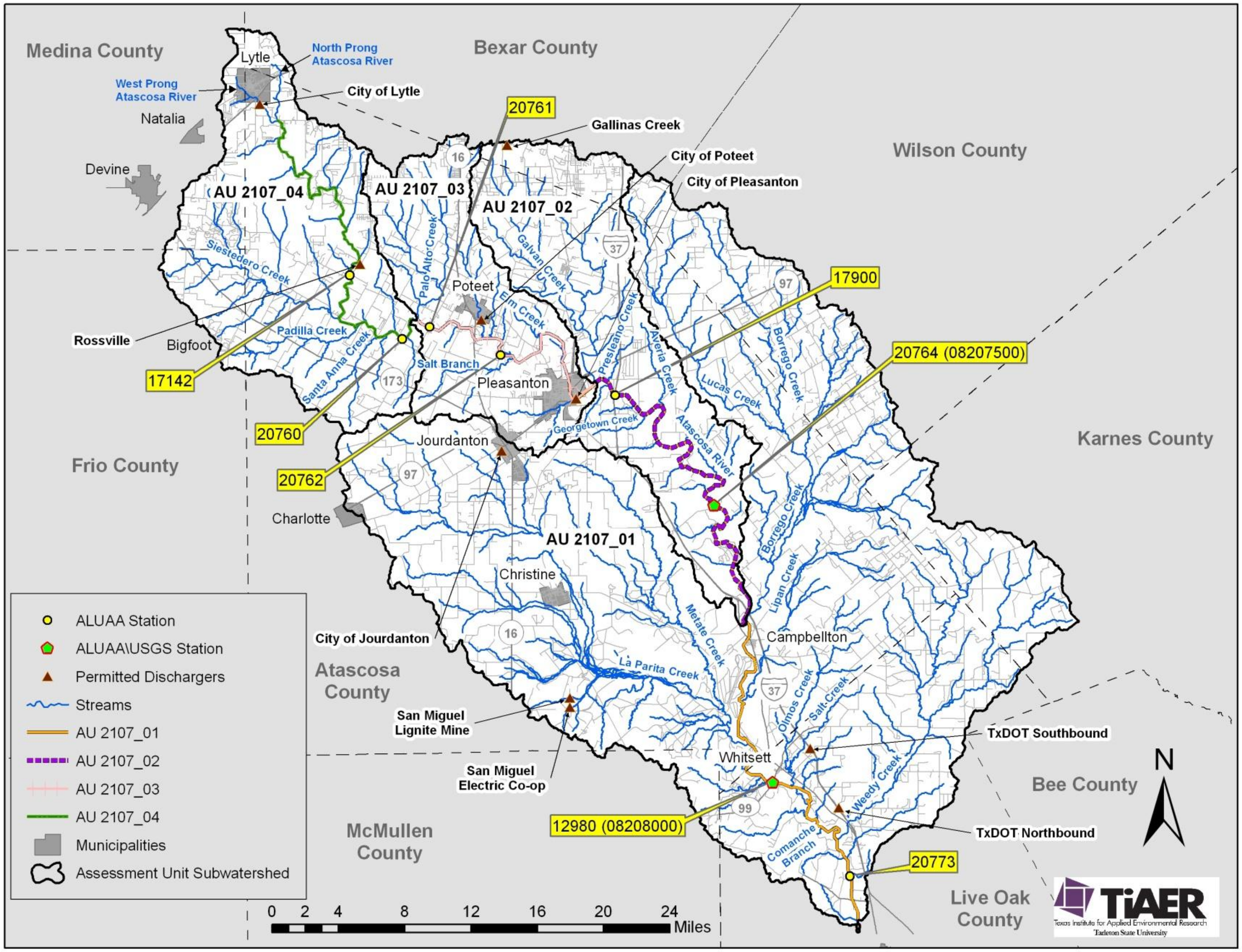

Figure 2-5 Regulated dischargers in the Atascosa River watershed and ALUAA project stations

Table 2-2 Permitted dischargers in the Atascosa River watershed

AU	NPDES Permit No.	TPDES Permit No.	Permittee	Facility	Final Permitted Discharge (MGD)
2107_01	TX0090611	WQ0002601-000	San Miguel Electric Cooperative Inc.	San Miguel Electric Cooperative	Report[a]
2107_01	TX0083445	WQ0002043-000	San Miguel Electric Cooperative Inc.	San Miguel Lignite Mine	Report[b]
2107_01	TX0082589	WQ0010418-001	City of Jourdanton	City of Jourdanton WWTF	0.330
2107_01	TX0129305	WQ0014767-001	Texas Dept. of Transportation	Live Oak Co. Safety Rest Area WWTF (North)	0.01
2107_01	TX0129321	WQ0014768-001	Texas Dept. of Transportation	Live Oak Co. Safety Rest Area WWTF (South)	0.01
2107_02	TX0127744	WQ0014600-001	Presto Utilities, Inc.	Gallinas Creek WWTF	0.375[c]
2107_03	TX0022594	WQ0010598-001	City of Pleasanton	City of Pleasanton WWTF	1.420
2107_03	TX0032387	WQ0013630-006	City of Poteet	City of Poteet WWTF	0.640
2107_04	TX0057509	WQ0010096-001	City of Lytle	City of Lytle WWTF	0.450
2107_04	TX0124036	WQ0014265-001	Benton City Water Supply Corporation	Rossville WTF	0.015

[a] For a 91-month reporting period encompassing 2001 – 2009, stormwater was discharged in 4 months at an average rate for those 4 months of 1.1 MGD. The overall average monthly discharge was 0.048 MGD for the 91-month period.

[b] For a 114-month reporting period encompassing discharge data from 1999 – 2009, stormwater discharges from the two major outfalls (001 & 101) occurred in 49 months, frequently with both outfalls discharging in the same month. During months of reported discharge, the average for each outfall was 4.2 MGD, and the overall average monthly outfall discharge was 1.3 MGD for the 114-month period.

[c] This permit is currently inactive and best available information is that the facility has not been built.

Watershed Hydrology

The Atascosa River has a complex hydrology that is influenced by groundwater levels that have lowered over recent decades, permitted discharges, and, of course, rainfall-runoff events. These factors result in a river hydrology that changes from upstream reaches to the confluence of the river with the Frio River. U.S. Geological Survey (USGS) gage streamflow records, field technician observations, and landowner testimonies can be leaned upon to create a fuller picture of the flow regime of the Atascosa River.

Extrapolation of data from USGS gage 08207500 located near McCoy at the middle of Segment 2107 (see Figure 2-2 for gage location, see Figures 2-6 & 2-7 for streamflow), along with landowner and TIAER staff observations and comments, indicate that upstream reaches above the Pleasanton WWTF outfall are largely ephemeral to intermittent. Perennial pools exist in portions of these upstream reaches, including a pool or impoundment above a small dam within the City of Pleasanton. Flows immediately below Pleasanton can reach very low levels but appear to be augmented substantially by the Pleasanton WWTF discharge that maintains nearly perennial conditions for some distance below Pleasanton (Figure 2-5). However, the gains in flow from the City of Pleasanton WWTF dissipate with downstream distance such that intermittent conditions prevail for some distance below USGS gage 08207500 until artesian wells and springs in the lower half of the watershed return instream flow to a predominately perennial state. Flow is perennial most years in the lower reaches of the Atascosa River based on historical streamflow records from the USGS station 08208000 located near the outlet of the watershed (see Figure 2-2 for gage location, see Figures 2-8 & 2-9 for streamflow). The exception was periods within 1995 - 1998 and briefly in 2009 when flows were below measurability (<0.01 cfs).

Two separate conversations with Mr. Larry Akers of the Evergreen Underground Water Conservation District, summarized in this paragraph, provided additional understanding of the hydrology of the Atascosa River and interactions with groundwater resources (Akers, 2008 & 2010). Until roughly the 1960s springs existed above the Pleasanton/Poteet area and water wells were artesian throughout much of the Atascosa River watershed. The springs were largely located on tributaries of the Atascosa River north of Pleasanton and Poteet, TX. Over-pumping due to farming resulted in lowering of groundwater levels in the area between the 1950s through the 1990s with the hard drought of the 1950s exacerbating the over pumping. All springs ceased to flow and wells were no longer artesian in the much of the watershed by the 1990s affecting base flow along much of the river. Below Pleasanton there are still a few artesian wells. Depending upon the manner of operation of these wells, they can provide some base flow at times to the lower reaches of the Atascosa River and its tributaries. According to Mr. Akers, in general, the Atascosa River is more stagnant than it was a few decades ago prior to the drop in groundwater levels.

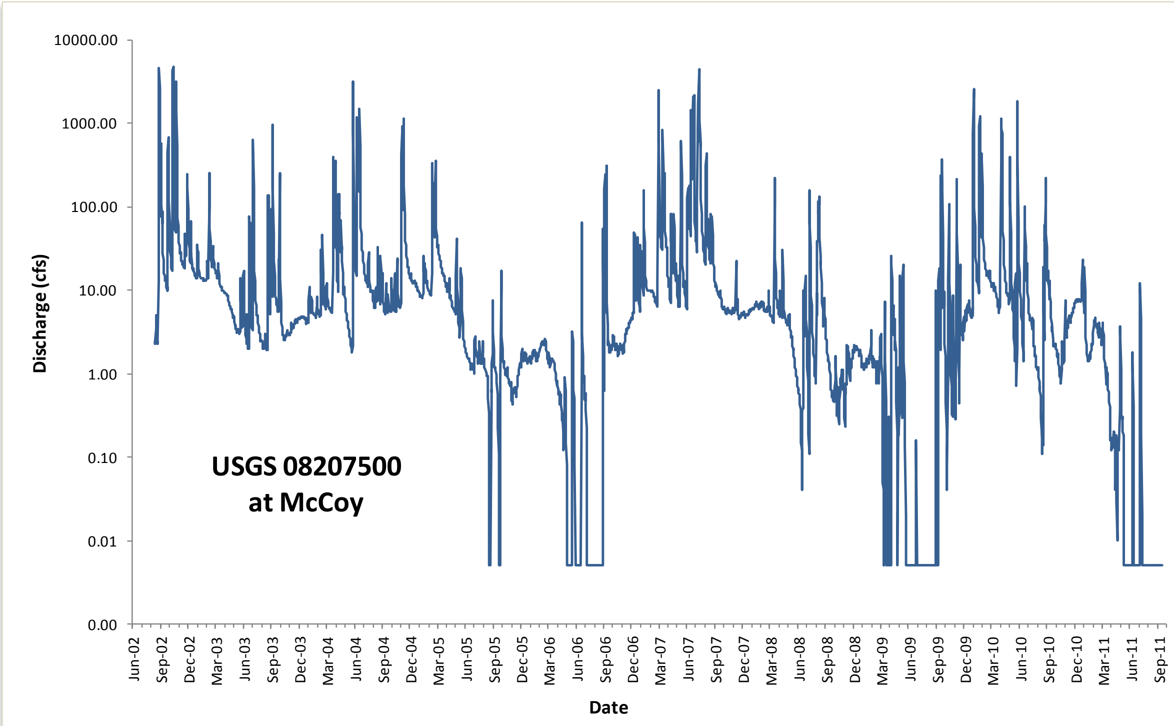

Figure 2-6 Streamflow record of USGS gage 08207500, McCoy, Texas, 26 August 2002 – 30 September 2011 (full period of record). Zero values were assigned 0.005 cfs, half the data reporting limit, to enable log-scale graphics.

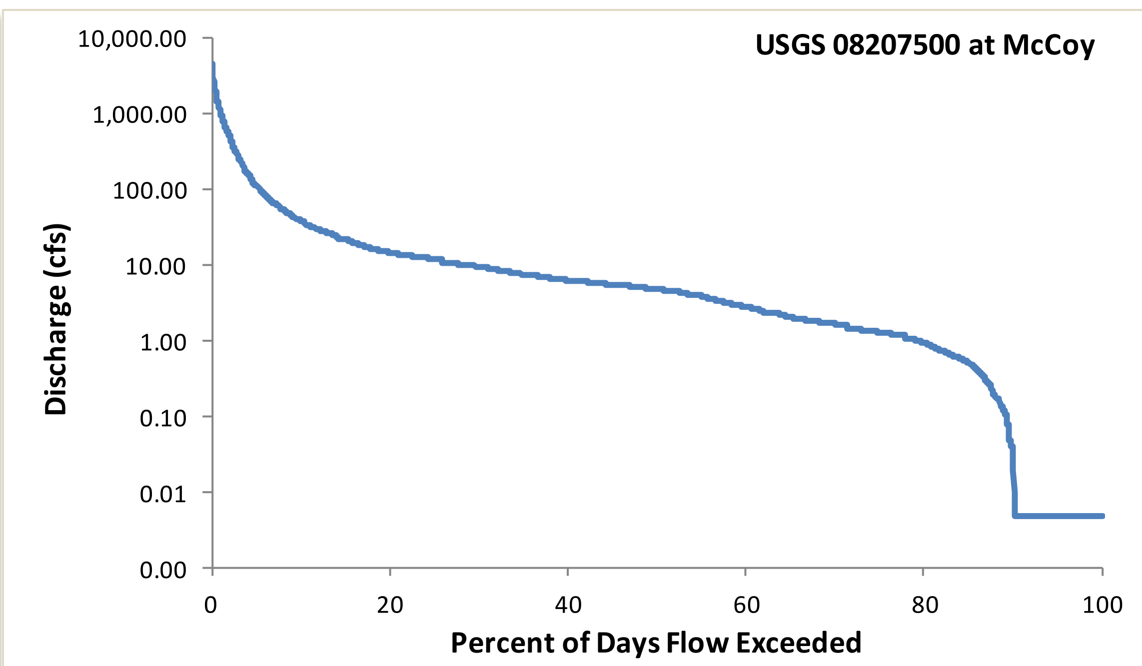

Figure 2-7 Flow duration curve for USGS 08207500, McCoy, Texas, 26 August 2002 – 30 September 2011 (full period of record). Zero values were assigned 0.005 cfs, half the data reporting limit, to enable log-scale graphics.

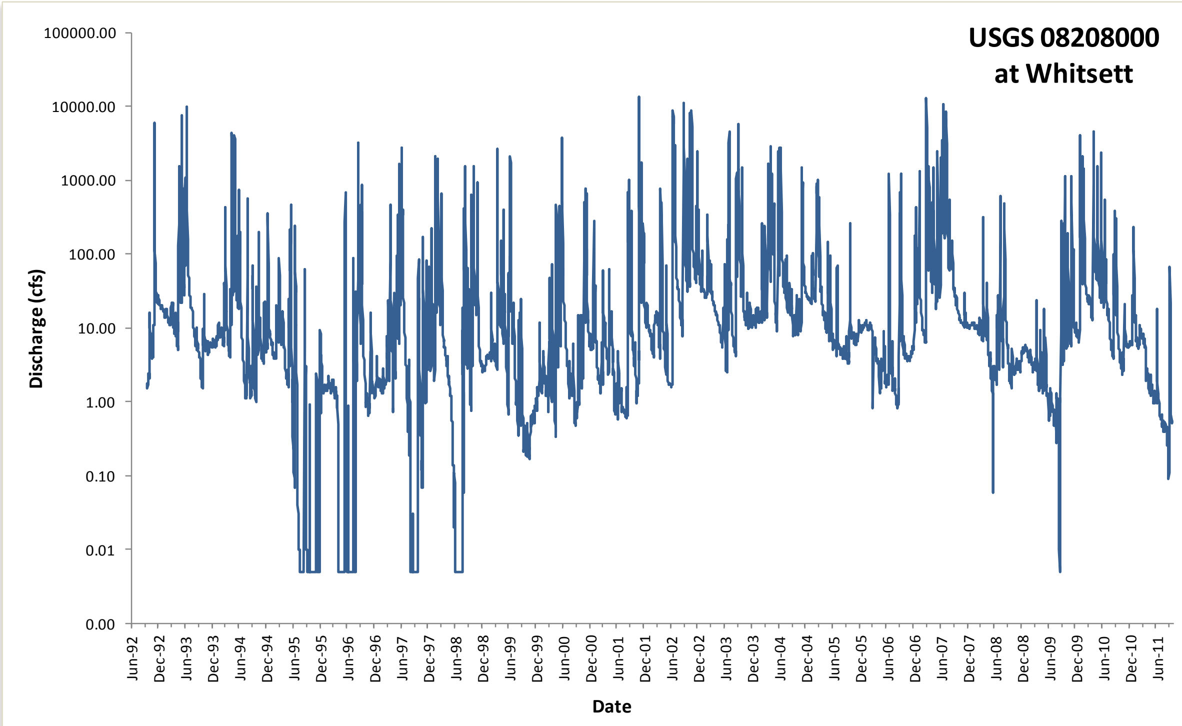

Figure 2-8 Streamflow (cfs) of USGS 08208000, Whitsett, Texas, 01 October 1992 – 30 September 2011. Zero values were assigned 0.005 cfs, half the data reporting limit, to enable log-scale graphics.

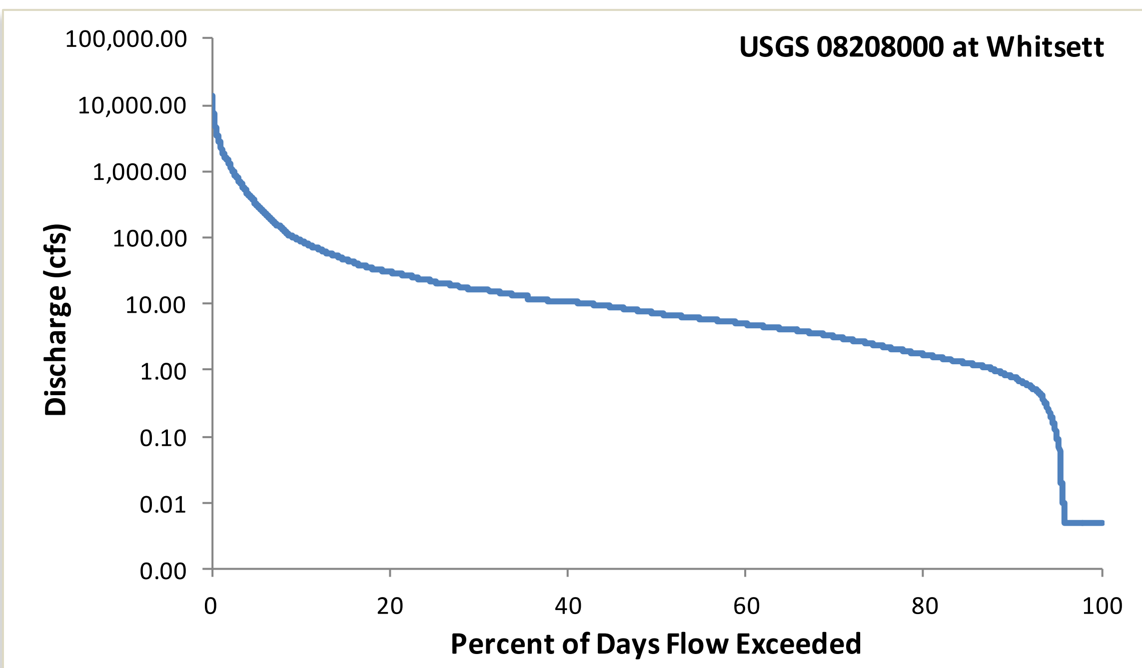

Figure 2-9 Flow duration curve for USGS 08207500, Whitsett, Texas, 01 October 1992 – 30 September 2011. Zero values were assigned 0.005 cfs, half the data reporting limit, to enable log-scale graphics.

Landowner testimonies regarding hydrology were gathered in 2010 for each AU during a Recreational Use-Attainability Analysis (RUAA) study of the Atascosa River (TIAER, 2010). Respondents in AU 2107_01 had familiarity with the river ranging 25 – 60 years and could claim observations of the river from monthly to simply "off and on." All reported seeing the streambed dry in the previous 5 years and during several other periods previous to the recent droughts of the last decade. Dry river bed covered 500 - 1500 feet and lasted 1 – 8 weeks during average rainfall years according to most of the respondents, who also reported persistent pools during dry spells. Only one person responded to the hydrology survey in AU 2107_02. The responder claimed weekly observations for 40 years and reported seeing the river dry the entire length of his ranch (miles) during June – August 2009. He had also seen the river dry for at least one week during most years of normal precipitation. Responders to the survey from AU 2107_03 indicated familiarity with the river ranging from 10 to 40 years. Observations of the river ranged from daily to monthly. All reported seeing the Atascosa River dry during the last five years and more. One reported the river on their property dried up every year for the past 20+ years. A second related that the river was typically dry during summers and if water was present it only occurred in small amounts. A third indicated the river on his land was dry in April 2007 and from June – October in 2009. In normal rainfall years, responders indicated the river was dry about 1 – 2 months of the year. Each response indicated persistent pools of varied sizes. Respondents to the survey from AU 2107_04 indicated familiarity with the Atascosa River for 45 to 50 years with observations ranging from daily to monthly. All interviews indicated a dry streambed during the last five years. In a downstream to upstream direction, the responses indicated the following recent periods of dry river bed: March through August 2009; summer of 2008 through September 2009; and 2003 to April 2007 and October 2007 to present. Again from downstream to upstream by response, the length of stream observed to be dry was reported as five miles; entire length of property (miles); and 30 miles. All reported seeing the river dry prior to the drought of 2009 with time frames ranging from 1 to 11 months. Two responders observed pools during dry periods of various sizes whereas a third landowner did not observe any pools when the stream was dry.

Extremely dry conditions from late 2010 through 2011 resulted in dry streambed in sections of the Atascosa River that only occasionally had gone dry historically, but most often have flow, such as the WWTF-augmented stretch below Poteet and below Pleasanton. During the July 2011 survey even the lower reaches of the river had only a light trickle of flow. A brief but heavy pulse of precipitation (5 - 7 in.) was dropped by Tropical Storm Hermine over the upper extremity of the watershed in early September 2010 that enabled sampling at the typically-dry stations in AU 2107_04 in mid-September though flow had returned to low or pooled by the time of the survey.

Chapter 3
Monitoring Plan and Procedures

Overview of Monitoring Activities

Monitoring activities in support of a UAA were performed to evaluate the appropriate ALU and DO criteria for the Atascosa River (Segment 2107). Data were collected at eight fixed sampling stations within the four AUs that define the Atascosa River. Data collection activities included 24-hour multiprobe instrument deployments, physicochemical instantaneous grabs, routine water chemistry analyses, flow measurements, flow severity, benthic macroinvertebrate sampling, nekton sampling, habitat assessment, and associated observations and photographs. All monitoring activities were conducted in accordance with SWQM Procedures Manual, Volumes 1 (TCEQ, 2008) and 2 (TCEQ, 2007).

The ALUAA monitoring occurred over a two-year period (calendar years 2010 and 2011) during the index period (which includes the critical period). The index period is defined as March 15 through October 15, with a critical period defined as July 1 through September 30. Protocol for distribution of sampling efforts during this time period is defined in the TCEQ SWQM Procedures Manual Volume 2 (TCEQ, 2007) with additional surveys as described herein and as determined in discussions with TCEQ Standards Group staff.

Prior to the assessment period, reconnaissance occurred to find suitable locations to perform ALUAA study surveys (see Chapter 2). TIAER staff visited publicly accessible locations as well as private properties controlled by cooperative landowners.

Activities performed during the ALUAA study included the following activities:

- Instantaneous flows at each selected station (once per station for each survey; 10 surveys)
- 24-hour dissolved oxygen collection using a multiprobe at each station (one deployment per station; 10 surveys)
- Multiprobe and water quality data in addition to 24-hour dissolved oxygen data (one deployment per station; 10 surveys)
- Stream habitat assessments, which include stream cross section measurements (once per station for each survey; 3 surveys)
- Benthic macroinvertebrate samples (once per station for each survey, 3 surveys)
- Fish samples (once per station for each survey; 3 surveys)
- Anecdotal record and photographs (once per station for each survey; 10 surveys)

Beginning in June 2010, all ten sampling surveys occurred during the index period (March 15 – October 15). In addition, six of the ten 24-hour surveys, occurred during the critical period (July 1 – September 30). Four sampling periods occurred during 2010 (June, July August and September) and the remaining six were collected during 2011 (March, April, May, July, August and September). A period of approximately one month (defined as 28 days) or more separated each 24-hour survey. Sampling was concluded in September 2011.

Data collection activities included 10 surveys at each station with 24-hour multiprobe deployments made near the water surface (0.3 m depth if depth exceeded 0.45 m (1.5 ft) or 1/3 of the total depth if equal to or less than 0.45 m (1.5 ft)), one routine water chemistry sample, a streamflow measurement, and anecdotal records and photographs.

Three of the ten surveys at each station included biological sampling. Each biological survey consisted of fish assemblage characterization, benthic macroinvertebrate community characterization, and stream physical habitat assessment, in addition to the data collection activities associated with the other surveys (i.e., 24-hour multiprobe deployments, instantaneous flow measurements, routine water chemistry samples, and anecdotal records and photographs). One biological survey was performed in each of the critical periods of 2010 and 2011, and a third biological survey was performed within the index period—though outside of the critical period—of 2011.

For convenience in this report, the seven surveys that did not include biological sampling will be referred to as 24-hour surveys and the other three surveys will be referred to as biological surveys.

Monitoring Locations and Station Descriptions

The monitoring strategy for Segment 2107 included four AUs in which ALUAA protocols were performed. Two stations within each AU were monitored ten times during the index periods of calendar years 2010 and 2011, if water was present. The location of each AU and selected points within each AU are provided in Figure 2-1. Brief station location descriptions are presented in Table 3-1 in order of downstream to upstream. This order will be the convention for the report to reflect AU enumeration.

Table 3-1 Brief station location descriptions for the Atascosa River ALUAA

AU	Station	Description
2107_01	20773	Atascosa River west of US Hwy 281 north of Three Rivers, TX
	12980	Atascosa River at FM 99 west of Whitsett, TX
2107_02	20764	Atascosa River at FM 541 east of McCoy, TX
	17900	Atascosa River at IH 37 east of Pleasanton, TX
2107_03	20762	Atascosa River at Granato Road southeast of Poteet, TX
	20761	Atascosa River at FM 2146 west of Poteet, TX
2107_04	20760	Atascosa River at Lozano Road west of Poteet, TX
	17142	Atascosa River at FM 2504 west of Poteet, TX

A brief description of each AU, the stations within each, and reasons for station selection are provided below. Station locations were selected to provide reasonable spatial representation within each AU; however, stations were only considered if cooperating landowner permission for access to the river was obtained. Each station was also included in the recreational use-attainability analyses (RUAA) surveys that were conducted during the spring and summer of

2010.

The descriptions of each AU used in the report are as found in the 2010 water quality assessment (TCEQ, 2010). In the following the AUs and stations are listed in a downstream to upstream order.

Assessment Unit 2107_01

AU 2107_01 is the lower portion of the Atascosa River described as beginning at the downstream end of the segment at the confluence with the Frio River and continuing upstream to the confluence with Borrego Creek (Figure 2-1).

TCEQ Station 20773

Station 20773 is located on private land west of US Hwy 281 north of Three Rivers, Texas in Live Oak County. This property was only accessible through private property via a locked gate and required landowner permission, which was obtained. This station was selected because a local landowner agreed to cooperate in the project and the site is located on the lower portion of AU 2107_01. Representative photographs collected at this station are provided in Figures 3-1 and 3-2. This station was characterized by a “waterfall” over a rock outcrop that fed a large pool that averaged > 9.0 m in width. Upstream of the falls, stream width averaged > 9.0 m, whereas downstream average widths were > 6.0 m. Above the falls, substrate was bedrock but transitioned to silt over sand further upstream. Below the falls, substrate was predominately sand. During the survey, average stream depth ranged from 0.4 m (July 2010) to 0.18 m (July 2011), excluding the pool which ranged from 1.3 to 1.1 m. The wide riparian (> 20 m) was dominated by trees with an understory of shrubs, grasses and forbs. Although cattle were observed on the cooperating landowner’s property, a perimeter fence prevented livestock from accessing the river. Banks were high (> 4 m) and relatively steep (averaging 45º).

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Figure 3-1 Station 20773 general appearance. Top Left – June 2011, upstream toward falls; Top Right – May 2011, upstream toward falls; Bottom Left - August 2010, downstream; Bottom Right – September 2011, downstream view.

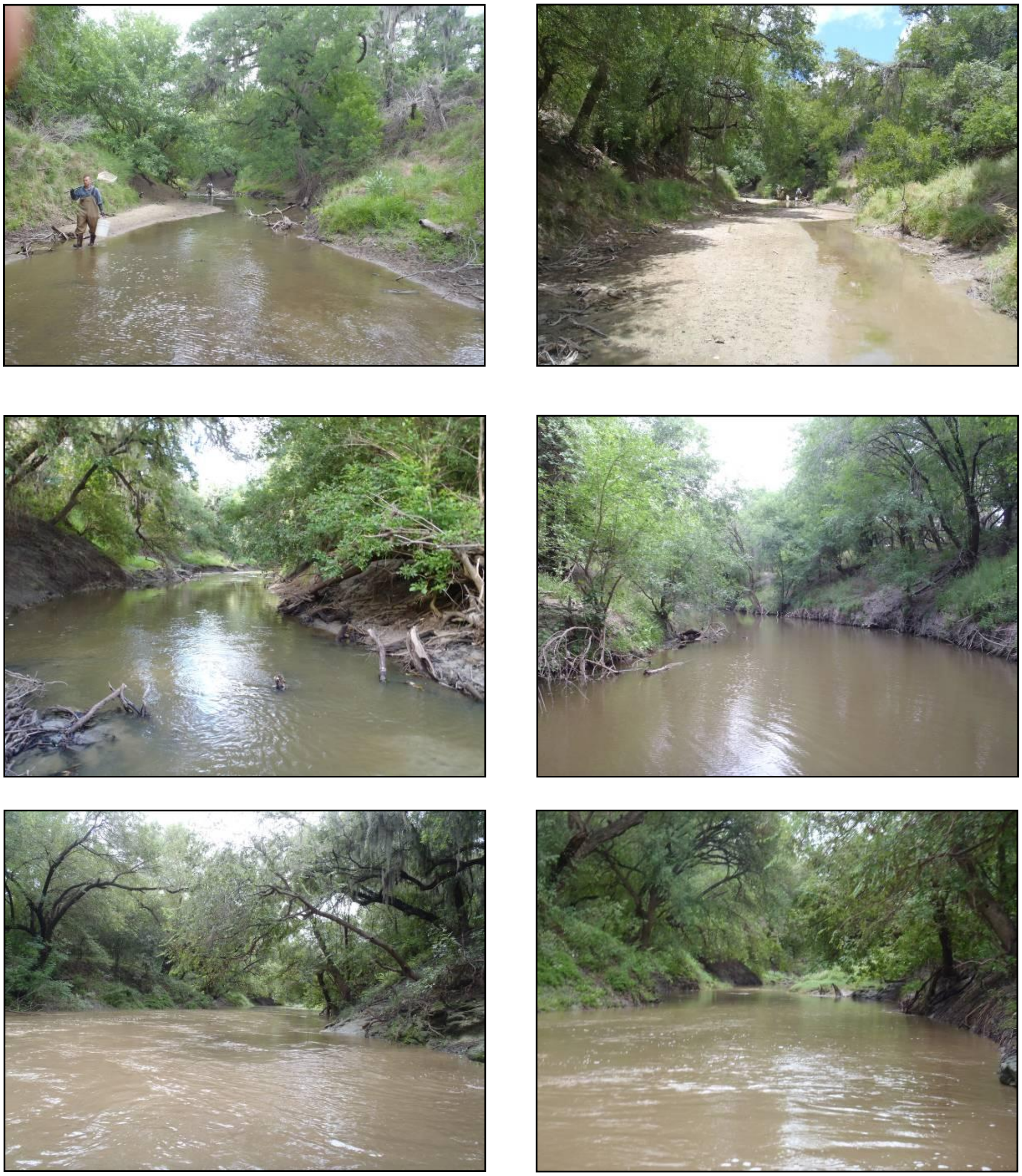

Figure 3-2 Station 20773 photos from habitat assessments. Top Left – April 2011, 0-m transect upstream view; Top Right - July 2011, 0-m transect upstream view; Middle Left – July 2010, 150-m downstream view; Middle Right - April 2011, 150-m upstream view; following Tropical Storm Hermine: Bottom Left – 21September2010, downstream view; Bottom Right – 22September 2010, downstream view.

TCEQ Station 12980

Station 12980 is located at the crossing of FM 99 and the Atascosa River west of Whitsett, Texas upstream of AR113. The stream is publically accessible at this location but requires entering private land on either side of the bridge to be able to perform the required survey. This station was selected because of the public accessibility from the road crossing and the local landowner agreed to cooperate in the project. Furthermore, this site is the most upstream location within AU 2107_01 for which access could be obtained for the study. Representative photographs collected at this station are provided in Figures 3-3 and 3-4. The deployment site at Station 12980 was generally upstream of the bridge. All biological surveys were conducted upstream of FM 99 due to a large log jam immediately downstream the bridge that prohibited passage downstream of the entry point. Average stream width ranged from 6.2 m (July 2010) to 3.3 m (July 2011). Substrate was predominately sand. During the survey, average stream depth ranged from 0.4 m (July 2010) to 0.1 m (April 2011) meters. The wide riparian (> 20 m) was dominated by trees with an understory of shrubs, grasses and forbs. As reported at Station 20773, banks were high (> 4 m) and relatively steep (averaging 42º).

Figure 3-3 Station 12980 general appearance. Top Left – July 2010, upstream view; Top Right – August 2011, upstream view; Bottom Left – March 2011, downstream view; Bottom Right – May 2011, downstream view.

Figure 3-4 Station 12980 photos from habitat assessments. Top Left – July 2010, 300-m transect downstream view; Top Right - April 2011, 200-m transect upstream view; Middle Left – April 2011, 50-m downstream view; Middle Right - July 2011, 37.5-m upstream view; following Tropical Storm Hermine: Bottom Left – 21September2010, upstream view; Bottom Right – 22September 2010, upstream view.

Assessment Unit 2107_02

AU 2107_02 is a reach of the Atascosa River described as beginning at the confluence with Borrego Creek and continuing upstream to the confluence with Galvan Creek (Figure 2-1).

TCEQ Station 20764

Station 20764 is located on the Atascosa River at the FM 541 bridge crossing east of McCoy, Texas. Although this site is accessible from the bridge, access to sufficient stream reach to allow ALUAA surveys requires landowner cooperation. This station was selected because of public access to the stream and the local landowner agreed to cooperate in the project. This station is located in the lower half of the AU 2107_02. Representative photographs collected at this station are provided in Figures 3-5 and 3-6. The deployment site at Station 20764 was generally upstream of the bridge in a shallow area above a fork in the stream. Average stream width ranged from 5.4-m (July 2010) to 5.1-m (July 2011). Substrate was predominately sand. During the survey, average stream depth ranged from 0.37 (July 2010) to 0.3 (April 2011) meters. The riparian averaged 18.5 m with trees and shrubs present about equally. Grasses and forbs were present but offered only 10% of the vegetation. Banks were moderately high (> 2.0 m) in the lower half of the reach and low (< 1.0 m) in the upper half. Bank slope averaged 41º.

Figure 3-5 Station 20764 general appearance. Top Left – August 2010, upstream view; Top Right – May 2011, upstream view; Bottom Left – June 2010, downstream view; Bottom Right – August 2011, downstream view.

Figure 3-6 Station 20764 photos from habitat assessments. Top Left – July 2010, 0-m transect upstream view; Top Right - April 2011, 80-m transect downstream view; Middle Left – July 2010, 200-m downstream view; Middle Right - April 2011, 120-m upstream view. Station 20764 following Tropical Storm Hermine. Bottom Left – 21September2010, upstream view; Bottom Right – 22September 2010, upstream view.

TCEQ Station 17900

Station 17900 is an existing TCEQ station located on the Atascosa at IH 37 southeast of Pleasanton. It is accessible from the access road on the north side of the stream through a wide floodplain that is heavily vegetated during the growing season. This site is representative of the upper portion of AU 2107_02 and is located approximately 3.3 miles below the outfall of the Pleasanton WWTF, which provides perennial flow in the Atascosa River at this location. Representative photographs collected at this station are provided in Figures 3-7 and 3-8. The deployment site at Station 17900 was generally upstream of the bridge in a shallow area (generally < 0.3 m) where the stream narrowed and passed beneath a large log that served as an appropriate anchor for the equipment. Average stream width ranged from 4.9 m (July 2010) to 4.5 m (July 2011). Substrate was predominately sand. During the survey, stream depth averaged 0.4 meters. The wide riparian (> 20 m) was dominated by trees with an understory of shrubs, grasses and forbs. Banks were generally high (> 3.0 m) and relatively steep (average 46º).

Figure 3-7 Station 17900 general appearance. Top Left – June 2010, upstream view; Top Right – May 2011, upstream view; Bottom Left – March 2010, upstream view; Bottom Right – September 2011, downstream view.

Figure 3-8 Station 17900 photos from habitat assessments. Top Left – July 2010, 0-m transect upstream view; Top Right - April 2011, 100-m transect downstream view; Middle Left – July 2010, 240-m upstream view; Middle Right - July 2011, 150-m upstream view; Bottom Left – April 2011, 200-m downstream view; Bottom Right – July 2011, 0-m downstream view.

Assessment Unit 2107_03

AU 2107_03 is a reach of the Atascosa River described as beginning at the confluence with Galvan Creek and continuing upstream to the confluence with Palo Alto Creek. It includes the City Park in Pleasanton, Texas (Figure 2-1).

TCEQ Station 20762

Station 20762 is located at Granato Road and the Atascosa River southeast of Poteet. Although the river at this site is initially accessible from a low-water crossing, access to sufficient stream reach to allow the biological surveys required landowner cooperation. This station was selected because the local landowner agreed to cooperate in the project and because the location is located in the middle portion of AU 2107_03. Representative photographs collected at this station are provided in Figures 3-9 and 3-10. The deployment site at Station 20762 was generally downstream of the bridge in a riffle immediately upstream of the landowner's boundary fence. In August 2011, the monitoring equipment was deployed in a pooled area upstream of Granato Road due to dry conditions in the downstream portion of the Atascosa River. Average stream width ranged from 4.4-m (July 2010) to 1.4-m (July 2011). Substrate was predominately sand, although areas of gravel were present. During the surveys, stream depth ranged from 0.2 m (July 2010) to 0.04 m (July 2011), but was dry in August 2011. The wide riparian (averaging < 20 m) was dominated by shrubs, grasses and forbs, with trees making up 17.5% of the bank vegetation. Banks were generally high on the right side (> 3.0 m) and lower on the left (< 2.0 m) and relatively steep (average 42º).

Figure 3-9 Station 20762 general appearance. Top Left – June 2010, upstream view; Top Right – September 2010, downstream view; Bottom Left – May 2011, downstream view; Bottom Right – September 2011, downstream view.

Figure 3-10 Station 20762 photos from habitat assessments. Top Left – July 2010, 0-m transect upstream view; Top Right - July 2010, 150-m downstream view; Middle Left –April 2011, 150-m transect downstream view; Middle Right - April 2011, 112-m upstream view; Bottom Left – July 2011, 0-m upstream view; Bottom Left – July 2011, 112-m upstream view.

TCEQ Station 20761

Station 20761 is located at FM 2146 and the Atascosa River west of Poteet. Although the river at this site is initially accessible from the bridge, access to sufficient stream reach to allow the biological surveys required landowner cooperation. This station was selected because the local landowner agreed to cooperate in the project and because it is located in the upper portion of AU 2107_03. Representative photographs collected at this station are provided in Figure 3-11. Station 20761 offered a pool sufficient to warrant sampling only in June and September 2011. The September survey followed the passage of Tropical Storm Hermine. Sufficient water was never observed during any visit in 2011. No biological and habitat data were collected at this station.

Figure 3-11 Station 20761 general appearance. Top Left – June 2010, upstream view; Top Right – July 2010, downstream view; Middle Left –September 2010, upstream view; Middle Right - March 2011, upstream view; Bottom Left – July 2011, upstream view; Bottom Right – September 2011, downstream view.

Assessment Unit 2107_04

AU 2107_04 is the reach of the Atascosa River described as beginning at the confluence with Palo Alto Creek and continuing to the upper end of this segment at the confluence of the West Prong Atascosa River and North Prong Atascosa River (Figure 2-1). Based on landowner comments and TIAER observations, this AU is anticipated to by dry and without pools much of the time.

TCEQ Station 20760

Station 20760 is located on the Atascosa River at Lozano Road. This station was selected because the local landowners agreed to cooperate in the project and because the station is located in the lower portion of AU 2107_04. Representative photographs collected at this station are provided in Figure 3-12. Station 20760 offered a pool sufficient to warrant sampling only in June and September 2010. The September survey followed the passage of Tropical Storm Hermine. No water was observed during any visit in 2011. No biological and habitat data were collected at this station.

Figure 3-12 Station 20760 general appearance. Top Left – June 2010, upstream view; Top Right – August 2010, upstream view; Middle Left –September 2010, upstream view; Middle Right - March 2011, upstream view; Bottom Left – July 2011, upstream view; Bottom Right – September 2011, downstream view.

TCEQ Station 17142

Station 17142 is located at the FM 2504 crossing of the Atascosa River. This station was selected because the upstream landowner agreed to cooperate in the project and because the station is located in the middle to upper portion of AU 2107_04. This station was selected because the local landowners agreed to cooperate in the project and because the station is located in the lower portion of AU 2107_04. Representative photographs collected at this station are provided in Figures 3-13. Station 17142 offered a pool sufficient to warrant sampling only in September 2010 following the passage of Tropical Storm Hermine. No water was observed during any visit in 2011. No biological and habitat data were collected at this station.

Figure 3-13 Station 20760 general appearance. Top Left – June 2010, upstream view; Top Right – July 2010, upstream view; Middle Left –September 2010, upstream view; Middle Right - September 2010, downstream view; Bottom Left – March 2011, upstream view; Bottom Right – September 2011, downstream view.

Description of Individual Monitoring Components

Data Collection and Procedures

The various data collection activities associated with the monitoring study can be conveniently separated into several components:

- 24-hour Deployed Multiprobe for Physiochemical Data Collection
- Instantaneous Streamflow Measurement
- Grab Water Samples Analyzed for Routine Chemistry Analytes
- Photographic Records
- Anecdotal Observations
- Biological Sample Collection (performed in July 2010, April 2011, and July 2011)

All components were performed during each of the 10 surveys, with the exception of biological sample collections. All components were performed at each of the eight monitoring stations when water was present at a station.

The performance of each survey was constrained by the following temporal requirements. Beginning in summer 2010, all sampling occurred during the index period (March 15 – October 15). In addition, at least one-half of the 24-hour surveys, but no more than two-thirds, were spaced over the critical period (July 1 – September 30). No more than two-thirds of the samples were taken in the same year. A period of approximately one month (28 days) or more separated each 24-hour survey.

These time constraints resulted in the survey dates presented in Table 3-2 with the first survey occurring shortly after approval of the quality assurance project plan (QAPP). The final break down of the timing of these 10 surveys was 6 surveys conducted during the Critical Period and 4 surveys conducted within the Index Period but outside of the Critical Period. Four sampling surveys occurred during year 2010 and six surveys during year 2011. A description of each data collection component and basic procedures follows.

24-hour (Diel) Physicochemical Measurements

Diel physicochemical parameters were measured using YSI 600 XLM multiprobes for DO, water temperature (T), specific conductivity (SC), and pH. The 24-hour multiprobe data were logged at 15-minute intervals and stored in the sonde. Following post-calibrations checks, these data were later downloaded to a laptop for transport to TIAER where they were transferred to the TIAER database for storage. Diel measurements followed procedures described in the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (2008 or most recent version) and relevant updates located on the TCEQ website.

At each station designated for diel data collection, a calibrated logging multiprobe was programmed to record the physiochemical parameters at intervals of 15 minutes. At each site a sonde was placed inside a 4-inch diameter PVC tube perforated to allow water to freely flow though the protective tube. A chain was run through the tube from end to end and through the bailer on the multiprobe. A lock was placed through a link at each end to prevent the end caps from being unscrewed while the multiprobe was housed in the tube. The multiprobe, in the housing, was placed at the appropriate sampling depth (0.3 m if depth exceeded 0.46 m, or 1/3 the total depth if < 0.46 m) and secured to an immovable object, such as a large tree or bridge structure. At the end of the sampling period, the multiprobe and housing were retrieved and a post-deployment check was performed in an aerated bucket of DO saturated water to determine if the multiprobe was still within calibration. If the post-deployment check indicated the multiprobe reading differed from the calculated standard by more than 0.5 mg/L, another calibrated and programmed multiprobe was deployed and the 24-hour data was collected again. If the multiprobe passed a post-calibration check for DO, post-calibration checks were performed on the remaining constituents of pH and SC.

Table 3-2 Summary of collection efforts in the Atascosa River (Segment 2107) 2010 – 2011. All sampling occurred in the index period; italics indicate critical period sampling. Dashes indicate no data. D = data collection components of 24-hour (diel) deployment, streamflow measurement, grab water sample, photographic record, and anecdotal record. B = biological sampling component.

		AU2107_01		AU2107_02		AU2107_03		AU2107_04	
		20773	**12980**	**20764**	**17900**	**20762**	**20761**	**20760**	**17142**
2010	**Jun 15-16**	D	D	D	D	D	D	D	--
	Jul 26-29	*D / B*	*D / B*	*D / B*	*D / B*	*D / B*	--	--	--
	Aug 25-26	*D*	*D*	*D*	*D*	*D*	--	--	--
	Sep 21-23	*D*	*D*	*D*	*D*	*D*	*D*	*D*	*D*
2011	**Mar 15-16**	D	D	D	D	D	--	--	--
	Apr 18-20	D / B	D / B	D / B	D / B	D / B	--	--	--
	May 18-19	D	D	D	D	D	--	--	--
	Jul 11-13	*D / B*	*D / B*	--	*D / B*	*D / B*	--	--	--
	Aug 10-11	*D*	*D*	--	*D*	*D*	--	--	--
	Sep 27-28	*D*	*D*	--	*D*	*D*	--	--	--

When TIAER field staff had sufficient multiprobe instruments and site conditions allowed, two multiprobes were deployed at each station in tandem at the identical depth and in immediate proximity to one another. One multiprobe was designated as the primary unit and the other as the secondary unit. If the primary unit passed the post-deployment check, its data were used and the data from the secondary unit discarded. If the primary unit did not pass the check and the secondary unit successfully passed the post-deployment check, then the data from the secondary unit were used in lieu of the data in the primary unit.

In addition to the 24-hour physiochemical data, an instantaneous sample of these data was collected with each water chemistry grab sample. Data were collected at an appropriate depth (see above) and stored in a YSI 650MDS handheld display until it could be transferred to a laptop for storage. At TIAER the data were subsequently transferred to the main database for storage.

Instantaneous Streamflow Measurements

Instantaneous water velocity measurements were made using the most applicable current meter. The collection of velocity measurements under wadeable stream conditions will be performed using a SonTek Flow Tracker™ Acoustic Doppler Velocimeter. Velocity measurements followed protocols outlined in the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (2008 or most recent version) and relevant updates located on the TCEQ website. TIAER personnel used a streamflow measurement form developed by TIAER.

Grab Water Samples Analyzed for Routine Chemistry Analytes

In addition to the 24-hour physiochemical data and streamflow measurements, a single near surface (0.3-m) water sample was collected for analysis of routine chemistry analytes at each station for each of the 10 surveys. Conventional water chemistry analyses included: total nitrite + nitrate-N (NO_{2+3}-N), total phosphorus-P (TP), total Kjeldahl nitrogen (TKN), total suspended solids (TSS), total dissolved solids (TDS), volatile suspended solids (VSS), total ammonia nitrogen (NH_3-N), dissolved orthophosphate-P (PO_4-P), chlorophyll-α (Chl-a), pheophytin-a (Pheo-a), chloride (Cl^{-1}), sulfate (SO_4^{-2}), total alkalinity (Tot-Alk), and total organic carbon (TOC).

At each station, water was collected in appropriate sample containers provided by the TIAER laboratory. Once collected, the water was transported back to the TIAER Laboratory in Stephenville. Water for the horizontal samplers was divided as follows:

- Water for Chl-a and Pheo-a analysis was placed in a 1000-ml dark pre-cleaned plastic bottle.
- Water for TSS, TDS, and VSS analysis was placed in a 1000-ml pre-cleaned plastic bottle.
- Water for NO_{2+3}-N, TP, TKN and NH_3-N was placed in a 250-ml pre-acidified, pre-cleaned plastic bottle.
- Water for TOC analysis was placed in a 250-ml pre-acidified, pre-cleaned plastic bottle.
- Water for Cl^{-1}, $SO4^{-2}$, and Tot-Alk was placed in discrete 250-ml non-acidified bottles.
- Dissolved PO_4-P was filtered in the field, less than 15-minutes after collection from the 1000-mL plastic bottle using a 60-ml pre-cleaned syringe and a 0.45 micron filter disk and stored in the syringe.

All samples were stored immediately in an ice water bath within an ice chest for transportation from the field. Before final transportation from the field to the TIAER lab in Stephenville, Texas, excess water was drained from the chests and all samples were re-iced to ensure the samples remained sufficiently chilled. Once ice chests arrived at the Tarleton campus, the samples were relinquished to the TIAER Laboratory following chain-of-custody procedures and within constraining holding times. Appropriate sample bottles were repackaged and iced for shipment to the Trinity River Authority Laboratory for analysis of TOC, Cl^{-1}, $SO4^{-2}$, and Tot-Alk. All other chemistry analytes were performed at the TIAER Laboratory.

Simultaneous to the grab of the water samples, an instantaneous discrete set of physiochemical parameters (T, DO, pH, and SC) was collected at an appropriate depth (see above).

Photographic Records

Photographs were taken at all stations during all 10 surveys. At a minimum, upstream, downstream, left bank, and right bank views were taken. Other photographs were taken of items of interest or to record anomalous situation.

Anecdotal Observations

Observations at each station were recorded on field data sheets during each visit. These observations included meteorological conditions, water color, unusual presence of aquatic vegetation, flow severity, and observed water activities by humans. Efforts were made to include photographic records of observations.

Biological Sample Collection

Three biological surveys were coordinated with the July 2010, April 2011 and July 2011 24-hour surveys where sufficient water was encountered. The biological sampling consisted of a habitat assessment and benthic macroinvertebrate sampling performed by TIAER staff at each station. Nekton sampling also occurred at each station using TCEQ staff and boat equipped with electroshocking equipment. Biological sampling for this ALUAA study was performed in strict adherence to the TCEQ SWQM Procedures Manual, Volume 2 (TCEQ, 2007 or most recent version).

Habitat Assessment

Habitat assessments were performed at each of the eight stations in the Atascosa River where sufficient water allowed. Length of reaches surveyed ranged from 150 - 375 m based on average stream widths at each location. (The reach length of a wadeable stream is based on 40 times the average stream width, but not less than 150 m). The length of each reach evaluated varied from station to station and within each station (Table 3-3). Habitat assessments were only performed at Stations 20773 (3), 12980 (3), 20764 (2), 17900 (3), and 20762 (3). Assessments were performed following the procedures specified in the TCEQ Surface Water Quality (SWQM) Procedures, Volume 2 (TCEQ, 2007).

Table 3-3 Length of reach evaluated and number of transects (XS) at each station

	20773		12980		20764		17900		20762	
	Reach Length (m)	# XS (m)	Reach Length (m)	# XS (m)	Reach Length (m)	# XS (m)	Reach Length (m)	# XS (m)	Reach Length (m)	# XS (m)
July 2010	375	6	300	6	200	5	240	5	150	5
April 2011	200	5	200	5	160	5	200	5	150	5
July 2011	200	5	150	5	-	-	200	5	150	5

At each station, the total length was divided by five or six to get the distance between each transect. Six transects were used at Stations 20773 and 12980 in July 2010 as reach lengths were 300 meters or greater. Once the distances between each transect was determined, each transect was marked with colored survey flagging or colored spray paint as the distances were measured. Stream width and depth were measured using 1) a surveyor's staff (depth and width) or 2) a surveyor's tagline (width) and a surveyor's staff (depth). Canopy cover at mid-stream up and down views and left and right bank positions were collected using a densiometer. An average canopy was calculated by averaging the four measurements. Bank slope was measured using a survey staff and clinometer and recorded in degrees slope. Additional habitat information was collected by observation and best professional judgment. These data were recorded on a Stream Physical Characteristics Worksheet (SPCW)-Part 1 for determining data required for the SPCW-Part 2. Data from the Worksheet-Part 2 were transferred to TIAER chain-of-custody sheets for entry into the TIAER managed database for storage and later data submittal.

Photographs were also taken at each cross section within a station reach in upstream, downstream, left bank, and right bank views.

The habitat data were used to rate the habitat of each stream station according to the Habitat Quality Index (HQI). HQI scores rank the habitat use from Limited (≤ 13) to Exceptional (26 - 31).

Benthic Macroinvertebrate Samples

Freshwater benthic macroinvertebrate samples for the ALUAA study were collected according to the TCEQ Rapid Bioassessment Protocols set forth in the TCEQ SWQM Procedures Manual, Volume 2 (TCEQ, 2007 or most recent version). Every effort was made to sample invertebrates in a riffle habitat using a standard D- net. If riffle habitats were not present alternative methods such as snag sample collections were employed.

Macroinvertebrate samples were processed in the field to ensure an adequate number of organisms had been collected. Samples from two stations in April 2011 were processed in the lab after a rough initial count in the field was made to ensure the minimum number of individuals was collected. Specimens were preserved and transported to the TIAER lab for identification. Once identified, the data collected were used to develop a benthic index of biological integrity (B-IBI).

Freshwater Fish Samples

Freshwater fish samples were collected according to TCEQ SWQM protocols using a backpack electroshocker and supplemental seine hauls. As stipulated, the electroshocker was used in the area of the sampling station for a minimum of 900 seconds (15 minutes). Shocking occurred until no new species were observed.

Seines were used to supplement the electroshocker samples. Seine samples were collected with a 4.9-m by 1.8-m net with 3.1-mm ace mesh. The distance covered using seines was at least 10 meters per haul, with at least six seine hauls taken at each station to total a minimum of 60 m sampled. Only successful hauls were counted. If the hauls encountered a major snag resulting in loss of fish, it was performed again.

When possible, all fish were identified in the field and released. Specimens that could not be identified were preserved in 10% formalin and returned to the lab. Once fixed, the specimens were transferred to a 70% ethanol solution for processing. All fish were identified to the species level using the taxonomic key of Hubbs et al. (1991) and Thomas et.al. (2007). Efforts were also made to produce a photographic voucher collection. Large, easily identified specimens were photographed but not archived. Field notes were kept describing collection methods, equipment used, duration of sampling effort, habitat description, external anomalies, and unusual station characteristics.

Fish data collected were used to develop an Index of Biotic Integrity (IBI) for each station. IBIs were developed using the ecoregion metrics found in Appendix B of the SWQM Procedures Manual (TCEQ, 2007 or most recent version). Because the Atascosa River appears to form the boundary between Ecoregions 31 and 33, IBI scores were calculated for both ecoregions.

Chapter 4
Results from Monitoring Surveys

Overview of Monitoring Surveys

During the Index Periods of 2010 and 2011, the seven 24-hour surveys and three biological surveys described in Chapter 3 were performed. An overview of each survey follows.

June 2010 Survey

On June 15 and 16, 2010, TIAER staff performed the first of seven 24-hour surveys in the Atascosa River. Multiprobe sondes were deployed at seven of eight stations identified for the survey. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data. Photographs were taken at each station where sondes were deployed. All measurements were made at Stations 20773, 12980, 20764, 17900, and 20762, including flows. All measurements were made at Stations 20761 and 20760 except flow; as flow was too low for measurement at Station 20761, and Station 20760 was pooled and not flowing. Additionally, photos were taken at Station 17142 where insufficient water existed to warrant sonde deployment or sample retrieval. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions during the sampling effort ranged from partly cloudy to mostly sunny with moderate to strong winds. Maximum daily temperatures were hot (mid 90s). No rainfall was observed during the survey, and data from the Pleasanton Municipal Airport indicated only a single rain event had occurred (0.5 inches) during the previous two weeks of March; however, a significant rainfall event had occurred six days prior to the survey in the lower two-thirds of Atascosa River watershed.

Water color at Stations 20760, 20761, and 29762 were generally clear (the locations above Pleasanton), but exhibited more turbidity starting at Station 17900 and increased downstream to Station 20773. Flow severity estimates at the upper stations ranged from dry (Station 17142) to normal (Station 20762). Flow severity estimates from Station 17900 to Station 20773 were all recorded as high.

July 2010 Survey

From July 26 through 30, 2010, TIAER staff performed the first of three biological surveys in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at five of eight stations identified for the ALUAA survey. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. All measurements were made at Stations 20762, 17900, 20764, 12980, and 20773, including flows. No measurements were made at Stations 17142, 20760, and 20761, because Stations 17142 and 20760 were dry and Station 20761 did not have sufficient water to perform all required sampling.

Photos were also taken at these three stations not monitored to show conditions at the time of the survey. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

In addition to the water quality monitoring effort, fish, macroinvertebrate, and habitat data were collected at Stations 20762, 17900, 20764, 12980, and 20733. At each station: 1) a nekton effort of at least 900 seconds of electrofishing and 60 m of seining was conducted; 2) at least a 5 – minute D-net sample was collected for macroinvertebrates, with a minimum of 140 organisms picked and preserved in the field; and (3) a habitat assessment was performed at a minimum of 5 transects. Data were returned to TIAER and appropriate analyses were performed.

Meteorological conditions during the survey ranged from partly cloudy to overcast with moderate winds. Maximum daily temperatures were moderately hot (upper 80s - lower 90s). Data from the Pleasanton Municipal Airport indicated no rain had fallen in the area since the June 15 – 16 survey, and the survey started dry. However, from July 27 – 29, scattered showers moved through the area, though none of sufficient magnitude to hinder the effort.

Water color at Station 20762 was generally clear due to the shallowness of the stream. Stations 17900, 20764, 12980 and 20773 were generally brown due to turbidity that increased from upstream to downstream. Visibility at the four lower stations was limited to just below the surface (< 0.3 m), which inhibited seeing fish during the electroshocking. Flow severity was recorded as normal based on past observations.

August 2010 Survey

On August 25 and 26, 2010, TIAER staff performed the second of seven 24-hour surveys. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at five of eight stations identified for the ALUAA survey. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. All measurements were made at Stations 20773, 12980, 20764, 17900, and 20762, including flows. Additionally, photos only were taken at Stations 20761, 20760 and 17142. Station 20761 exhibited only a small puddle inside the boundary fence on private land upstream of the road, and Stations 20760 and 17142 were dry. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions during the third survey were generally partly cloudy with mostly moderate winds observed. Maximum daily temperatures were hot (upper 90s). No rainfall was observed during the monitoring period and data from the Pleasanton Municipal Airport reported no rainfall in the area since the July 2010 survey.

Water transparency was generally clearer at all sites compared to the July survey. Little color was observed at Stations 20762 or 20764, while Station 17900 appeared more green than brown. Stations 12980 and 20773, though clearer than previously observed, still appeared brown in the deeper portions due to the effects of turbidity. Flow severity at Stations 20762 and 20773 were reported as low while the remaining stations (17900, 20764, and 12980) were reported as normal since conditions were similar to the July survey.

September 2010 Survey

On September 21 - 23, 2010, TIAER staff performed the third of seven 24-hour surveys in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at all eight stations identified for the ALUAA survey. Data collected included DO, pH, T, and SC; flow measurements, water chemistry samples, observational data and photographs were taken at each station where sondes were deployed. Measurements were made at Stations 17142, 20760, 20761, 20773, 12980, 20764, 17900, and 20762. Although water was present at Stations 17142, 20760 and 20761, the stream was not flowing at these locations. Therefore, no flow data were collected at these three stations. It was necessary to redeploy multiprobes and measure flows at Stations 12980 and 20773 as the elevated water levels receded rapidly over night, leaving the previously deployed equipment out of the water. Photos were taken at all stations. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions this survey was mostly cloudy with moderate to strong winds. Maximum daily temperatures were milder than July and August (mid 80s). No rainfall was observed during the monitoring period and data from the Pleasanton Municipal Airport indicated < 0.25 inches of rain occurring in the previous seven days, and only 1.05 inches on September 7. Although only 1.05 inches was registered in Pleasanton on September 7 – 8, 2010, Tropical Storm Hermine brushed the western portion of the watershed depositing > 6.0 inches of rainfall near Lytle, Texas, according to locals with whom TIAER field staff spoke. This tropical storm resulted in water being encountered at all eight stations. Additionally, a significant rainfall event occurred south and east of Pleasanton within two days of the survey that impacted Stations 12980 and 20773.

Water appearance at Stations 17142 and 20762 was generally clear, with a tannic brown tint. Water at Station 20761 was brown and turbid. Station 20762 was more typical that the previous being generally clear and green. Stations 17900 and 20764 were slightly elevated and brown due to turbidity. Stations 12980 and 20773 were greatly elevated, very turbid and brown. Although the upper three stations exhibited non-flowing conditions, flow severity at the remaining five lower stations were reported as high, increasing in severity from upstream to downstream.

March 2011 Survey

On March 15 - 16, 2011 TIAER staff performed the fourth of seven 24-hour surveys in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at five stations. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. Data collections occurred at Stations 20773, 12980, 20764, 17900, and 20762. Stations 17142, 20760 and 20761, were dry (though a small puddle was observed upstream of 20761). Therefore, no data were collected at these three stations and only photos were taken at these stations. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions during the survey were partly cloudy to cloudy with moderate to strong winds. Maximum daily temperatures were mild, ranging from 75 – 85 °F. No precipitation was observed nor was any recorded for the previous two weeks at the Pleasanton Municipal Airport.

Water color at Station 20762 and 17900 were clear with duckweed present and scum on the surface upstream of 17900. Station 20764 was clear exhibiting amber, tannic color. Stations 12980 and 20773 were slightly turbid and brown. Water visibility at all stations was limited to 0.3 m or less. Flow severity appeared normal at all stations except Station 20773, which was reported as low.

April 2011 Survey

From April 18 through April 21, 2011 TIAER staff performed the second of three biological surveys in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at five of eight stations identified for the ALUAA survey. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. All measurements were made at Stations 20762, 17900, 20764, 12980, and 20773, including flows. No measurements were made at Stations 17142, 20760, and 20761, because Stations 17142 and 20760 were dry and Station 20761 exhibited only a small puddle. Photos were also taken at the stations not monitored to show conditions at the time of the survey. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

In addition to the water quality monitoring effort, fish, macroinvertebrates, and habitat data were collected at Stations 20762, 17900, 20764, 12980, and 20773. At each station: 1) a nekton effort of at least 900 seconds of electrofishing and 60 m of seining was conducted; 2) at least a 5 – minute D-net sample was collected for macroinvertebrates, with a minimum of 140 organisms picked and preserved in the field; and (3) a habitat assessment was performed at a minimum of 5 transects. Data were returned to TIAER and appropriate analyses were performed.

Meteorological conditions during the April 2010 survey ranged from partly cloudy to mostly cloudy with winds ranging from moderate to strong. Maximum daily temperatures were hot (low to mid 90s). No rainfall was observed during the survey, data from the Pleasanton

Municipal Airport indicated no significant rainfall had been was recorded since the March survey prior to this effort.

Water appearance at Station 20762 was clear. Stations 17900, 20764 and 20773 exhibited water that was clear in the shallower portions but was a gray-green to brown in the deeper areas. Station 12980 appeared more turbid than the other four and was tan-brown in color. Water visibility was limited at Station 20773, which caused difficulty in seeing shocked fish. Flow severity appeared low for each station in the system.

May 2011 Survey

On May 18 - 19, 2011 TIAER staff performed the fifth of seven ALUAA surveys in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at five of eight stations. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. All required measurements were made at Stations 20762, 17900, 20764, 12980, and 20773, including flows. No measurements were made at Stations 17142, 20760, and 20761, because Stations 17142 and 20760 were dry and Station 20761 exhibited only a small puddle. Photos were also taken at the stations not monitored to show conditions at the time of the survey. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions during the May 2010 survey were partly cloudy with winds ranging from moderate to strong on 18 and 19 May (15 – 30 mph). Temperatures were hot (mid to upper 90s). No rainfall was encountered while in the field, and data from the Pleasanton Municipal Airport indicated no significant rainfall recorded since the April 2011 survey.

Water appearance in May ranged from clear at Station 20762 to clear but amber at Station 17900. Station 20764 was described as slate gray and turbid, while Stations 12980 and 20773 were both brown and very turbid. Water visibility was affected at both Stations 12980 and 20773 with visibilities < 0.1 m. Flow severity was described as low throughout the system.

July 2011 Survey

On July 11-13, 2011 TIAER staff performed the third of three biological surveys in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at four of eight stations identified for the ALUAA survey. Data collected included DO, pH, T, and SC; flow measurements, water chemistry samples, observational data and photographs were taken at each station where sondes were deployed. All measurements were made at Stations 20762, 17900, 12980, and 20773, including flows. No measurements were made at Stations 17142, 20760, 20761, which were dry, and Station 20764 which exhibited only a small puddle. Photos were also taken at the stations not monitored to document conditions at the time of the survey. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the

TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

In addition to the water quality monitoring effort, fish, macroinvertebrate, and habitat data were collected at Stations 20762, 17900, 12980, and 20773. At each of these four stations: 1) a nekton effort of at least 900 seconds of electrofishing and 60 m of seining was conducted; 2) at least a 5 – minute D-net sample was collected for macroinvertebrates, with a minimum of 140 organisms picked and preserved in the field; and (3) a habitat assessment was performed at a minimum of 5 transects. Data were returned to TIAER and appropriate analyses were performed.

During the July 2011 survey meteorological conditions were generally mostly sunny with winds ranging from light to moderate. Maximum daily temperatures were hot (> 100 °F). No rainfall was encountered during the survey and data from the Pleasanton Municipal Airport indicated only a single event (1.4-in.) since the May visit.

In July 2011 water appearance at 20762 was clear but water levels were very low and duck weed (*Lemna* sp.) was present on the surface. At Station 17900, water colors ranged from clear in the shallow areas to slate green in deeper segments. Stations 12980 and 20773 both exhibited a brown color and very turbid conditions, which inhibited seeing fish during electrochocking. Flow severity was low throughout and in fact the area in which the sonde was deployed at Station 20762 dried up leaving the sonde exposed and requiring redeployment in a deeper area. Conditions at Station 17900 did appear to be closer to normal, presumably due to the influence the City of Pleasanton WWTF.

August 2011 Survey

The sixth of seven 24-hour surveys in the Atascosa River occurred August 10 - 11, 2011. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at four of eight stations. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. Sonde measurements and water quality samples were collected at Stations 20762, 17900, 12980, and 20773. Flow measurements were only made at 17900 and 12980 as Stations 20762 and 20773 were only pooled. Downstream of Granato Road at Station 20762, conditions were dry necessitating the sonde deployment and water chemistry samples being collected from the pool upstream of the road. No measurements were made at Stations 17142, 20760, 20761, and, 20764, because Stations 17142, 20760, and 20761 were dry and conditions at Stations 20764 exhibited only a small puddle. Photos were also taken at the stations not monitored to show conditions at the time of the survey. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions during the August survey were mostly sunny with moderate to strong winds, gusting into the 25 mph range. Maximum daily temperatures were hot (> 100 °F). No rainfall was encountered during the monitoring period and rainfall data from the Pleasanton Municipal Airport indicated no rainfall had fallen since the July 2011 visit.

Station 20762 exhibited clear water in the pooled area, but a brown tinge was observed. Floating algae were also present on the surface. Water appearance at Station 17900 was clear though slight turbidity was noted. Stations 12980 and 20773 were both very turbid, limiting visibility, and brown in color. Flow severity was low at Stations 17900 and 12980, while no flow was observed at Stations 20762 and 20773.

September 2011 Survey

On September 27 - 28, 2011 TIAER staff performed the seventh and final 24-hour survey in the Atascosa River. Multiprobe sondes for 24-hour DO and other physicochemical parameters were deployed at four of eight stations. Data collection included DO, pH, T, SC, flow measurements, conventional water chemistry samples, and observational data with photographs taken at each station where sondes were deployed. Sonde measurements and water quality samples were collected at Stations 20762, 17900, 12980, and 20773. Flow measurements were made at all four stations. No measurements were made at Stations 17142, 20760, 20761, and 20764; all were dry. Photos were also taken at the stations not monitored to show conditions at the time of the survey. Water quality samples were relinquished to the TIAER laboratory for analysis. All multiprobe instruments passed post-calibration checks and sonde data were submitted to the TIAER database manager for entry into the TIAER database. Photographs were labeled and flow data were processed.

Meteorological conditions for the September 2011 survey ranged from partly cloudy to sunny with moderate to strong winds (> 30 mph). Maximum daily temperatures were hot (upper 90s). No rainfall was encountered during the monitoring period; however, rainfall data from the Pleasanton Municipal Airport indicated a 1.75 inch rainfall event occurred on September 17, which accounted for the presence of streamflow at Stations 20762 and 20773.

Water color at Station 20762 was clear and the water surface upstream of Granato Road was covered in *Lemna* sp. Stations 17900, 12980 and 20773 were all turbid and brown. Flow severity, though low, appeared to have returned to a more normal state during this survey, for the time of year.

Presentation of Results

For a monitoring study of this magnitude the generated data are voluminous. To the degree practical these data will be presented in a series of tables within this section. Following the convention of this report, data by station is presented in order of downstream to upstream. For some data sets, the complete presentation will be relegated to a series of appendices.

Water Quality Samples and Streamflow

The complete suite of laboratory-analyzed parameters performed on water samples collected during the study are summarized in Table 4-1 as averages of concentrations by station over the 10 surveys. In determining the averages, concentrations less than the reporting limits (<) were set to one-half the reporting limit. The individual laboratory results and the physical parameter values taken by a multiprobe instrument at the time of water sample collection are provided in Appendix A. Instantaneous flow measurements for each survey are displayed in Table 4-2.

Table 4-1 Average concentrations from water quality laboratory analyses of samples collected during ten surveys spanning June 2010 through September 2011[a]

Location	Station	Number of Samples	TP (mg/L)	PO_4-P (mg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_{2+3}-N (mg/L)	TDS (mg/L)	TSS (mg/L)	VSS (mg/L)	Cl^{-1} (mg/L)	SO_4^{-2} (mg/L)	Tot Alk (mg/L)	TOC (mg/L)	Chl-a (µg/L)	Pheo-a (µg/L)
2701_01	20773	10	0.51	0.297	1.56	< 0.1	0.163	1204	46	9	229.7	146.7	426	10.8	32.1	9.1
2701_01	12980	10	0.51	0.254	1.77	< 0.1	0.175	1342	54	9	209.3	116.5	541	10.0	43.0	14.0
2701_02	20764	7	0.45	0.264	1.20	< 0.1	0.243	1199	66	11	256.7	307.5	274	7.2	11.0	8.1
2701_02	17900	10	2.50	2.360	0.95	< 0.1	8.109	948	11	3	200.1	199.2	212	6.1	21.5	3.6
2701_03	20762	10	1.09	0.882	1.46	0.182	0.869	849	20	7	183.6	188.8	197	7.7	50.7	11.3
2701_03	20761	2	0.21	0.089	2.06	0.192	0.199	878	41	7	195.8	155.2	279	10.5	36.9	< 3.0
2701_04	20760	2	0.50	0.175	3.23	0.326	< 0.05	400	75	18	43.5	25.5	171	12.5	122.8	11.9
2701_04	17142	1	0.49	0.277	1.88	< 0.1	< 0.05	467	10	4	88.2	66.1	165	12.6	50.7	3.6

[a] In the computations to determine all averages, concentrations less than the reporting limits were set to one half the reporting limit.

Table 4-2 Measured streamflow in cfs in Segment 2107 (Atascosa River), 2010 – 2011, from downstream to upstream

Station	June 2010	July 2010	August 2010	September 2010	March 2011	April 2011	May 2011	July 2011	August 2011	September 2011
20773	74.1	14.2	4.0	92.9	5.7	1.9	1.2	0.2	Pooled	0.9
12980	60.3	12.4	3.5	72.9	5.4	2.6	1.3	0.6	0.4	0.9
20764	21.9	4.1	1.1	6.2	3.4	0.8	0.3	Dry	Dry	Dry
17900	9.1	2.4	1.4	3.7	2.1	1.4	1.0	1.0	0.3	1.0
20762	0.6	0.5	0.2	1.2	0.5	0.3	0.3	Pooled	Pooled	0.1
20761	< 0.01	Dry	Dry	Pooled	Dry	Dry	Dry	Dry	Dry	Dry
20760	< 0.01	Dry	Dry	Pooled	Dry	Dry	Dry	Dry	Dry	Dry
17142	-	Dry	Dry	< 0.01	Dry	Dry	Dry	Dry	Dry	Dry

Pooled = pools present, no flow; Dry = dry, no pools present

Results from 24-Hour Data Collection

Data collected at 15-minute intervals from the 24-hour multiprobe instrument deployments results in relatively large sets of 96 data points per parameter. Graphical representations of the 15-minute interval 24-hour DO data are presented in Appendix B. Mean, maximum and minimum, values for T, SC, DO, and pH are located in Appendix C.

The critical parameter collected under the 24-hour data collection is DO. For the Atascosa River the relevant criteria to protect the designated high aquatic life use are a 24-hour mean DO of 5.0 mg/L and a minimum of 3.0 mg/L. Historically the Atascosa River has suffered from depressed DO concentration based on these criteria. A rigorous assessment of the 24-hour DO data collected during this study using TCEQ guidance (TCEQ, 2010a) was performed. The collected data continue to show occasions of depressed DO (Table 4-3).

While an assessment of criteria is not the purpose of this data report, certain observations can be made regarding conditions during the surveys of this study. All occurrences of depressed DO at any station involved the depressed mean 24-hour DO and some of these occurrences also coincided with a depressed minimum DO for 24-hour deployment period.

Table 4-3 Atascosa River (Segment 2701) 24-hour DO deployment data (basic statistics) Highlighted values are below criteria (5.0 mg/L for mean, 3.0 mg/L for minimum).

Station	Dates	24-hour DO (mg/L)		
		Minimum	Maximum	Mean
20773	15 - 16 June 2010	6.5	6.7	6.6
12980	15 - 16 June 2010	6.1	6.4	6.3
20764	15 - 16 June 2010	5.3	5.5	5.4
17900	15 - 16 June 2010	4.6	4.9	4.7
20762	15 - 16 June 2010	5.0	10.7	7.1
20761	15 - 16 June 2010	0.4	6.0	2.4
20760	15 - 16 June 2010	0.2	2.2	0.7
17142	15 - 16 June 2010	ND	ND	ND
Station	Dates	24-hour DO (mg/L)		
		Minimum	Maximum	Mean
20773	28 - 29 July 2010	5.3	6.0	5.6
12980	28 - 29 July 2010	5.8	6.7	6.3
20764	27 - 28 July 2010	4.8	6.4	5.4
17900	27 - 28 July 2010	5.0	5.4	5.1
20762	26 - 27 July 2010	4.7	8.7	6.1
20761	26 July 2010	ND	ND	ND
20760	26 July 2010	ND	ND	ND
17142	26 July 2010	ND	ND	ND
Station	Dates	24-hour DO (mg/L)		
		Minimum	Maximum	Mean
20773	25 - 26 August 2010	5.2	6.7	5.9
12980	25 - 26 August 2010	4.9	8.2	6.1
20764	25 - 26 August 2010	4.1	6.1	4.9
17900	25 - 26 August 2010	3.4	4.7	4.0
20762	25 - 26 August 2010	4.1	7.4	5.2
20761	25 August 2010	ND	ND	ND
20760	25 August 2010	ND	ND	ND
17142	25 August 2010	ND	ND	ND

Table 4–3 *Cont.*

Station	Dates	24-hour DO (mg/L)		
		Minimum	Maximum	Mean
20773	22 - 23 September 2010	6.7	7.0	6.8
12980	22 - 23 September 2010	6.4	6.6	6.4
20764	21 - 22 September 2010	3.8	5.3	5.1
17900	21 - 22 September 2010	4.9	5.2	5.1
20762	21 - 22 September 2010	4.1	6.2	4.9
20761	21 - 22 September 2010	3.0	4.5	3.6
20760	22 - 23 September 2010	2.0	4.0	3.0
17142	21 - 22 September 2010	0.4	3.0	1.7
Station	**Dates**	**24-hour DO (mg/L)**		
		Minimum	**Maximum**	**Mean**
20773	15 - 16 March 2011	6.6	8.3	7.5
12980	15 - 16 March 2011	7.2	9.6	8.1
20764	15 - 16 March 2011	5.8	12.0	8.1
17900	15 - 16 March 2011	5.4	9.0	7.2
20762	15 - 16 March 2011	7.6	9.7	8.8
20761	15 March 2011	ND	ND	ND
20760	15 March 2011	ND	ND	ND
17142	15 March 2011	ND	ND	ND
Station	**Dates**	**24-hour DO (mg/L)**		
		Minimum	**Maximum**	**Mean**
20773	19 - 20 April 2011	6.3	7.9	7.1
12980	19 - 20 April 2011	5.3	9.1	6.8
20764	19 - 20 April 2011	2.1	9.5	4.6
17900	19 - 20 April 2011	3.2	4.2	3.9
20762	18 - 19 April 2011	6.3	11.5	8.4
20761	18 April 2011	ND	ND	ND
20760	18 April 2011	ND	ND	ND
17142	18 April 2011	ND	ND	ND

Table 4–3 *Cont.*

Station	Dates	24-hour DO (mg/L) Minimum	Maximum	Mean
20773	18 - 19 May 2011	4.5	6.4	5.6
12980	18 - 19 May 2011	5.4	7.8	6.4
20764	18 - 19 May 2011	3.7	5.9	5.0
17900	18 - 19 May 2011	5.5	7.6	6.5
20762	18 - 19 May 2011	3.4	5.9	4.8
20761	18 May 2011	ND	ND	ND
20760	18 May 2011	ND	ND	ND
17142	18 May 2011	ND	ND	ND

Station	Dates	24-hour DO (mg/L) Minimum	Maximum	Mean
20773	12 - 13 July 2011	1.2	4.9	3.0
12980	12 - 13 July 2011	3.5	7.4	5.2
20764	12 July 2011	ND	ND	ND
17900	12 - 13 July 2011	4.3	5.7	5.0
20762	12 - 13 July 2011	0.0	7.6	2.2
20761	12 July 2011	ND	ND	ND
20760	12 July 2011	ND	ND	ND
17142	12 July 2011	ND	ND	ND

Station	Dates	24-hour DO (mg/L) Minimum	Maximum	Mean
20773	10 - 11 August 2011	1.0	2.9	2.0
12980	10 - 11 August 2011	3.8	8.3	5.2
20764	10 August 2011	ND	ND	ND
17900	10 - 11 August 2011	4.8	6.2	5.3
20762	10 - 11 August 2011	0.3	9.6	3.8
20761	10 August 2011	ND	ND	ND
20760	10 August 2011	ND	ND	ND
17142	10 August 2011	ND	ND	ND

Table 4–3 *Cont.*

Station	Dates	24-hour DO (mg/L)		
		Minimum	Maximum	Mean
20773	27 - 28 September 2011	4.4	5.4	4.9
12980	27 - 28 September 2011	5.3	6.5	5.7
20764	27 September 2011	ND	ND	ND
17900	27 - 28 September 2011	4.5	6.0	5.0
20762	27 - 28 September 2011	2.6	5.4	3.8
20761	27 September 2011	ND	ND	ND
20760	27 September 2011	ND	ND	ND
17142	27 September 2011	ND	ND	ND

Results of Biological Sampling

Contemporaneous to the July 2010, April 2011, and July 2011 surveys, TIAER staff performed nekton and benthic macroinvertebrate sampling along with habitat assessments. The results of these efforts are provided under separate headings of habitat, benthic macroinvertebrate, and nekton results. Note that only the five downstream most stations (20733, 12980, 20764, 17900 and 20762) of the total of eight stations provided conditions allowing biological sampling (see Figure 2-1).

Habitat Results

Summaries of the habitat data collected using the current Surface Water Quality Monitoring manual guidance are provided in Tables 4-4 – 4-6 for the three biological surveys. The habitat data are provided more completely in Appendix D. Average stream width increased with distance downstream, but depth was variable. Station 12980 was the second widest station but among the shallowest during the 2011 surveys. Sand was the dominant substrate at all stations on all dates. Although Station 20762 had more gravel/cobble substrate, on average (38%), than the other stations evaluated, sand was still dominant and coarser substrate was generally deeply embedded in the sand and silt. No station had a high average density of riffle habitat: Station 20764 had the highest relative density at 1 riffle per 60 m of stream evaluated. Station 17900 averaged only one riffle per 213 m of evaluated stream length. As flow diminished in the July 2011 survey, the number of riffles doubled at Stations 20773, 12980, and 17900. The number of riffles is misleading and may inflate the overall habitat scores and ratings because riffles in almost every instance were areas of shallow, turbulent flow over sandy substrate. Such habitat is technically classified as a riffle, yet it falls short of usefulness to aquatic organisms that depend on coarse, loose substrate in well-oxygenated flows in order to thrive.

Table 4-4 Summary of habitat assessments for stations in the Atascosa River (Segment 2107), 26-28 July 2010

Parameter Code	Habitat Descriptors	20773 (AU01)	12980 (AU01)	20764 (AU02)	17900 (AU02)	20762 (AU03)
00061	Instantaneous stream flow (in ft^3/sec)	14.2	12.4	4.1	2.4	0.5
72051	Stream bed slope over evaluated reach	0.7	0.7	1.15	0.62	1.22
84159	Average instream cover (%)	18.3	5	16	15	24
84161	Stream order	6	6	5	5	4
89832	Number of lateral transects made	6	6	5	5	5
89835	Flow measurement method	5	5	5	5	5
89839	Total number of stream bends	2	3	3	1	2
89840	Number of well defined stream bends	0	0	0	0	0
89841	Number of moderately defined stream bends	0	1	0	0	0
89842	Number of poorly defined stream bends	2	2	3	1	2
89843	Total number of riffles	2	1	2	2	5
89844	Dominant substrate[2]	3	3	3	3	3
89845	Average substrate gravel size (>2mm) or larger (%)	18.7	0.8	0	0	28
89846	Average stream bank erosion (%)	61.3	67.3	63.5	63	46
89847	Average stream bank angle (degrees)	65.7	34	45	53.4	45.3
89848	Channel flow status[1]	3	3	3	3	3
89849	Average trees as riparian vegetation (%)	85	60	43	85	18
89850	Average shrubs as riparian vegetation (%)	7.5	20	47.5	10	32.5
89851	Average grasses and forbs as riparian vegetation (%)	7.5	20	10	5	50
89852	Average percent cultivated fields as riparian vegetation (%)	0	0	0	0	0
89853	Average other as riparian vegetation (%)	0	0	0	0	0
89854	Average tree canopy coverage (%)	73.7	81	96.2	98.2	93.4

Table 4-4 *Cont.*

Parameter Code	Habitat Descriptors	20773 (AU01)	12980 (AU01)	20764 (AU02)	17900 (AU02)	20762 (AU03)
89859	Approx. drainage area above transect furthest downstream (km^2)	3588	2967	1323	1170	754
89860	Length of stream evaluated (km)	0.375	0.3	0.2	0.24	0.15
89861	Average stream width (m)	9.1	6.2	5.4	4.9	4.1
89862	Average stream depth (m)	0.4	0.4	0.3	0.4	0.2
89864	Maximum pool width at time of study (m)	9.7	9.9	6.4	7	5.5
89865	Maximum pool depth in study area (m)	1.3	0.9	1.3	1.3	0.5
89866	Average width of natural riparian vegetation (m)	>20	>20	19.2	20	17.5
89867	Aesthetics[3]	2	2	2	3	2
89929	Number of stream cover types	5	5	4	3	5
89961	Ecoregion (Texas Ecoregion Code)	31 or 33	31 or 33	31 or 33	31 or 33	31 or 33
89962	Land development impact[4]	1	2	2	2	2

[1] 1=no flow, 2=low, 3=moderate, 4=high

[2] 1=clay, 2=silt, 3=sand, 4=gravel, 5=cobble, 6=boulder, 7=bedrock, 8=other

[3] 1=wilderness, 2=natural, 3=common, 4=offensive

[4] 1=unimpacted, 2=low, 3=moderate, 4=high

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Table 4-5 Summary of habitat assessments for stations in the Atascosa River (Segment 2107), 18-20 April 2011

Parameter Code	Habitat Descriptors	20773 (AU01)	12980 (AU01)	20764 (AU02)	17900 (AU02)	20762 (AU03)
00061	Instantaneous stream flow (in ft^3/sec)	1.94	2.56	0.79	1.37	0.29
72051	Stream bed slope over evaluated reach	0.7	0.7	1.15	0.62	1.22
84159	Average instream cover (%)	10	10	28	21	44
84161	Stream order	6	6	5	5	4
89832	Number of lateral transects made	6	5	5	5	5
89835	Flow measurement method	5	5	5	5	5
89839	Total number of stream bends	2	3	3	1	2
89840	Number of well defined stream bends	0	0	0	0	0
89841	Number of moderately defined stream bends	0	2	1	0	0
89842	Number of poorly defined stream bends	2	1	2	1	2
89843	Total number of riffles	2	1	2	2	7
89844	Dominant substrate[2]	3	3	3	3	3
89845	Average substrate gravel size (>2mm) or larger (%)	5	5	0	1	38
89846	Average stream bank erosion (%)	52.9	30	31.5	47	36.5
89847	Average stream bank angle (degrees)	35.25	37.5	36.1	44.9	42.7
89848	Channel flow status[1]	2	2	2	2	2
89849	Average trees as riparian vegetation (%)	60	55	40	85	18
89850	Average shrubs as riparian vegetation (%)	20	15	50	10	40
89851	Average grasses and forbs as riparian vegetation (%)	20	30	10	5	42.5
89852	Average percent cultivated fields as riparian vegetation (%)	0	0	0	0	0
89853	Average other as riparian vegetation (%)	0	0	0	0	0
89854	Average tree canopy coverage (%)	75.8	63.4	86.8	98.2	74

Table 4-5 *Cont.*

Parameter Code	Habitat Descriptors	20773 (AU01)	12980 (AU01)	20764 (AU02)	17900 (AU02)	20762 (AU03)
89859	Approx. drainage area above transect furthest downstream (km^2)	3588	2967	1323	1170	754
89860	Length of stream evaluated (km)	0.2	0.2	0.16	0.2	0.15
89861	Average stream width (m)	8.2	5.7	5.1	4.5	2.2
89862	Average stream depth (m)	0.24	0.12	0.37	0.4	0.9
89864	Maximum pool width at time of study (m)	8.7	9	5.9	6.4	0
89865	Maximum pool depth in study area (m)	1	0.26	1.2	1.3	0
89866	Average width of natural riparian vegetation (m)	>20	>20	18	20	20
89867	Aesthetics[3]	2	2	2	3	3
89929	Number of stream cover types	5	5	4	4	5
89961	Ecoregion (Texas Ecoregion Code)	31 or 33	31 or 33	31 or 33	31 or 33	31 or 33
89962	Land development impact[4]	1	2	2	2	2

[1] 1=no flow, 2=low, 3=moderate, 4=high

[2] 1=clay, 2=silt, 3=sand, 4=gravel, 5=cobble, 6=boulder, 7=bedrock, 8=other

[3] 1=wilderness, 2=natural, 3=common, 4=offensive

[4] 1=unimpacted, 2=low, 3=moderate, 4=high

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Table 4-6 Summary of habitat assessments for stations in the Atascosa River (Segment 2107), 11-13 July 2011

Parameter Code	Habitat Descriptors	20773 (AU01)	12980 (AU01)	20764 (AU02)	17900 (AU02)	20762 (AU03)
00061	Instantaneous stream flow (in ft^3/sec)	0.22	0.6	Dry	0.99	<0.1
72051	Stream bed slope over evaluated reach	0.7	0.7		0.62	1.22
84159	Average instream cover (%)	13	17		16	52
84161	Stream order	6	6		5	4
89832	Number of lateral transects made	5	5		5	5
89835	Flow measurement method	5	5		5	5
89839	Total number of stream bends	3	2		1	2
89840	Number of well defined stream bends	0	0		0	0
89841	Number of moderately defined stream bends	0	1		1	0
89842	Number of poorly defined stream bends	3	1		0	2
89843	Total number of riffles	5	3		3	5
89844	Dominant substrate[2]	3	3		3	3
89845	Average substrate gravel size (>2mm) or larger (%)	5	8		5	48
89846	Average stream bank erosion (%)	30	19.4		43.5	37
89847	Average stream bank angle (degrees)	32.9	54.6		40.3	37.4
89848	Channel flow status[1]	2	2		2	2
89849	Average trees as riparian vegetation (%)	80	50		80	18
89850	Average shrubs as riparian vegetation (%)	10	15		10	40
89851	Average grasses and forbs as riparian vegetation (%)	10	35		10	42.5
89852	Average percent cultivated fields as riparian vegetation (%)	0	0		0	0
89853	Average other as riparian vegetation (%)	0	0		0	0
89854	Average tree canopy coverage (%)	66.2	73		88.2	81.4

Table 4-6 *Cont.*

Parameter Code	Habitat Descriptors	20773 (AU01)	12980 (AU01)	20764 (AU02)	17900 (AU02)	20762 (AU03)
89859	Approx. drainage area above transect furthest downstream (km^2)	3588	2967	Dry	1170	754
89860	Length of stream evaluated (km)	0.2	0.15		0.2	0.15
89861	Average stream width (m)	5.14	3.3		4.5	1.42
89862	Average stream depth (m)	0.22	0.14		0.4	0.04
89864	Maximum pool width at time of study (m)	9	5.8		8.3	2.8
89865	Maximum pool depth in study area (m)	1.1	0.63		1.2	0.67
89866	Average width of natural riparian vegetation (m)	>20	>20		>20	20
89867	Aesthetics[3]	2	2		3	3
89929	Number of stream cover types	4	4		5	6
89961	Ecoregion (Texas Ecoregion Code)	31 or 33	31 or 33		31 or 33	31 or 33
89962	Land development impact[4]	1	2		2	2

[1] 1=no flow, 2=low, 3=moderate, 4=high

[2] 1=clay, 2=silt, 3=sand, 4=gravel, 5=cobble, 6=boulder, 7=bedrock, 8=other

[3] 1=wilderness, 2=natural, 3=common, 4=offensive

[4] 1=unimpacted, 2=low, 3=moderate, 4=high

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Instream cover averaged 15-20% among the lower four stations but was considerably higher at Station 20762 ranging 24 – 52%. All five stations were heavily shaded with canopy cover averaging over 90% at Stations 20764 and 17900 and between 70 – 85% at the other three stations. Trees and shrubs dominated the riparian zone at all stations except 20762 where grass was plentiful.

Station 20762 stands out as the exception in many habitat categories yet the HQI final score and rating is indistinct from the other stations (Table 4-7). This is probably due to the fact that the HQI scoring system distinguishes between ecosystems with more distance between their average values for the nine parameters used in the HQI. Station 20762 was, on average, narrower, shallower, and had a higher number of riffle-run-pool sequences but these qualities were not sufficiently distinct from the other stations to show marked higher quality in HQI score comparisons. This speaks to the degree of habitat homogeneity in the Atascosa River, at least among the stations assessed for habitat and aquatic life.

Table 4-7 HQI scores and ratings for stations in the Atascosa River (Segment 2107). Stations 20761 (AU 2107_03) and 20760 and 17142 (AU 2107_04) had insufficient flow to conduct habitat assessments.

AU	Station	July 2010		April 2011		July 2011	
		HQI Score	HQI Rating	HQI Score	HQI Rating	HQI Score	HQI Rating
2701_01	20773	19	Intermediate	18	Intermediate	17	Intermediate
2701_01	12980	16	Intermediate	15	Intermediate	17	Intermediate
2701_02	20764	17	Intermediate	17	Intermediate	--	--
2701_02	17900	17	Intermediate	17	Intermediate	18	Intermediate
2701_03	20762	18	Intermediate	18	Intermediate	19	Intermediate

Nekton Results

A total of 1,470 fish represented by 29 taxa were collected during 2010 – 2011 (Table 4-8). The upper two stations, 17900 and 20762, had the highest taxonomic richness among the five stations (20 and 19, respectively) yet Station 20762 had the highest total individuals (672) and Station 17900 had the second lowest total individuals (153). Station 12980 had the least number of fish taxa (14) and all but two of the species collected there were cosmopolitan to the Atascosa River, i.e., collected from at least two of the other four stations. The four most abundant species collected at all five stations were: western mosquitofish (*Gambusia affinis*), bluegill (*Lepomis macrochirus*), red shiner (*Cyprinella lutrensis*), and the green sunfish (*Lepomis cyanellus*). The high relative abundance of these taxa in the overall count is largely attributable to their dominant numbers at the uppermost station, 20762. Sunfish were generally diverse and numerous among the five stations whereas minnows, shiners, and other small-bodied fish (except for *C. lutrensis*) were only locally abundant and not a consistently dominant feature of the fish populations at any station save 12980 where *G. affinis*, *C. lutrensis*, and bullhead minnow (*Pimephales vigilax*) were abundant.

The scores and ratings from the regional IBI for Atascosa River fish depend on the ecoregion applied. The Atascosa River lies on the boundary between Ecoregions 31 and 33 (see Figure 2-3), the Southern Texas Plains and East Central Texas Plains, respectively, and slightly different metric criteria are used to determine the IBI score. The resulting scores, presented in Table 4-9, differ only by 1 or 2 points but since most stations were marginally intermediate to high the change in score resulted in altering the IBI rating in some instances. In general, by the standards of Ecoregion 31, the Atascosa River stations were consistently rated intermediate to high but mostly rated limited to intermediate by Ecoregion 33 criteria. Thus, the condition of the Atascosa River can be broadly described as intermediate according to IBI criteria. The lower three stations, 20773, 12980, and 20764, generally attained higher scores than the upper two stations, 17900 and 20762. The July 2010 samples produced the highest scores for most stations during the two years of sampling. April 2011 produced generally lower scores and July 2011 returned to the intermediate-high range with the exception of Station 20764 which was dry. Appendix E presents the full results of the fish survey.

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Table 4-8 Summary of fish collected during the 2010 - 2011 survey by station in the Atascosa River (Segment 2107). Stations 20761 (AU 2107_03) and 20760 and 17142 (AU 2107_04) had insufficient flow to conduct nekton surveys. Count indicates the number of stations at which the species was collected.

Scientific Name	Common Name	20773	12980	20764	17900	20762	Sum	Count
Gambusia affinis	Western mosquitofish	11	81	10	11	105	218	5
Lepomis macrochirus	Bluegill	4	13	11	42	136	206	5
Cyprinella lutrensis	Red shiner	85	79	17	12	4	197	5
Lepomis cyanellus	Green sunfish	24	6	30	21	112	193	5
Ameiurus melas	Black bullhead	0	0	0	0	135	135	1
Lepomis megalotis	Longear sunfish	22	8	5	33	39	107	5
Pimephales vigilax	Bullhead minnow	0	62	8	1	0	71	4
Ameiurus natalis	Yellow bullhead	0	1	0	0	47	48	2
Notropis amabilis	Texas shiner	32	4	1	4	1	42	5
Micropterus salmoides	Largemouth bass	1	0	10	2	23	36	4
Poecilia latipinna	Sailfin molly	27	3	0	0	2	32	3
Ictalurus punctatus	Channel catfish	11	9	0	2	6	28	4
Lepomis auritus	Redbreast sunfish	0	0	0	2	23	25	2
Lepomis gulosus	Warmouth	1	3	4	3	14	25	5
Pylodictis olivaris	Flathead catfish	16	4	0	1	0	21	3
Astyanax mexicanus	Mexican tetra	8	0	3	0	4	15	3
Cichlasoma cyanoguttatum	Rio Grande cichlid	4	0	1	5	1	11	4
Cyprinus carpio	Common carp	2	0	1	0	7	10	3
Lepomis humilis	Orangespotted sunfish	3	0	0	0	7	10	2
Dorosoma cepedianum	Gizzard shad	0	0	4	4	1	9	3
Lepomis microlophus	Redear sunfish	0	0	1	3	5	9	3
Ictalurus furcatus	Blue catfish	6	0	2	0	0	8	2

Table 4-8 *Cont.*

Scientific Name	Common Name	20773	12980	20764	17900	20762	Sum	Count
Lepisosteus oculatus	Spotted gar	1	3	1	2	0	7	4
Aplodinotus grunniens	Freshwater drum	0	0	0	2	0	2	1
Ictiobus bubalus	Smallmouth buffalo	0	0	0	1	0	1	1
Lepomis sp.(unknown)	Sunfish species	0	0	0	1	0	1	1
Opsopoeodus emiliae	Pugnose minnow	0	0	1	0	0	1	1
Pomoxis annularis	White crappie	0	1	0	0	0	1	1
Pomoxis nigromaculatus	Black crappie	0	0	0	1	0	1	1
	Total	**258**	**277**	**110**	**153**	**672**	***1470***	
	Richness	**17**	**14**	**17**	**20**	**19**	***29***	

Table 4-9 Nekton IBI scores and ratings for stations in the Atascosa River (Segment 2107) for Level III Ecoregions 31 and 33. Stations 20761 (AU 2107_03) and 20760 and 17142 (AU 2107_04) had insufficient flow to conduct nekton surveys.

Level III Ecoregion 31 Southern Texas Plains							
		July 2010		**April 2011**		**July 2011**	
AU	**Station**	**IBI Score**	**IBI Rating**	**IBI Score**	**IBI Rating**	**IBI Score**	**IBI Rating**
2701_01	20773	41	High	34	Intermediate	39	High
2701_01	12980	41	High	37	High	39	High
2701_02	20764	37	High	35	Intermediate	--	--
2701_02	17900	31	Intermediate	33	Intermediate	39	High
2701_03	20762	35	Intermediate	30	Intermediate	33	Intermediate
Level III Ecoregion 33 East Central Texas Plains							
		July 2010		**April 2011**		**July 2011**	
AU	**Station**	**IBI Score**	**IBI Rating**	**IBI Score**	**IBI Rating**	**IBI Score**	**IBI Rating**
2701_01	20773	42	High	34	Limited	38	Intermediate
2701_01	12980	40	Intermediate	34	Limited	38	Intermediate
2701_02	20764	38	Intermediate	36	Intermediate	--	--
2701_02	17900	32	Limited	34	Limited	40	Intermediate
2701_03	20762	34	Limited	30	Limited	30	Limited

Benthic Macroinvertebrate Results

A total of 2,829 macroinvertebrates covering 80 taxa[1] were collected during 2010 – 2011 (Table 4-10). The most abundant genus collected was the case-making Caddisfly *Cheumatopsyche sp.* which was collected at all five stations. Interestingly, it represented the most abundant taxa at most stations in July 2010 and April 2011 but it was nearly absent from July 2011 samples. Other taxa found in high abundance and at all five stations include the invasive Asiatic clam (*Corbicula fluminea*), collected primarily in the upper two stations, the riffle beetle *Stenelmis sp.*, and the ubiquitous midge Chironomidae. None of these three taxa were collected in high abundance at Station 20764, a station characterized by sluggish flow and sand-silt substrate. Among the 80 total taxa collected, 54 were collected in low numbers at only one or two stations. Thus, only a minority of taxa were common but they accounted for the majority of individuals collected. Riffle beetles, generally collector-gatherers and shredders, were among the most diverse and abundant group of insects during the 2010 – 2011 study and were primarily collected from snag material. Riffle beetle taxa in the Atascosa River from these collections include, in order of overall abundance, *Stenelmis sp.*, *Neoelmis sp.*, *Heterelmis sp.*, *Microcylloepus sp.*, and *Dubiraphia sp.*

B-IBI scores and ratings for qualitative benthic macroinvertebrate surveys—which do not vary with ecoregion—generally ranged from upper intermediate to the low-end of the high category (Table 4-11). The most downstream station (20773) and the uppermost station (20762) scored in the high range twice. The middle station near McCoy (20764) was the lowest-scoring among the five and had no flow during the final biological survey in July 2011. Appendix F presents the full results of the benthic macroinvertebrate survey.

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[1] This figure is slightly elevated by redundancies in the taxa list caused by some damaged and immature specimens keyed to family rather than genus. Actual richness is likely around 75.

Table 4-10 Summary of benthic macroinvertebrates collected during the 2010 - 2011 survey by station in the Atascosa River (Segment 2107). Stations 20761 (AU 2107_03) and 20760 and 17142 (AU 2107_04) had insufficient flow to conduct benthic surveys. Count indicates the number of stations at which the species was collected.

Taxa	20773	12980	20764	17900	20762	Sum	Count
Cheumatopsyche sp.	85	43	251	77	202	658	5
Corbicula fluminea	1	1	2	171	44	219	5
Stenelmis sp.	92	58	2	21	22	195	5
Chironomidae	27	13	5	66	67	178	5
Neoelmis sp.	47	117	0	8	0	172	3
Isonychia sp.	98	61	0	0	0	159	2
Heterelmis sp.	29	67	0	59	0	155	3
Hydropsyche sp.	23	73	1	0	0	97	3
Argia sp.	7	33	6	37	11	94	5
Fallceon sp.	35	17	4	18	20	94	5
Hyallela sp.	3	1	6	3	75	88	5
Pisidium sp.	8	17	1	0	38	64	4
Helichus sp.	19	27	0	13	0	59	3
Erpetogomphus sp.	8	11	0	23	3	45	4
Smicridea sp.	12	29	2	2	0	45	4
Caenis sp.	2	1	8	0	31	42	4
Oligochaeta	2	0	4	9	26	41	4
Dineutus sp.	0	0	31	0	0	31	1
Rhagovelia sp.	15	6	0	9	0	30	3
Progomphus sp.	0	7	6	14	0	27	3
Trichocorixa sp.	1	22	3	0	0	26	3
Dugesia sp.	0	0	0	13	11	24	2
Hetaerina sp.	1	8	5	8	1	23	5
Gomphus sp.	0	23	0	0	0	23	1
Arigomphus sp.	0	0	16	5	0	21	2
Stenacron sp.	10	6	0	2	1	19	4
Physella sp.	1	2	9	2	2	16	5
Farrodes sp.	3	1	0	12	0	16	3

Table 4-10 *Cont.*

Taxa	20773	12980	20764	17900	20762	Sum	Count
Hirudinea	0	0	2	0	13	15	2
Tricorythodes sp.	2	6	0	5	0	13	3
Chimarra sp.	0	0	1	0	12	13	2
Microcylloepus sp.	3	2	0	7	0	12	3
Peltodytes sp.	1	0	0	1	9	11	3
Farrodes texanus	0	0	0	9	0	9	1
Corydalus cornutus	5	3	0	0	0	8	2
Prosimulium sp.	1	1	0	1	2	5	4
Dubiraphia sp.	0	1	0	2	2	5	3
Biomphalaria sp.	0	0	0	0	5	5	1
Bouchardina sp.	0	0	0	1	3	4	2
Maccaffertium sp.	1	3	0	0	0	4	2
Nectopsyche sp.	2	2	0	0	0	4	2
Palaemonetes kadiakensis	2	0	0	0	2	4	2
Palaemonetes sp.	0	0	1	3	0	4	2
Ophiogomphus sp.	0	2	0	0	1	3	2
Gyretes sp.	0	3	0	0	0	3	1
Monohelea sp.	0	3	0	0	0	3	1
Nemotelus sp.	0	0	0	3	0	3	1
Pericoma sp.	0	0	0	3	0	3	1
Bezzia sp.	0	0	1	1	0	2	2
Microvelia sp.	1	0	0	1	0	2	2
Cambaridae	0	0	2	0	0	2	1
Mesovelia sp.	0	0	0	0	2	2	1
Pomatiopsis sp.	0	0	0	2	0	2	1
Baetidae	0	0	0	0	1	1	1
Belostoma sp.	1	0	0	0	0	1	1
Camelobaetidius sp.	1	0	0	0	0	1	1
Crambidae	1	0	0	0	0	1	1
Culicoides sp.	0	0	0	0	1	1	1
Desmopachria sp.	0	0	0	0	1	1	1
Elophila sp.	0	0	0	0	1	1	1
Helisoma sp.	0	0	0	0	1	1	1
Hydrochus sp.	1	0	0	0	0	1	1
Hydroptilidae	0	0	0	1	0	1	1
Macromia sp.	0	0	1	0	0	1	1
Nematomorpha	0	0	1	0	0	1	1

Table 4-10 *Cont.*

Taxa	20773	12980	20764	17900	20762	Sum	Count
Neocorixa sp.	1	0	0	0	0	1	1
Orconectes sp.	0	1	0	0	0	1	1
Paracymus sp.	1	0	0	0	0	1	1
Perithemis sp.	0	0	0	0	1	1	1
Planariidae	0	0	0	0	1	1	1
Podocopida	0	0	1	0	0	1	1
Procambarus sp.	0	0	1	0	0	1	1
Ranatra sp.	0	0	1	0	0	1	1
Rheumatobates sp.	0	1	0	0	0	1	1
Setodes sp.	1	0	0	0	0	1	1
Sphaeriidae	0	0	1	0	0	1	1
Staphylinidae	0	0	0	1	0	1	1
Stratiomys sp.	0	0	0	1	0	1	1
Thraulodes sp.	1	0	0	0	0	1	1
Tipulidae	0	0	0	1	0	1	1
Totals	**555**	**672**	**375**	**615**	**612**	***2829***	
Richness	**40**	**36**	**29**	**38**	**32**	***80***	
% Dominance	**49.55**	**38.24**	**79.47**	**51.06**	**56.21**	***37.89***	

Table 4-11 Benthic-IBI scores and ratings for stations in the Atascosa River (Segment 2107). Stations 20761 (AU 2107_03) and 20760 and 17142 (AU 2107_04) had insufficient flow to conduct benthic surveys.

		July 2010		**April 2011**		**July 2011**	
AU	**Station**	B-IBI Score	ALU Rating	B-IBI Score	ALU Rating	B-IBI Score	ALU Rating
2701_01	20773	30	High	31	High	24	Intermediate
2701_01	12980	27	Intermediate	31	High	28	Intermediate
2701_02	20764	22	Intermediate	23	Intermediate	--	--
2701_02	17900	28	Intermediate	27	Intermediate	30	High
2701_03	20762	29	High	28	Intermediate	30	High

Chapter 5
Analysis of Recent and Historical Data

Overview of Analyses

The purpose of this chapter is to broaden the data presentation begun in the last half of Chapter 4 by including relevant aspects of the historical water quality data collected in the Atascosa River over the last few decades. To that end the following analyses were conducted:

- Trend analysis
- Correlation of key parameters
- Comparisons to Texas nutrient screening levels
- Examination of DO from 24-hour surveys
- Evaluation of historical and recent biological surveys

Within TCEQ's Surface Water Quality Monitoring Information System (SWQMIS) is contained a relatively long history of water quality data collection efforts for the Atascosa River system, but only a few stations contain extensive records prior to 1998. Data collection efforts date back to the late 1960s. The SWQMIS database was queried for this project in June 2011 and dozens of sampling stations were identified with records of collected data for hundreds of biological, chemical, and physical parameters. Many stations were infrequently sampled, and many water quality parameters either had few records or were not directly pertinent to the study of aquatic life use. Based on their strategic locations in the watershed and the robustness and relevance of their water quality datasets, a total of 18 stations were chosen for a preliminary dataset that could supply this study with relevant historical water quality data (Figure 5-1; Table 5-1). Upon further review it was deemed appropriate to remove several stations from historical data analyses for the following reasons:

- Station 12954 on Metate Creek, a tributary, had a single diel study performed in 1990 and this dataset was determined to be too limited in temporal scope and too old to be of value to the current analysis.
- Stations 20613 and 20614, like 12954, were located on tributaries and had extremely limited datasets.
- Station 17436 was located at the Hunt St. crossing in Pleasanton where it could not be determined whether data was collected in the lentic conditions above the crossing, thus disabling reasonable interpretation of the very limited data it provided.

The final dataset used in the following historical analyses thus consists of 14 stations spanning all four AUs (Table 5-2).

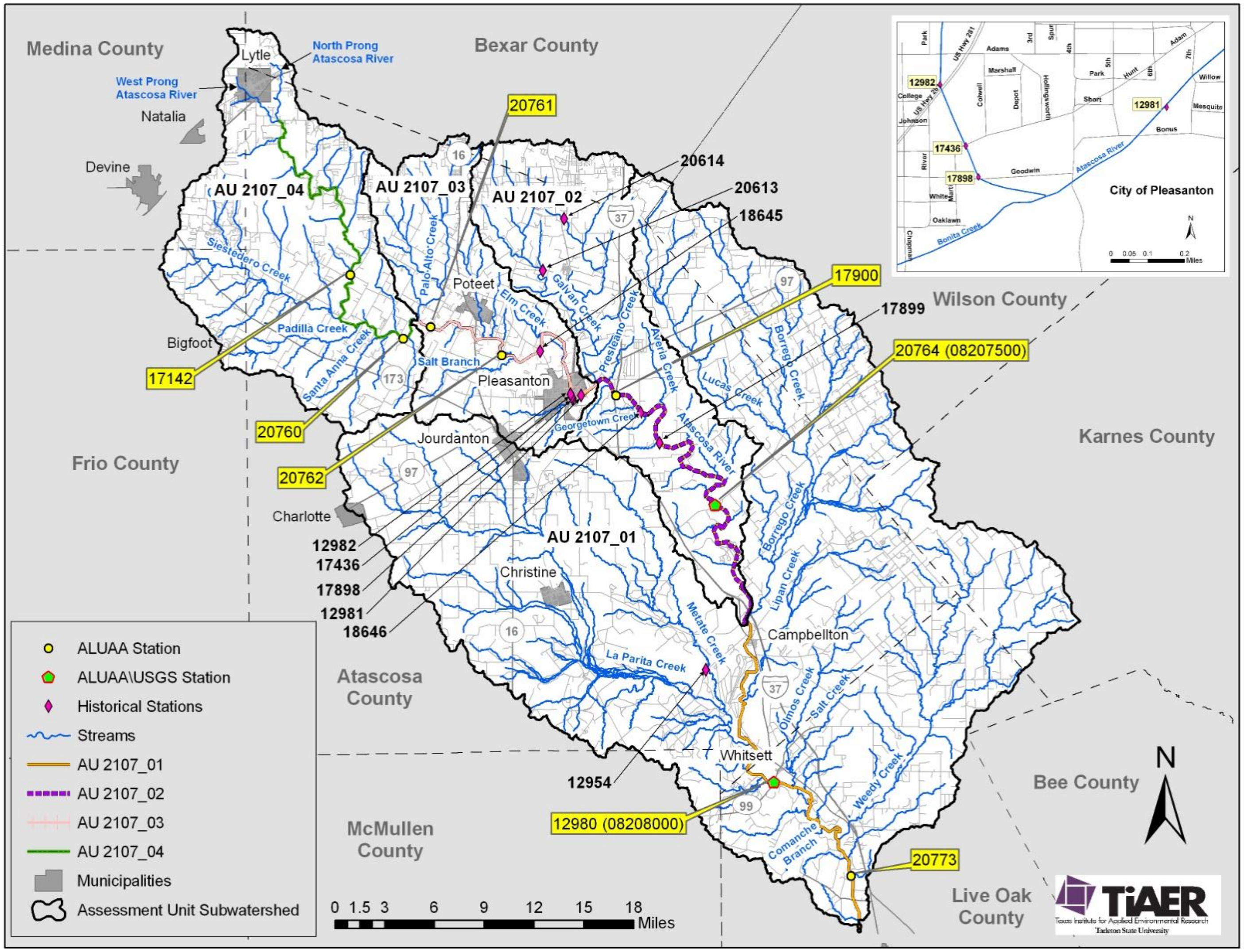

Figure 5-1 Atascosa River watershed depicting AUs and stations of the ALUAA survey of 2010 – 2011, and historical stations with relevant water quality data included in SWQMIS.

Table 5-1 Records by station and year in SWQMIS for the Atascosa River watershed (Segment 2107) for relevant water quality variables. ALUAA stations are highlighted blue. Gray stations had limited data and/or were located in irrelevant locations and are excluded from further analyses.

	AU2107_01			*AU2107_02*						*AU2107_03*							*AU2107_04*		Total
Year	**20773**	**12980**	**12954**	**20764**	**17899**	**18646**	**17900**	**20613**	**20614**	**12981**	**17898**	**17436**	**12982**	**18645**	**20762**	**20761**	**20760**	**17142**	**Records**
1968		8																	**8**
1969		26																	**26**
1970		24																	**24**
1971		24																	**24**
1972		24																	**24**
1973		26											8						**34**
1974		20											20						**40**
1975		14											14						**28**
1976		6											6						**12**
1977		22											8						**30**
1978		22											8						**30**
1979		28								6			4						**38**
1980		20								8			4						**32**
1981		24								10			4						**38**
1982		24								8			2						**34**
1983		24								8									**32**
1984		24								8									**32**
1985		22								6									**28**
1986		24								6									**30**
1987		24								8									**32**
1988		20								8									**28**
1989		22								8									**30**
1990		24	50							6									**80**
1991		24								6									**30**
1992		24								10									**34**
1993										16									**16**
1994										16									**16**
1995										16									**16**
1996		4								12									**16**
1997		10																	**10**
1998		10								2			8						**20**
1999		10	2							4			6						**22**

Table 5-1 *Cont.*

	AU2107_01			*AU2107_02*						*AU2107_03*								*AU2107_04*		Total
Year	**20773**	**12980**	**12954**	**20764**	**17899**	**18646**	**17900**	**20613**	**20614**	**12981**	**17898**	**17436**	**12982**	**18645**	**20762**	**20761**	**20760**	**17142**	**Records**
2000		20											18					2	**40**
2001		18										8	12					6	**44**
2002		8			14		13				14	16	20					4	**89**
2003		8			28		26				27		17						**106**
2004		17			9			4	2		9		16						**57**
2005		8											24						**32**
2006		38				30							34	20					**122**
2007		12				4							20	4					**40**
2008		8											30						**38**
2009		8											12						**20**
2010	24	32		24			24						20		24	8	8	4	**168**
2011	17	17		10			17								17	2	2	2	**84**
Total Records	**41**	**772**	**52**	**34**	**51**	**34**	**80**	**4**	**2**	**172**	**50**	**24**	**315**	**24**	**41**	**10**	**10**	**18**	***1734***

Table 5-2 SWQMIS water quality records for stations, years, and variables used for analyses contained in this report. Stations sampled for the current ALUAA are highlighted blue.

	AU2107_01		*AU2107_02*				*AU2107_03*						*AU2107_04*		Total
Year	**20773**	**12980**	**20764**	**17899**	**18646**	**17900**	**12981**	**17898**	**12982**	**18645**	**20762**	**20761**	**20760**	**17142**	**Records**
1968		8													**8**
1969		26													**26**
1970		24													**24**
1971		24													**24**
1972		24													**24**
1973		26							8						**34**
1974		20							20						**40**
1975		14							14						**28**
1976		6							6						**12**
1977		22							8						**30**
1978		22							8						**30**
1979		28					6		4						**38**
1980		20					8		4						**32**
1981		24					10		4						**38**
1982		24					8		2						**34**
1983		24					8								**32**
1984		24					8								**32**
1985		22					6								**28**
1986		24					6								**30**
1987		24					8								**32**
1988		20					8								**28**
1989		22					8								**30**
1990		24					6								**30**
1991		24					6								**30**
1992		24					10								**34**
1993							16								**16**
1994							16								**16**
1995							16								**16**
1996		4					12								**16**
1997		10													**10**
1998		10					2		8						**20**
1999		10					4		6						**20**
2000		20							18					2	**40**
2001		18							12					6	**36**
2002		8		14		13		14	20					4	**73**
2003		8		28		26		27	17						**106**
2004		17		9				9	16						**51**
2005		8							24						**32**
2006		38			30				34	20					**122**
2007		12			4				20	4					**40**
2008		8							30						**38**
2009		8							12						**20**
2010	24	32	24			24			20		24	8	8	4	**168**
2011	17	17	10			17					17	2	2	2	**84**
Total Records	**41**	**772**	**34**	**51**	**34**	**80**	**172**	**50**	**315**	**24**	**41**	**10**	**10**	**18**	***1652***

The following water quality parameters were selected for various analyses in this chapter: DO, DO percent saturation (DO%sat), Chl-a, Pheo-a, total nitrogen (TN), NH_3-N, TKN, total organic nitrogen (TON), nitrate nitrogen (NO_3-N), NO_{2+3}-N, TP, PO_4-P, SC, TDS, TSS, VSS, TOC, T and secchi depth (Sec_z). Note that TN is calculated as TKN plus NO_{2+3}-N, and TON is calculated as TKN minus NH_3-N. All of these parameters were chosen based on their potential relationships to DO concentrations encountered in the Atascosa River watershed.

DO concentrations are often correlated with season and T because of the inverse relationship of the saturation concentration of DO (DOsat) to T. This inverse relationship could have undesirable and unintended impacts on the intended analyses. In order to reduce the impact of T in several of the analyses included in this chapter, the ratio of measured DO to DOsat as a percentage (DO%sat), rather than simple DO, was employed as the dependent variable. Equation 5-1 shows the calculation for DOsat based on T (ASCE, 1960).

$$DOsat = 14.652-0.41022*(T)+0.007991*(T^2)-0.000077774*(T^3) \qquad \text{Eq. 5-1}$$

Wherever DO%sat was used it was based on surface samples so T, in this case, represents surface T (< 0.3 m).

General Analyses

Trend Analysis

Temporal trend analyses was performed for DO, Chl-a, TP, PO_4-P, TN, and TON from grab sample data at Stations 12980 in AU2107_01, 12981 in AU2107_03, and 12982 in AU2107_03, because of the robustness of their datasets and temporal coverage (Table 5-2). The mean of DO at Station 12980 decreased slightly between the 1970s data and the late 1990s through 2011 data (Figure 5-2). This trend is opposite the trend in Chl-a and nutrients, which all increased to some degree between the 1970s and more recent years (Figures 5-2 – 5-4). A similar pattern is not discernible at Station 12981 where data only covered the 1980s and 1990s (Figures 5-5 – 5-7). (Note: While Chl-a concentrations for Station 12981 during the period of 1979 – 1983 appear suspiciously high (Figure 5-5), nutrient levels are also elevated at this location, which could support high levels of suspended algae.) Data at Station 12982 shows a pattern similar to Station 12980 wherein DO decreased while nutrients increased (Figures 5-8 and 5-9).

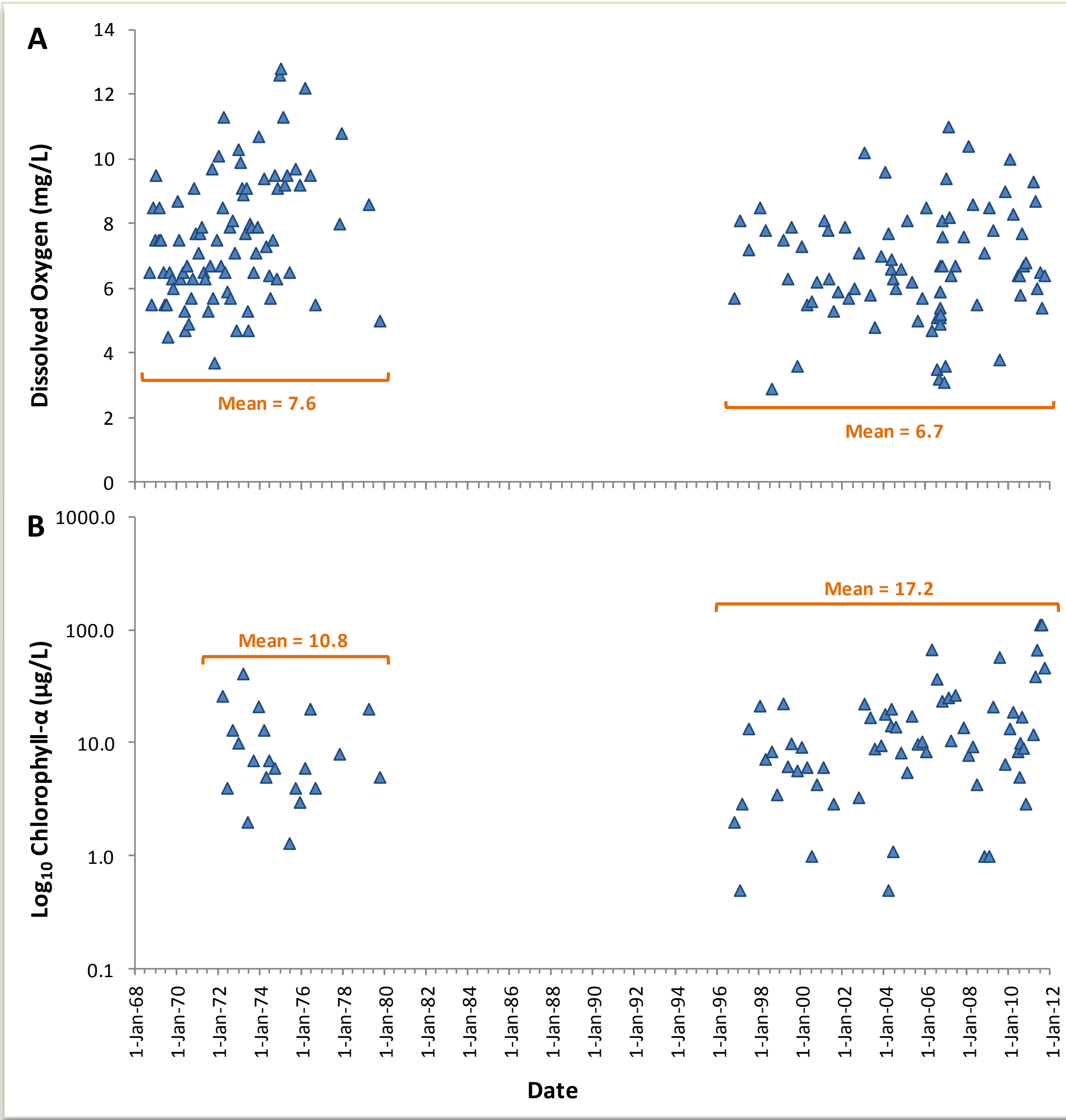

Figure 5-2 DO (A) and Log_{10} CHLA (B) from 1968 - 2011 at Station 12980 (AU2701_01)

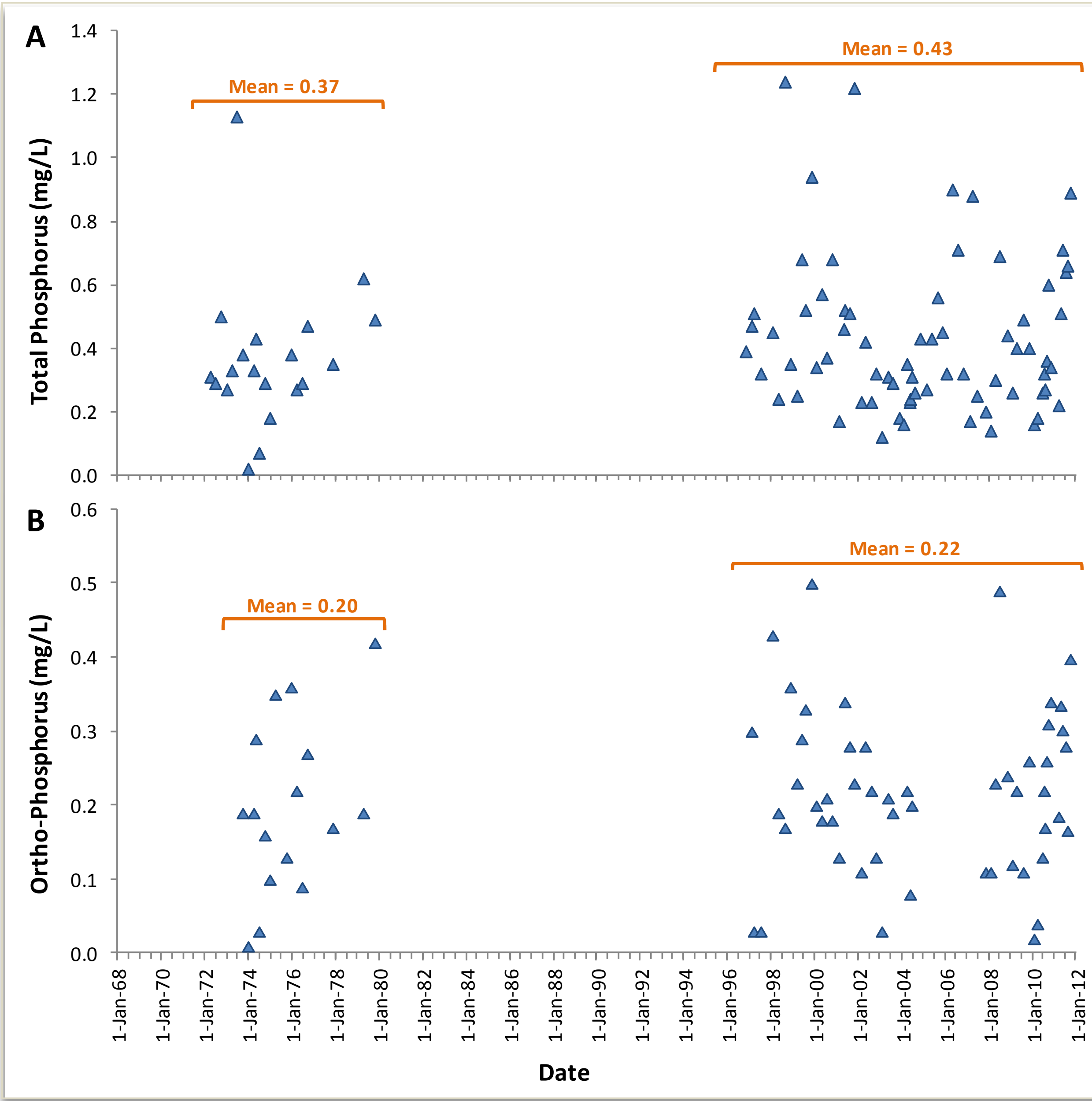

Figure 5-3 TP (A) and PO_4-P (B) from 1968 - 2011 at Station 12980 (AU2701_01)

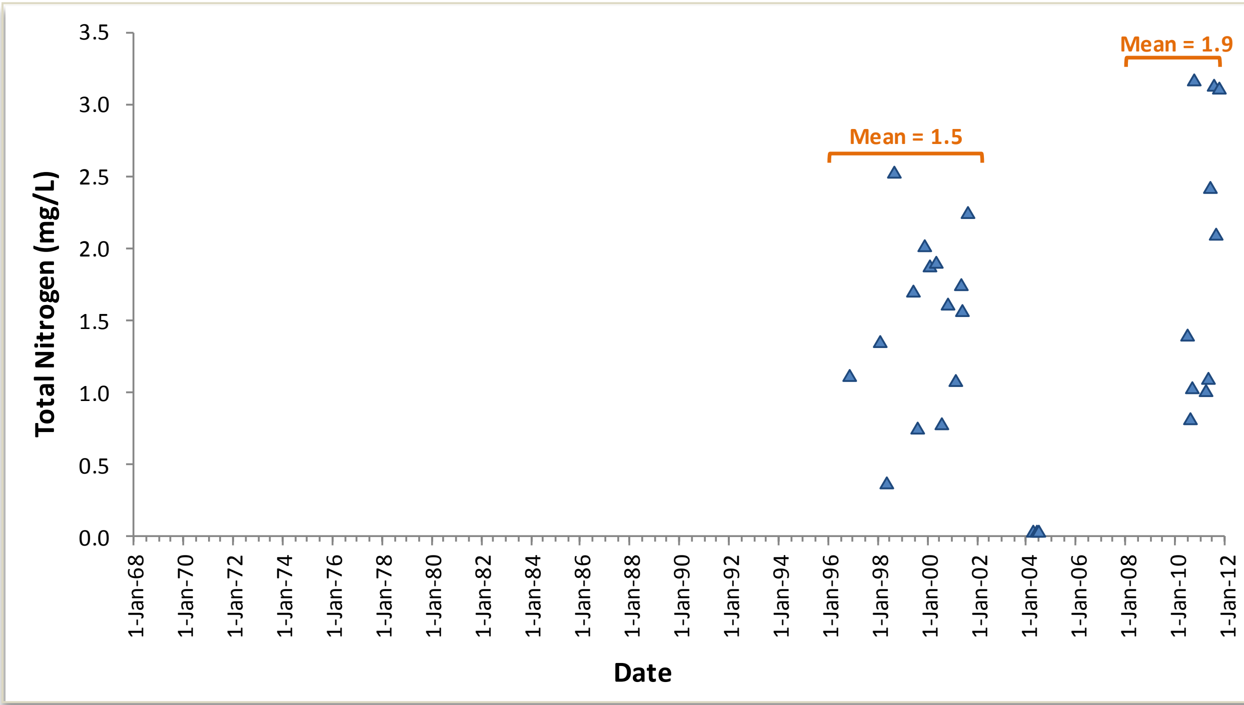

Figure 5-4 TN from 1968 - 2011 at Station 12980 (AU2701_01)

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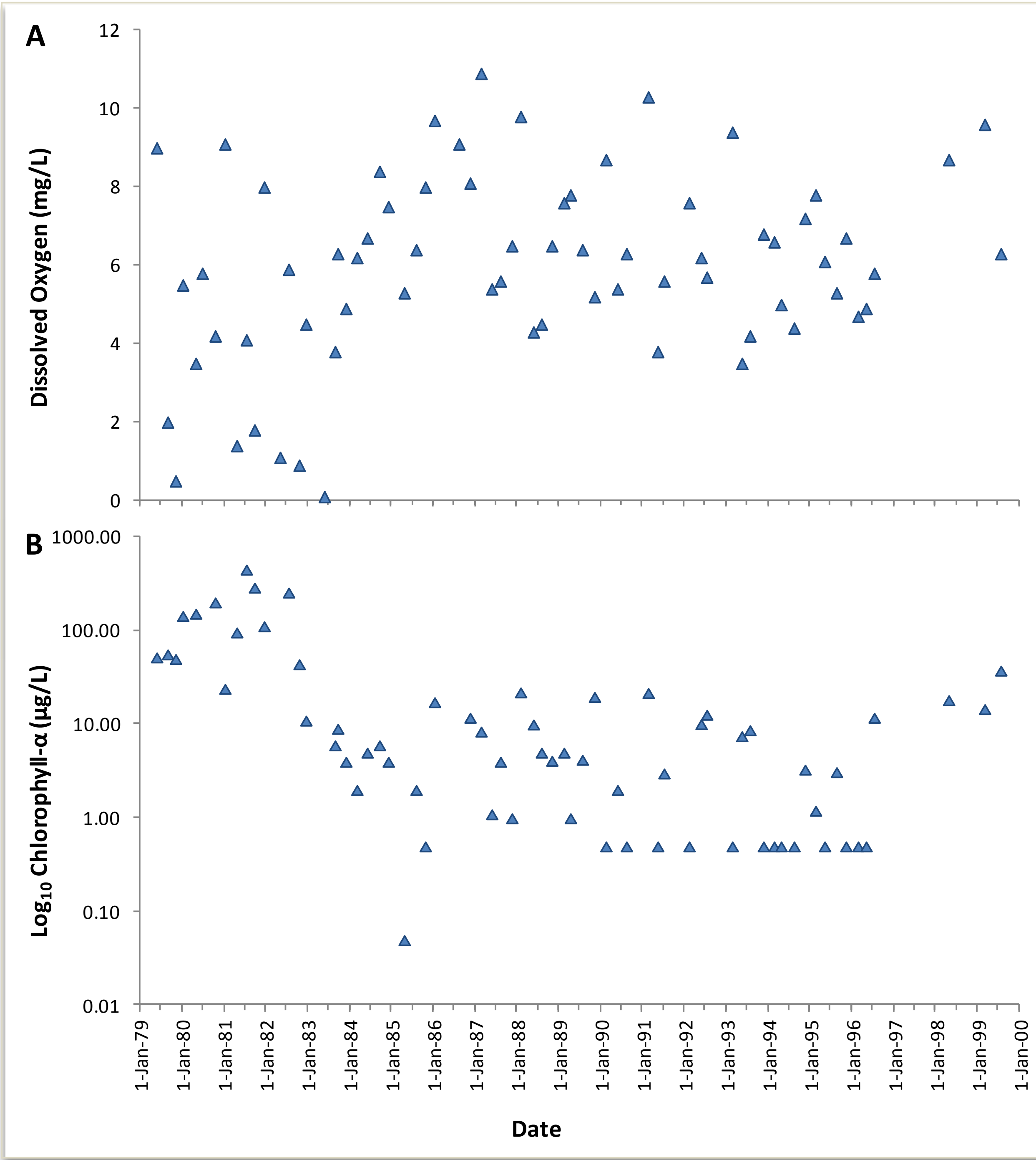

Figure 5-5 DO (A) and Log_{10} CHLA (B) from 1979 - 1999 at Station 12981 (AU2701_03)

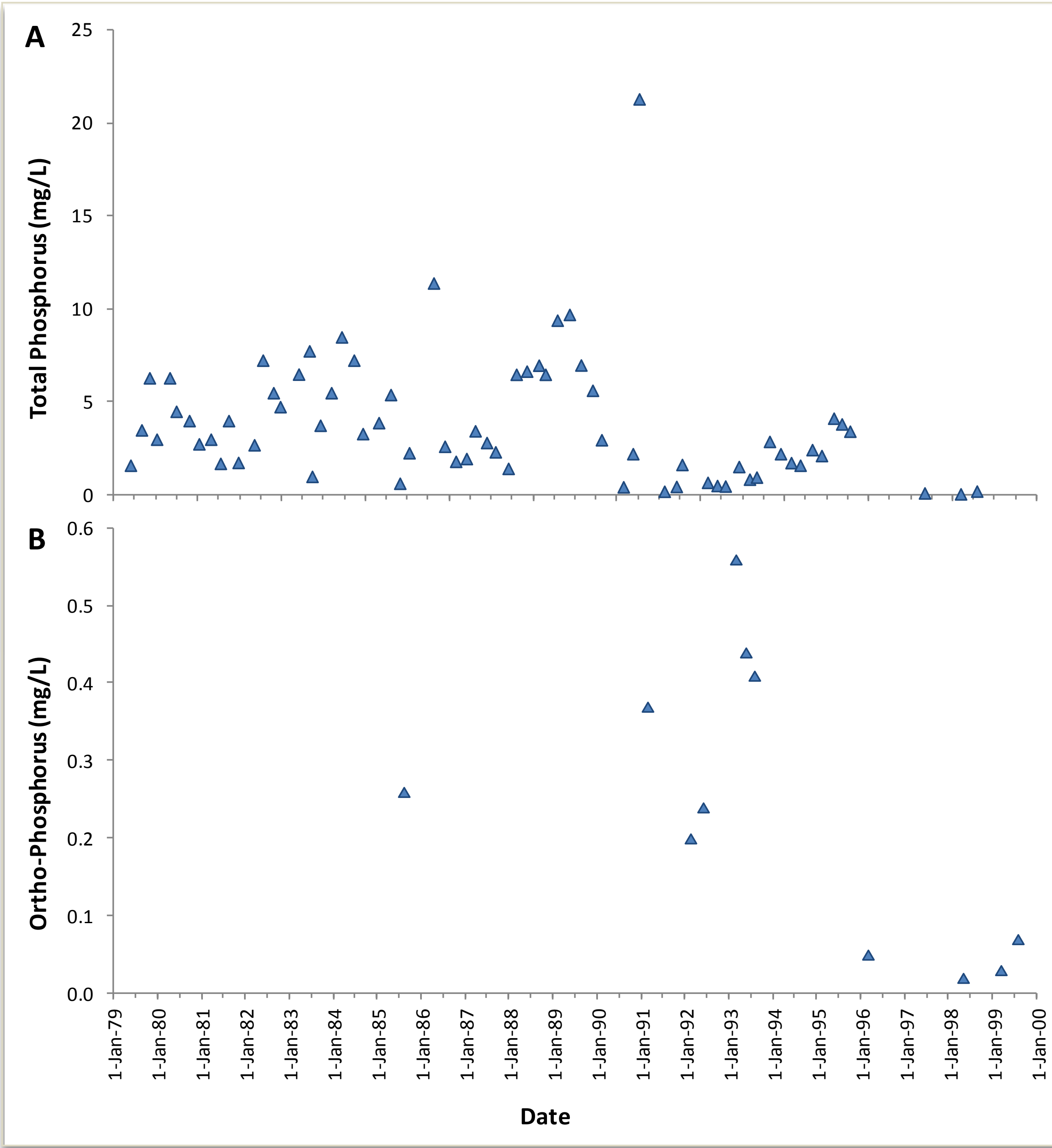

Figure 5-6 TP (A) and PO_4-P (B) from 1979 - 1999 at Station 12981 (AU2701_03)

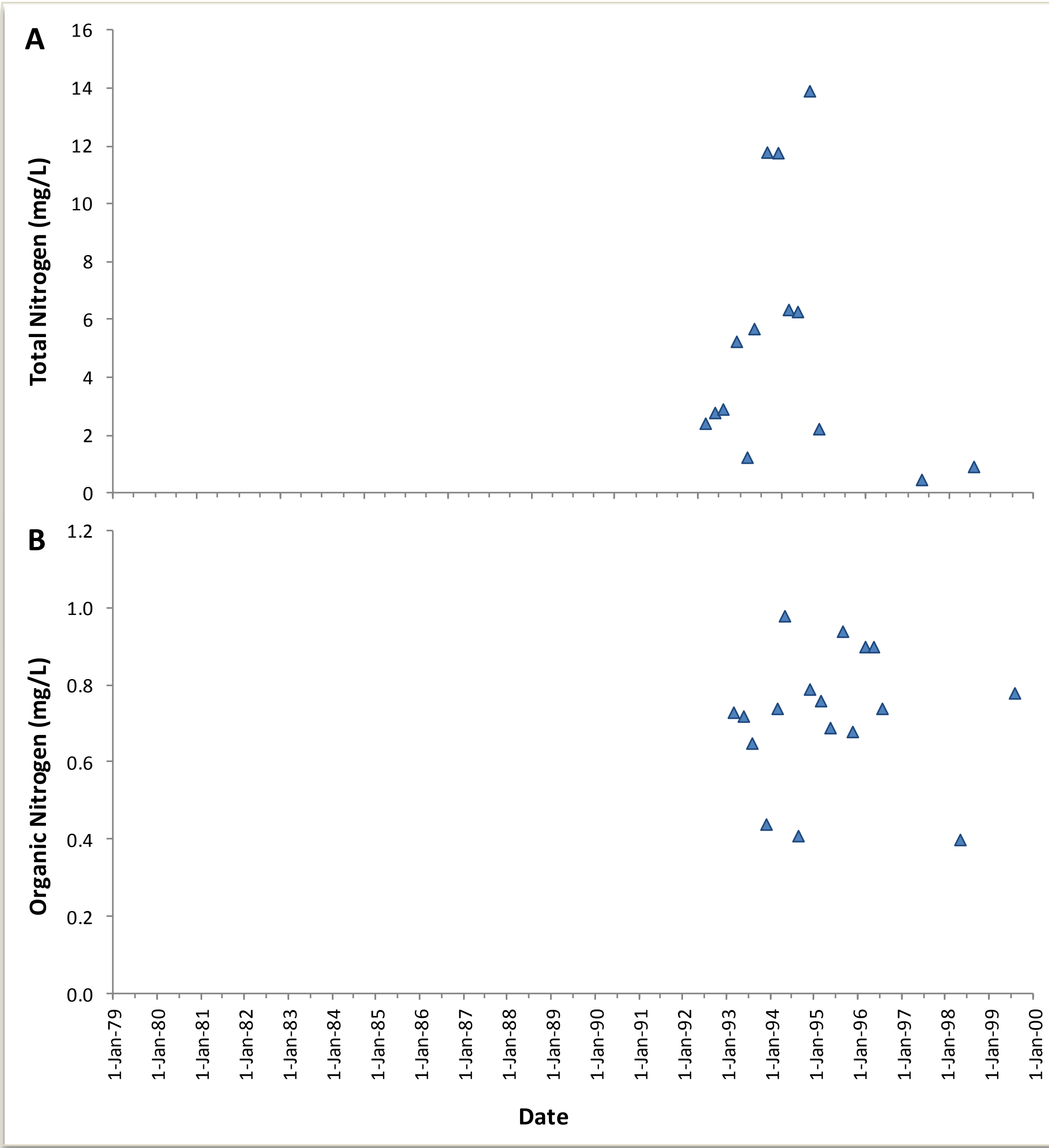

Figure 5-7 TN (A) and TON (B) from 1979 - 1999 at Station 12981 (AU2701_01)

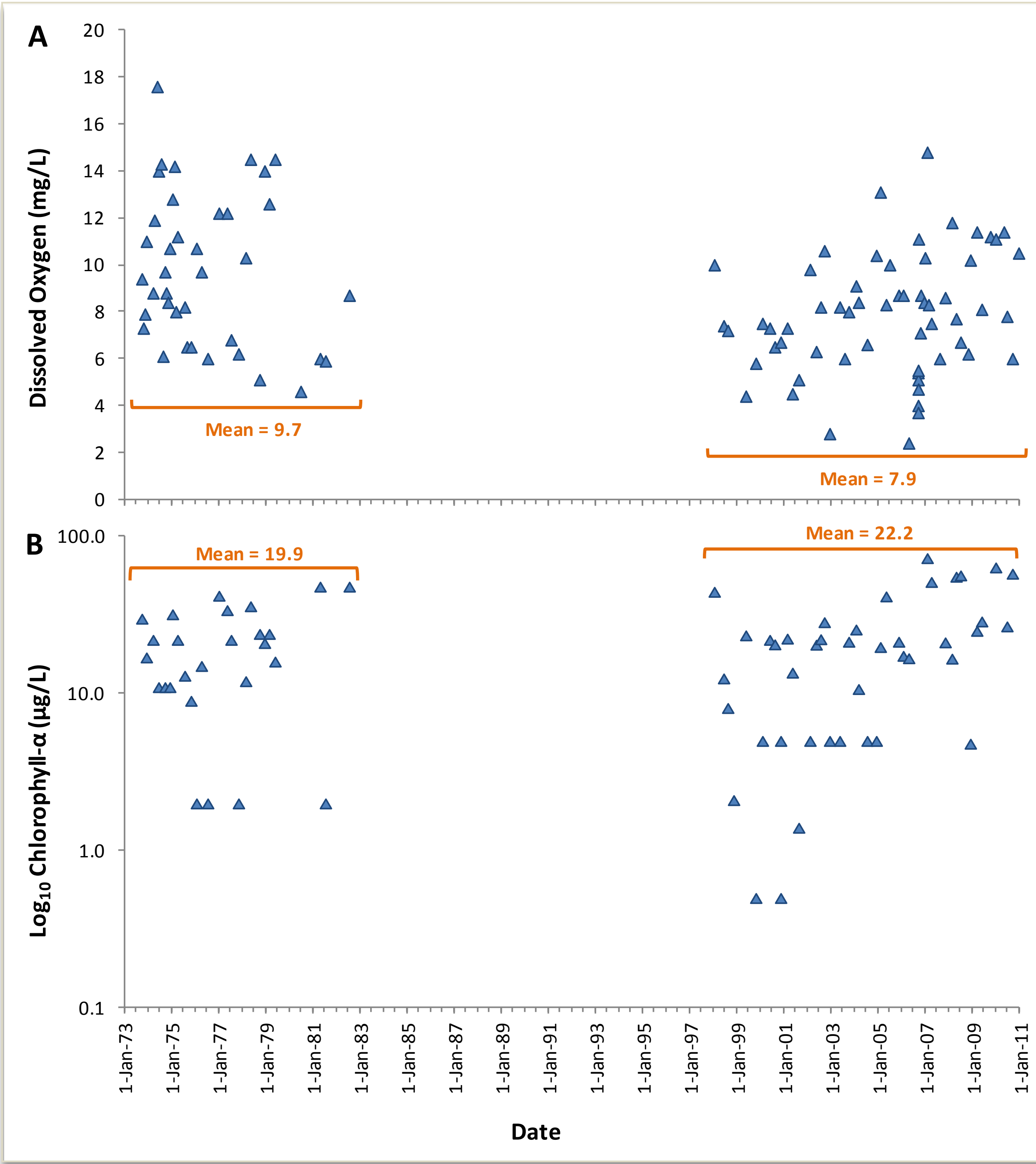

Figure 5-8 DO (A) and Log_{10} CHLA (B) from 1973 - 2010 at Station 12982 (AU2701_03)

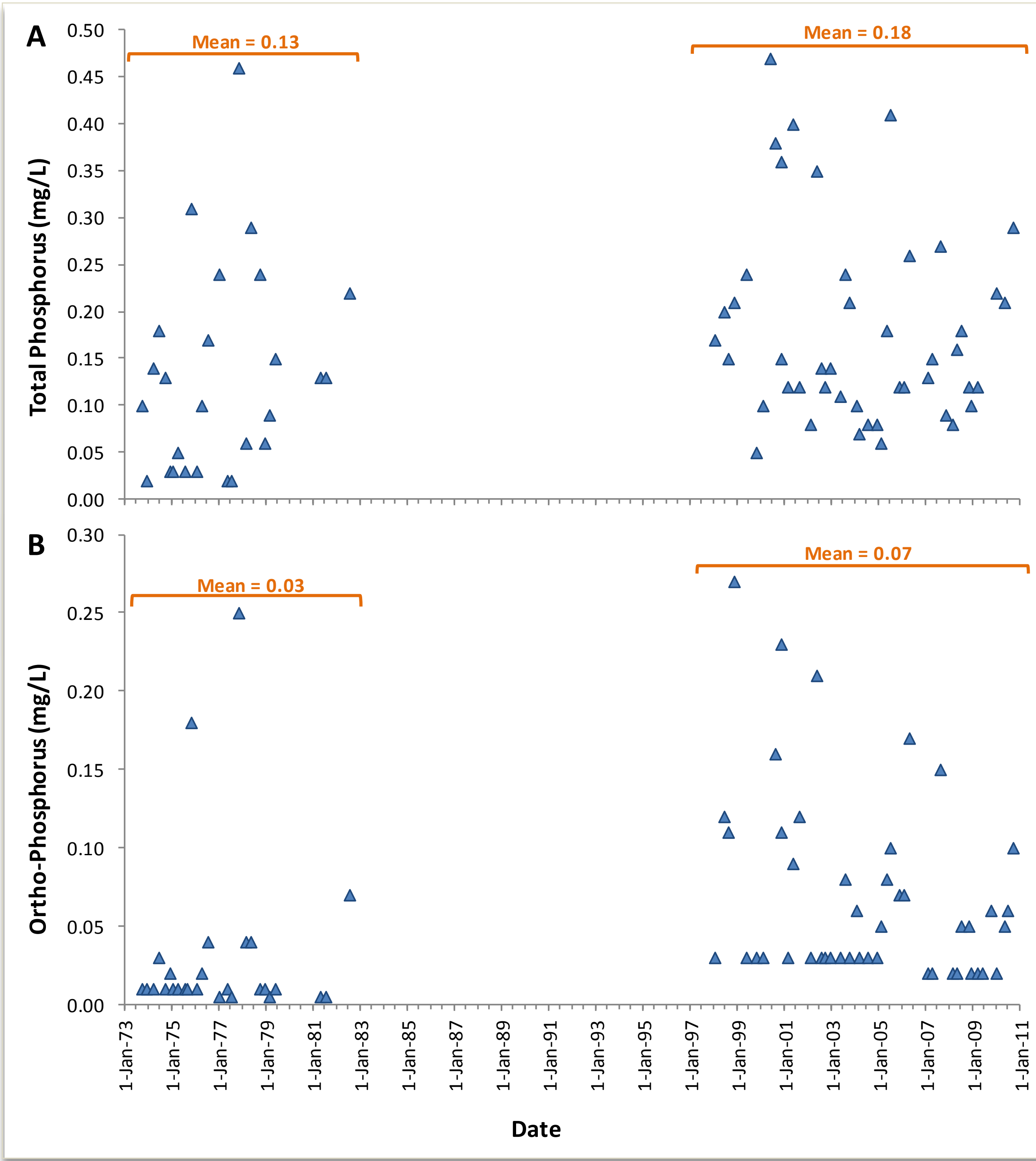

Figure 5-9 TP (A) and PO_4-P (B) from 1973 - 2010 at Station 12982 (AU2701_03)

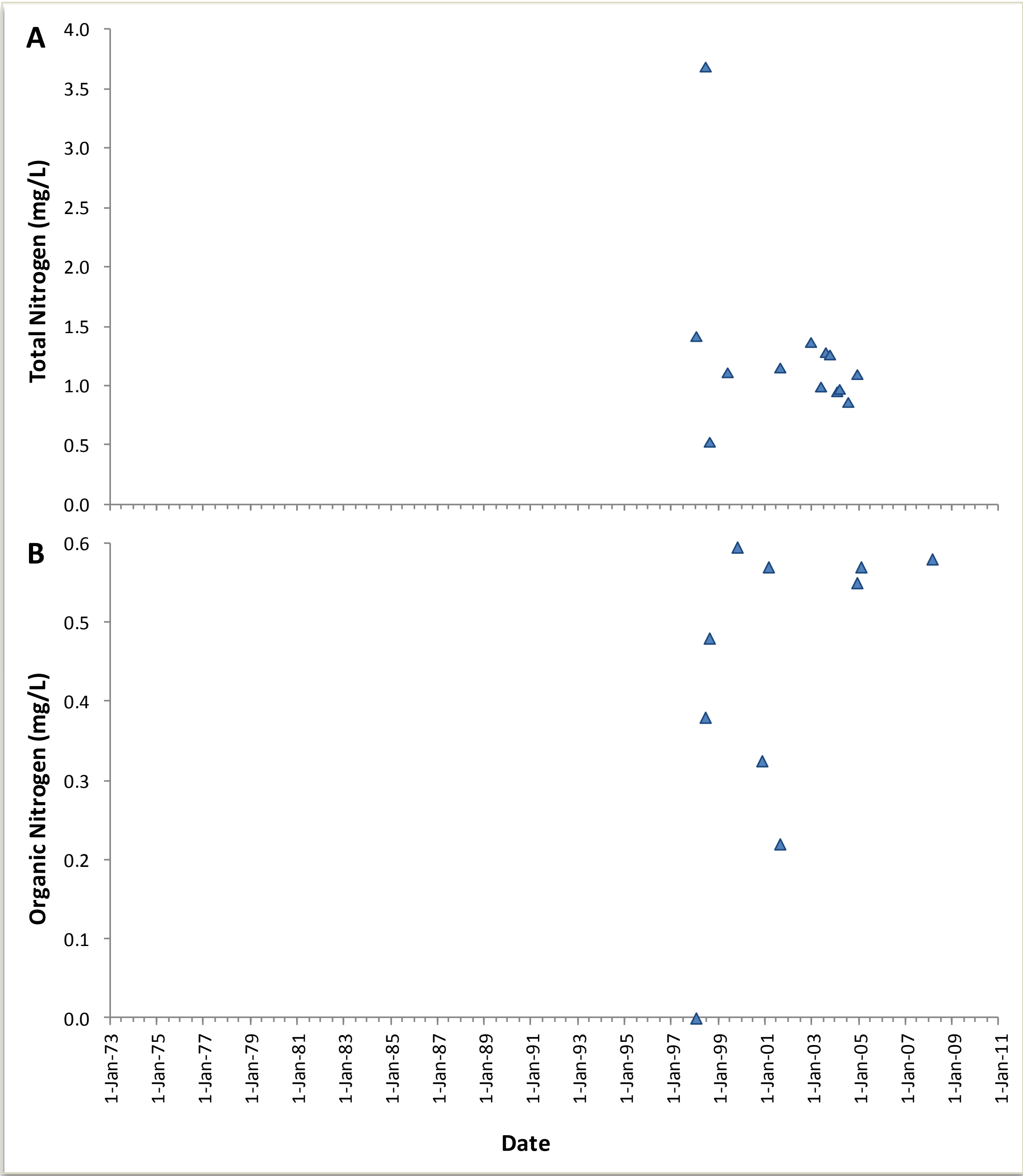

Figure 5-10 TN (A) and TON (B) from 1973 - 2010 at Station 12982 (AU2701_03)

Regression of Selected Water Quality Parameters to Flow at Station 12980

Flow is an important driver of DO concentrations in streams. Generally, sluggish flows lead to stagnation and depressed DO. Overland flow generated during rainfall-runoff events can also carry nutrients to waterways that increase production in plants and phytoplankton which, in turn, can lead to DO impairment. Linear regression of Chl-a, DO, TN, org-N, TP, and PO_4-P versus flow (log_{10}) was possible at Station 12980 near Whitsett, TX, because of nearly complete hydrological records available from the collocated USGS gage 08208000 from 1969 – present. All of the regressions in Figures 5-11 – 5-13 had extremely low r^2 values (< 0.12). Though weak, the response to flow was generally negative for all analytes in these regression analyses.

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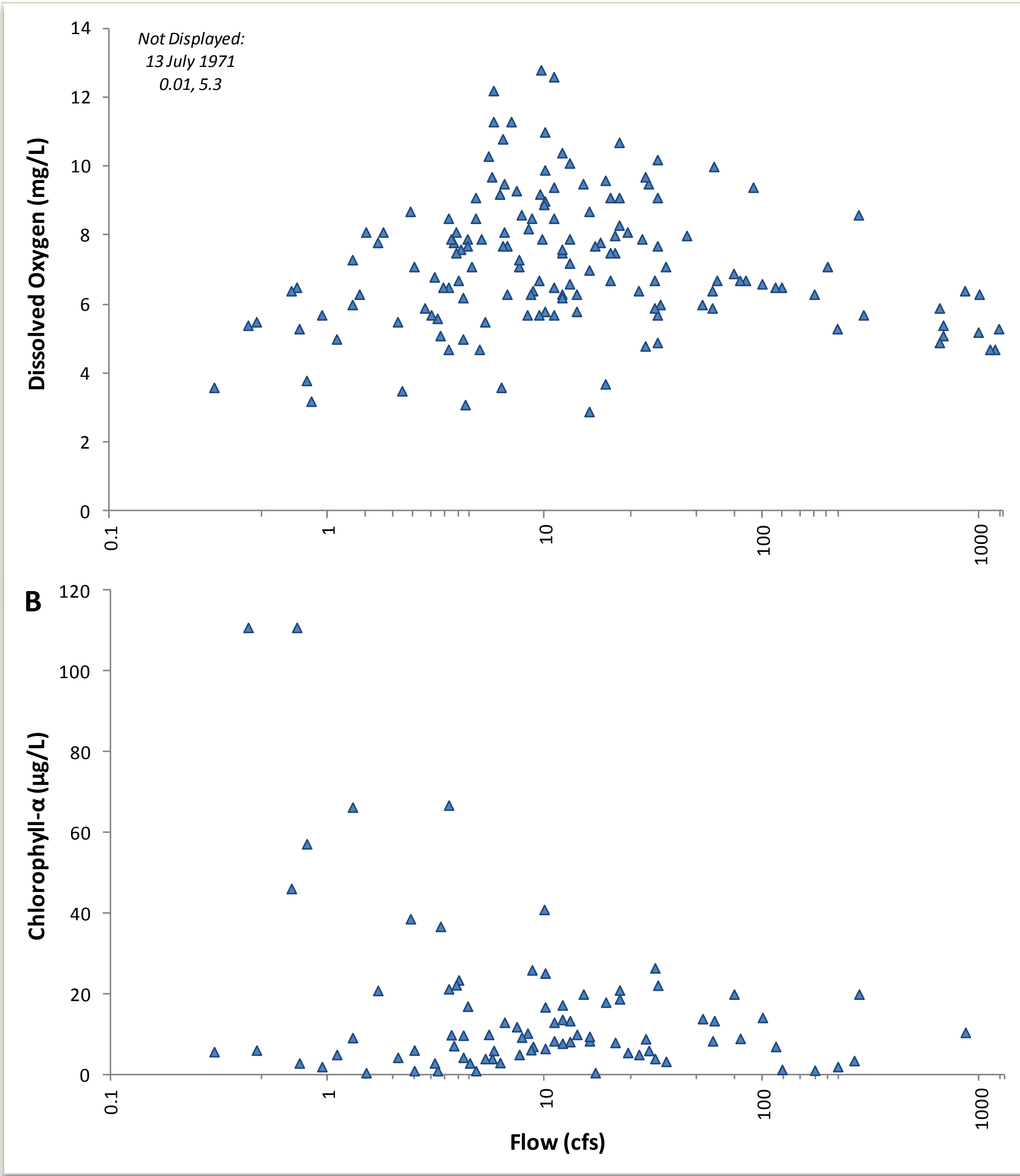

Figure 5-11 Chl-a (A) and DO (B) versus flow from 1969 - 2011 at Station 12980 (AU2701_01)

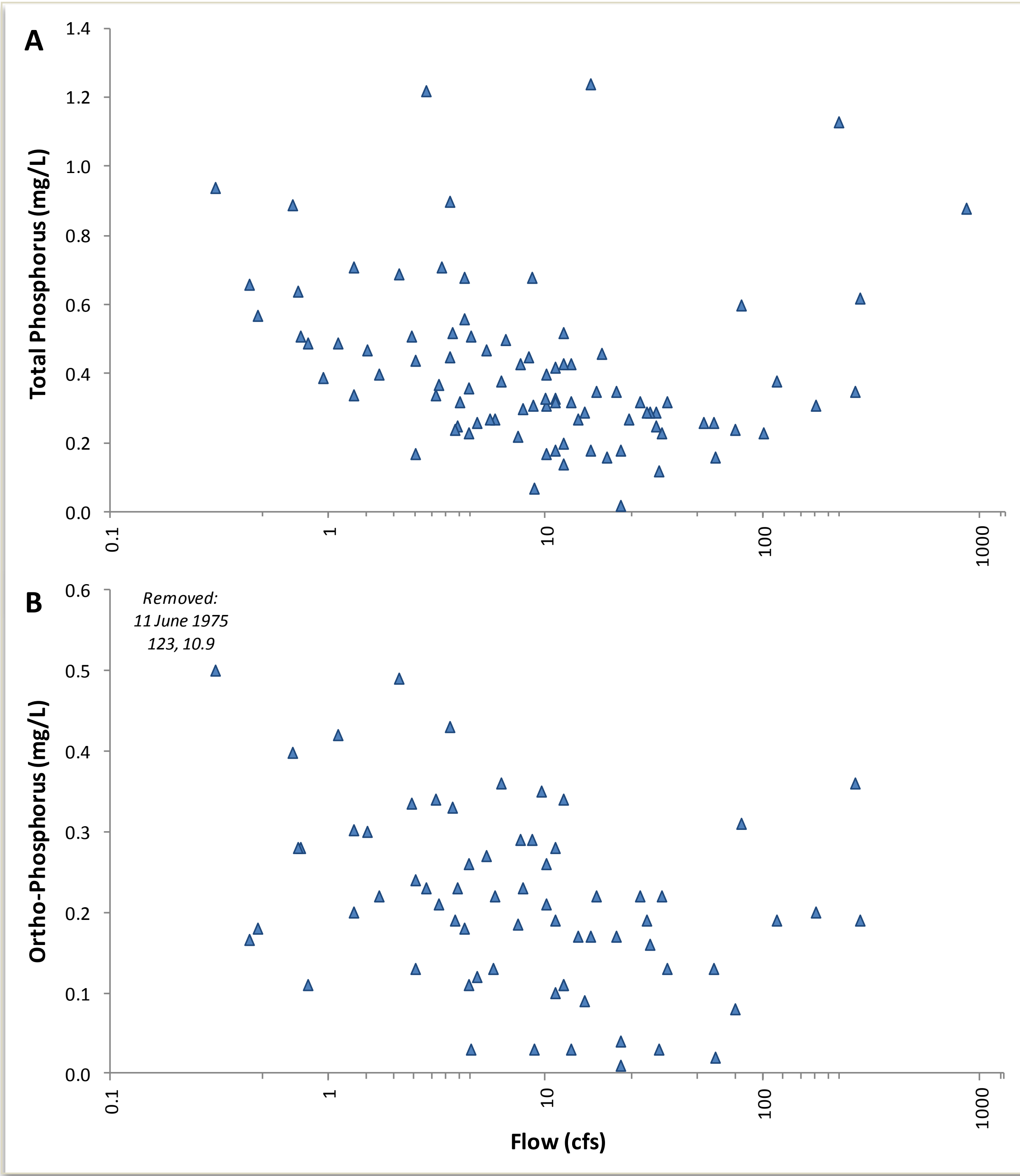

Figure 5-12 TP (A) and PO_4-P (B) versus flow from 1969 - 2011 at Station 12980 (AU2701_01)

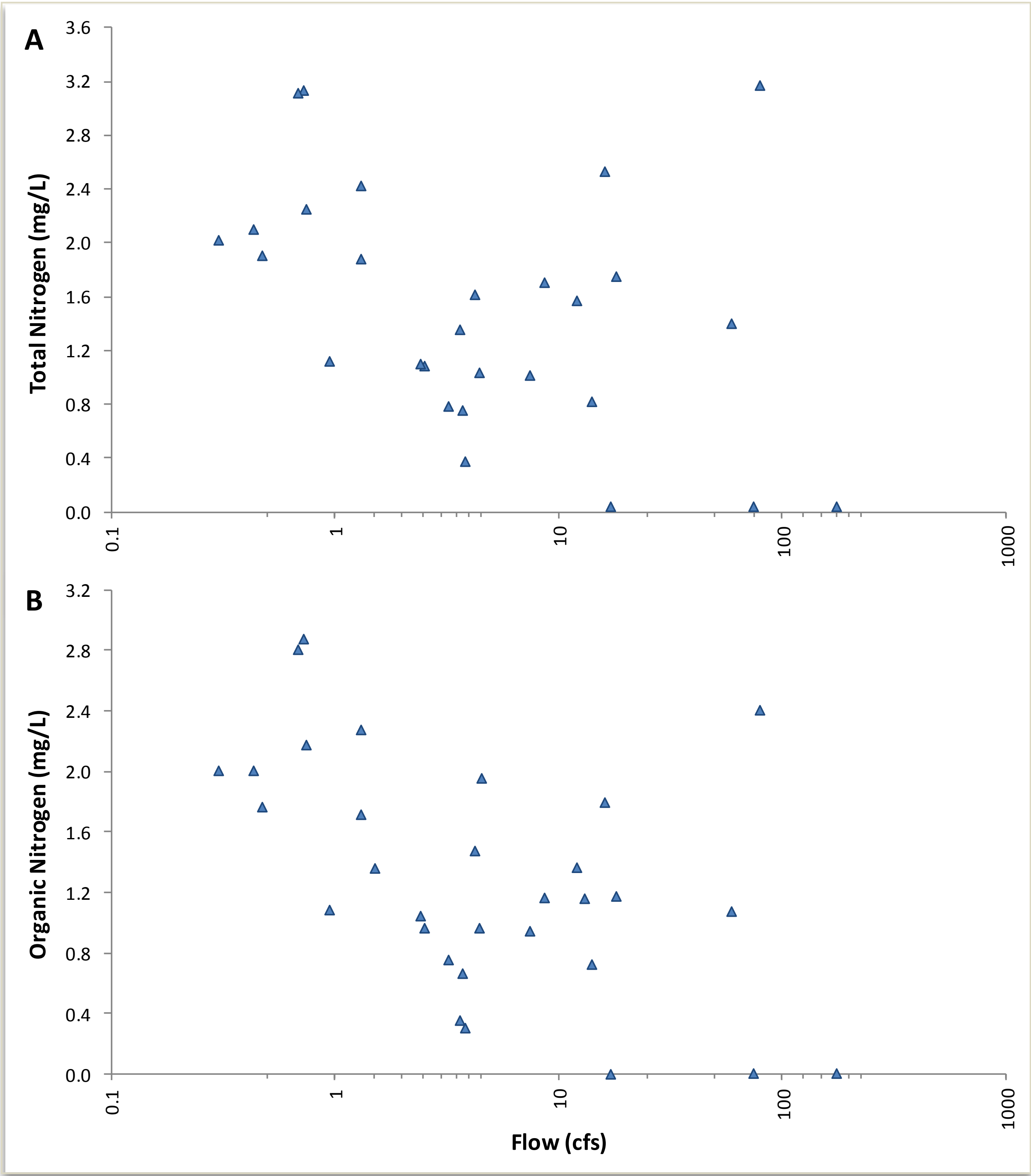

Figure 5-13 TN (A) and TON (B) versus flow from 1969 - 2011 at Station 12980 (AU2701_01)

Correlation Analysis of Water Quality Parameters

In an effort to identify significant relationships among 18 water quality parameters for historical and recent Atascosa River datasets, linear regression with Pearson correlation analysis was performed on four datasets: Station 12980 (AU2701_01; 1968 – 2011 and 1998 - 2011), Station 12982 (AU2701_03; 1998 – 2010), and all data from the current study (all four AUs; 2010 – 2011). These stations and periods of record were selected according to temporal and spatial coverage of available data (Table 5-2). The resulting correlation coefficients, r, can range from -1 to 1 and represent the strength of the correlation such that values closer to | 1 | are strong and values closer to 0 are weak (Table 5-3). Negative values represent an inverse relationship between the correlates. Combined with probability values (*p*-values), one can determine both direction of the correlative relationship and the likelihood that the correlation is not random. In the following analyses, p-values ≤ 0.05 are considered statistically significant and strongly significant below ≤ 0.01.

Table 5-3 Values of r and corresponding strength of linear relationship (broadly based on Cohen (1988); Santhi *et al.* (2001); Van Liew *et al.* (2003))

r-value	Negative	Positive
Weak	-0.59 to 0.00	0.00 to 0.59
Moderate	-0.79 to -0.60	0.60 to 0.79
Strong	-0.80 to -1.00	0.80 to 1.00

Cross-correlation was apparent between TDS and Cl^{-1}, SO_4^{-2}, and SC in all four datasets (Tables 5-4 – 5-7; prior to analysis Cl^{-1}, SO_4^{-2}, and SC were transformed (ln +1)). This cross-correlation is to be expected because TDS and SC are measures of total ion concentration and Cl^{-1} and SO_4^{-2} are a subset of total ion concentration. DO was significantly and moderately correlated only with TP in the Station 12980 dataset from recent historical collections (Table 5-5; 1998 - 2011). No strong and significant correlations were found between DO and other water quality constituents in any of the datasets. Neither Chl-a nor Pheo-a exhibited notable relationships to nutrients or ion concentrations.

Overall the cross-correlations of water quality parameters were weak for the datasets analyzed. The strongest correlations were between water quality parameters that were innately interrelated, such as measures of ions in the water (TDS, Cl^{-1}, SO_4^{-2}, and SC), nutrients (TN, TON), and DO (DO%sat and T). The weak cross-correlations of most water quality parameters are anticipated in complex aquatic systems, such as this one, where interactions and processes cannot be easily defined by simple linear regression approaches.

Table 5-4 Regression matrix of r- and *p*-values from Pearson correlation analyses of 18 water quality parameters from grab sample data at Station 12980 (AU2701_01), 1968 – 2011. Moderate and strong r-values are bold and red, respectively. Significant and strongly significant *p*-values are highlighted and bold, respectively. The *n* for each regression pair ranged 11 – 334. Regression pairs with low *n* (11 - 17) are shaded gray.

Parameter	Stat	DO%sat	T	Chl-a	Pheo-a	TP	PO_4-P	TN	TON	Sec_z	TDS	TSS	VSS	TOC	pH	SC_{ln+1}	CL^{-1}_{ln+1}	$SO_4^{-2}{}_{ln+1}$
DO	r	**0.89**	-0.57	-0.12	-0.18	-0.58	-0.08	-0.40	-0.44	0.13	-0.04	-0.26	-0.13	-0.25	0.06	0.27	0.39	0.52
	p	**<.0001**	**<.0001**	0.2873	0.2015	**<.0001**	0.5170	0.0411	0.0252	0.3810	0.7808	0.0160	0.2726	0.0415	0.4157	**0.0005**	**<.0001**	**<.0001**
DO%sat	r		-0.14	-0.04	-0.05	-0.54	-0.05	-0.36	-0.36	0.24	-0.10	-0.29	-0.18	-0.35	0.04	0.23	0.34	0.47
	p		0.0617	0.7150	0.7385	**<.0001**	0.6916	0.0733	0.0726	0.0946	0.4910	0.0062	0.1333	0.0043	0.6058	0.0027	**<.0001**	**<.0001**
T	r			0.23	0.31	0.32	0.08	0.12	0.16	0.10	0.00	0.08	-0.05	-0.03	-0.08	-0.17	-0.25	-0.32
	p			0.0422	0.0258	0.0030	0.5054	0.5523	0.4343	0.4975	0.9822	0.4622	0.6919	0.8029	0.3079	0.0211	0.0059	**0.0005**
Chl-a	r				**0.74**	0.24	-0.08	0.47	0.48	-0.13	0.45	-0.09	-0.16	-0.04	0.51	0.21	0.11	-0.21
	p				**<.0001**	0.0312	0.5370	0.0160	0.0081	0.4244	0.0013	0.3984	0.2129	0.7749	**<.0001**	0.0568	0.2995	0.0589
Pheo-a	r					0.29	0.10	0.27	0.28	-0.22	0.50	-0.05	-0.06	0.00	0.57	0.30	0.11	-0.35
	p					0.0318	0.5212	0.2147	0.1702	0.2018	**0.0007**	0.7307	0.6893	0.9808	**<.0001**	0.0331	0.4379	0.0090
TP	r						0.52	**0.69**	**0.64**	-0.38	0.02	0.54	0.46	0.46	0.03	-0.37	-0.39	**-0.61**
	p						**<.0001**	**<.0001**	**0.0001**	0.0076	0.9119	**<.0001**	**<.0001**	**<.0001**	0.7966	**0.0005**	**0.0002**	**<.0001**
PO_4-P	r							0.39	0.25	-0.30	-0.07	0.21	0.43	0.30	-0.07	-0.24	-0.05	-0.09
	p							0.0508	0.1977	0.0953	0.6949	0.0792	0.0021	0.0275	0.5649	0.0493	0.6648	0.4647
TN	r								**0.96**	**-0.61**	-0.11	0.22	0.11	0.21	0.31	-0.21	-0.46	**-0.80**
	p								**<.0001**	0.0476	0.7166	0.2716	0.6485	0.3597	0.1149	0.2856	0.0158	**<.0001**
TON	r									-0.53	0.13	0.09	0.09	0.21	0.48	0.00	-0.22	**-0.69**
	p									0.0952	0.6244	0.6172	0.6762	0.3039	0.0119	0.9968	0.2500	**<.0001**
Sec_z	r										-0.02	-0.32	-0.39	-0.04	-0.38	0.07	0.31	0.53
	p										0.9226	0.0285	0.0193	0.7700	0.0061	0.6153	0.0345	**0.0001**
TDS	r											-0.36	-0.39	0.06	**0.66**	**0.85**	0.27	0.00
	p											0.0064	0.0089	0.6927	**<.0001**	**<.0001**	0.0513	0.9934
TSS	r												**0.87**	0.42	-0.52	**-0.62**	-0.39	-0.34
	p												**<.0001**	**0.0003**	**<.0001**	**<.0001**	**0.0001**	**0.0008**
VSS	r													0.27	-0.30	-0.48	-0.20	-0.23
	p													0.0424	0.0127	**<.0001**	0.0931	0.0540
TOC	r														-0.17	-0.26	-0.27	-0.30
	p														0.1737	0.0354	0.0203	0.0110
pH	r															0.50	0.51	0.10
	p															**<.0001**	**<.0001**	0.2565
SC_{ln+1}	r																**0.94**	**0.71**
	p																**<.0001**	**<.0001**
CL^{-1}_{ln+1}	r																	**0.66**
	p																	**<.0001**

Table 5-5 Regression matrix of r- and *p*-values from Pearson correlation analyses of 18 water quality parameters from grab sample data at Station 12980 (AU2701_01), 1998 – 2011. Moderate and strong r-values are bold and red, respectively. Significant and strongly significant *p*-values are highlighted and bold, respectively. The *n* for each regression pair ranged 10 – 89. Regression pairs with low *n* (10 - 19) are shaded gray.

	DO	DO%sat	T	Chl-a	Pheo-a	TP	PO_4-P	TN	TON	Sec_z	TDS	TSS	VSS	TOC	pH	SC_{ln+1}	CL^{-1}_{ln+1}	$SO_{4}^{-2}{}_{ln+1}$
DO	r	0.90	-0.63	-0.11	-0.16	-0.62	-0.32	-0.44	-0.49	0.13	0.04	-0.35	-0.25	-0.50	-0.03	0.23	0.44	0.55
	p	<.0001	<.0001	0.4404	0.3007	<.0001	0.0358	0.0373	0.0189	0.3827	0.8054	0.0052	0.1107	0.0002	0.8291	0.0429	0.0004	<.0001
	DO%sat	r	-0.25	-0.10	-0.10	-0.61	-0.17	-0.47	-0.49	0.19	-0.06	-0.39	-0.30	-0.63	-0.07	0.18	0.42	0.56
		p	0.0307	0.4891	0.5415	<.0001	0.2712	0.0231	0.0175	0.2014	0.6802	0.0019	0.0502	<.0001	0.5174	0.1121	0.0009	<.0001
		T	r	0.12	0.20	0.28	0.22	-0.09	-0.07	0.03	-0.11	0.14	-0.04	0.04	-0.11	-0.19	-0.23	-0.22
			p	0.3842	0.1893	0.028	0.1439	0.6676	0.7287	0.8383	0.4742	0.2587	0.8075	0.7513	0.3485	0.0803	0.0754	0.0893
			Chl-a	r	0.55	0.20	-0.05	0.20	0.21	-0.13	0.50	-0.04	-0.08	0.00	0.34	0.18	0.13	-0.10
				p	0.0001	0.1268	0.7341	0.3728	0.3373	0.4244	0.0008	0.7866	0.6238	0.9862	0.0086	0.1688	0.3534	0.4724
				Pheo-a	r	0.19	0.03	-0.11	-0.08	-0.22	0.54	0.00	0.01	0.03	0.41	0.31	0.17	-0.20
					p	0.2173	0.8424	0.664	0.7513	0.2018	0.0009	0.9849	0.9649	0.8515	0.0052	0.0439	0.2696	0.1887
					TP	r	0.49	0.66	0.61	-0.38	-0.06	0.53	0.41	0.57	0.09	-0.40	-0.55	-0.70
						p	0.0006	0.0005	0.0017	0.0076	0.703	<.0001	0.0061	<.0001	0.4839	0.0013	<.0001	<.0001
						PO_4-P	r	0.35	0.30	-0.30	-0.16	-0.02	0.19	0.41	0.22	-0.14	-0.19	-0.44
							p	0.1026	0.1612	0.0953	0.3842	0.9067	0.3465	0.0106	0.1423	0.3594	0.2164	0.0023
							TN	r	0.94	-0.61	-0.12	0.32	0.25	0.28	0.14	-0.28	-0.46	-0.78
								p	<.0001	0.0476	0.7324	0.1321	0.3478	0.2624	0.5142	0.1863	0.0266	<.0001
								TON	r	-0.53	0.17	0.19	0.24	0.29	0.34	-0.03	-0.28	-0.64
									p	0.0952	0.6459	0.3687	0.3744	0.2447	0.1046	0.8818	0.1932	0.001
									Sec_z	r	-0.02	-0.32	-0.39	-0.04	-0.46	0.13	0.31	0.53
										p	0.9226	0.0285	0.0193	0.77	0.0012	0.3784	0.0345	0.0001
										TDS	r	-0.34	-0.39	0.05	0.61	0.87	0.71	0.15
											p	0.0211	0.0177	0.7348	<.0001	<.0001	<.0001	0.3131
											TSS	r	0.70	0.47	-0.51	-0.70	-0.74	-0.49
												p	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001
												VSS	r	0.21	0.10	-0.31	-0.38	-0.32
													p	0.1922	0.5383	0.0423	0.0141	0.0419
													TOC	r	-0.15	-0.27	-0.43	-0.43
														p	0.273	0.0499	0.0012	0.0011
														pH	r	0.49	0.43	-0.08
															p	<.0001	0.0005	0.5422
															SC_{ln+1}	r	0.90	0.58
																p	<.0001	<.0001
																CL^{-1}_{ln+1}	r	0.77
																	p	<.0001

Table 5-6 Regression matrix of r- and *p*-values from Pearson correlation analyses of 18 water quality parameters from grab sample data at Station 12982 (AU2701_03), 1998 – 2010. Moderate and strong r-values are bold and red, respectively. Significant and strongly significant *p*-values are highlighted and bold, respectively. The *n* for each regression pair ranged 7 –60. Regression pairs with low *n* (7 – 13). Values not displayed had *n* of 0 – 5.

		DO%sat	T	Chl-a	Pheo-a	TP	PO_4-P	TN	TON	Sec_z	TDS	TSS	VSS	TOC	pH	SC_{ln+1}	CL^{-1}_{ln+1}	$SO_{4}^{-2}{}_{ln+1}$
DO	r	***0.91***	-0.35							0.19					0.42	0.29		
	p	***<.0001***	*0.0069*							0.2569					***0.001***	*0.0235*		
DO%sat	r		0.07							0.04					0.50	0.29		
	p		0.6091							0.7876					***<.0001***	*0.0261*		
T	r									-0.32					0.12	-0.04		
	p									*0.0485*					0.3792	0.7439		
Chl-a	r				0.35	0.14	-0.27	0.08	0.50		-0.10	0.30	0.52	0.25			0.02	0.09
	p				0.1012	0.3721	0.0864	0.793	*0.0018*		0.5927	0.0533	*0.0011*	0.1437			0.9222	0.5849
Pheo-a	r					0.40	-0.05	0.17	***0.71***		0.22	0.35	0.44	0.30			0.25	0.24
	p					0.056	0.8384	0.7086	***0.0002***		0.2934	0.0942	*0.0343*	0.1601			0.2437	0.2604
TP	r						***0.62***	0.37	0.55		-0.37	0.26	0.37	0.30			-0.27	-0.31
	p						***<.0001***	0.2113	***0.0002***		*0.0226*	0.0864	*0.0219*	0.0607			0.0769	*0.0436*
PO_4-P	r							0.39	0.07		-0.29	0.24	-0.10	0.27			-0.34	-0.39
	p							0.1884	0.6804		0.0851	0.1126	0.5556	0.0924			*0.0271*	*0.0089*
TN	r								-0.26		***-0.71***	0.21	***0.64***	***-0.64***			0.12	0.08
	p								0.3829		*0.0468*	0.4912	0.0871	*0.0453*			0.7053	0.8018
TON	r										0.17	0.42	0.50	0.19			0.23	0.22
	p										0.3143	*0.0048*	*0.0014*	0.2403			0.1451	0.1645
Sec_z	r														-0.28	0.23		
	p														0.0862	0.1509		
TDS	r											-0.11	-0.16	0.08			***0.92***	***0.93***
	p											0.5174	0.3229	0.6234			***<.0001***	***<.0001***
TSS	r												***0.87***	0.00			-0.11	-0.10
	p												***<.0001***	0.9891			0.47	0.5078
VSS	r													0.09			-0.05	-0.03
	p													0.5607			0.7547	0.8657
TOC	r																0.15	0.15
	p																0.3359	0.3409
pH	r															0.07		
	p															0.6088		
SC_{ln+1}	r																	
	p																	
CL^{-1}_{ln+1}	r																	***0.98***
	p																	***<.0001***

Table 5-7 Regression matrix of r- and p-values from Pearson correlation analyses of 18 water quality parameters from ALUAA grab sample data, 2010 – 2011. Moderate and strong r-values are bold and red, respectively. Significant and strongly significant *p*-values are highlighted and bold, respectively. The *n* for each regression pair ranged 30 – 40.

	DO	DO%sat	T	Chl-a	Pheo-a	TP	PO_4-P	TN	TON	Sec_z	TDS	TSS	VSS	TOC	pH	SC_{ln+1}	CL^{-1}_{ln+1}	$SO_4^{-2}{}_{ln+1}$
DO	r	**0.98**	-0.30	-0.33	-0.23	-0.05	0.04	-0.17	-0.45		0.35	-0.21	-0.29	-0.45	0.49	0.36	0.44	0.39
	p	**<.0001**	0.0632	0.0375	0.1559	0.7378	0.8214	0.3045	0.0035		0.0254	0.2025	0.0664	0.0128	0.0015	0.0235	0.0088	0.0219
DO%sat	r		-0.10	-0.36	-0.26	-0.10	-0.01	-0.24	-0.46		0.35	-0.19	-0.29	-0.45	0.49	0.37	0.43	0.38
	p		0.5445	0.0223	0.1106	0.5378	0.9580	0.1341	0.0026		0.0261	0.2291	0.0736	0.0117	0.0014	0.0174	0.0096	0.0262
T	r			-0.06	-0.18	-0.26	-0.27	-0.28	0.08		-0.09	0.04	0.07	0.10	-0.15	-0.02	-0.15	-0.15
	p			0.7072	0.2634	0.1053	0.0981	0.0763	0.6106		0.5760	0.8299	0.6789	0.5889	0.3502	0.8828	0.3891	0.4044
Chl-a	r				0.55	0.23	0.14	0.38	0.51		-0.08	0.14	0.31	0.33	0.06	-0.27	-0.28	-0.48
	p				**0.0002**	0.1445	0.3889	0.0150	**0.0007**		0.6084	0.3921	0.0484	0.0774	0.7204	0.0874	0.0973	0.0035
Pheo-a	r					0.23	0.10	0.18	0.34		0.28	0.59	**0.64**	0.33	0.31	0.10	0.07	-0.19
	p					0.1471	0.5373	0.2661	0.0299		0.0752	**<.0001**	**<.0001**	0.0772	0.0486	0.5199	0.6805	0.2788
TP	r						**0.98**	**0.71**	-0.18		-0.05	-0.11	-0.08	-0.22	0.05	-0.01	0.07	0.06
	p						**<.0001**	**<.0001**	0.2719		0.7609	0.5002	0.6293	0.2488	0.7713	0.9556	0.7070	0.7534
PO_4-P	r							**0.66**	-0.31		-0.06	-0.21	-0.20	-0.34	0.02	0.03	0.11	0.14
	p							**<.0001**	0.0552		0.7329	0.1866	0.2176	0.0627	0.9154	0.8614	0.5167	0.4113
TN	r								0.25		-0.29	-0.05	0.07	-0.01	-0.20	-0.34	-0.30	-0.24
	p								0.1238		0.0694	0.7778	0.6647	0.9480	0.2062	0.0317	0.0802	0.1631
TON	r										-0.29	0.41	0.56	**0.81**	-0.08	**-0.60**	**-0.64**	**-0.81**
	p										0.0719	0.0092	**0.0002**	**<.0001**	0.6389	**<.0001**	**<.0001**	**<.0001**
Sec_z	r																	
	p																	
TDS	r											-0.08	-0.12	-0.12	**0.71**	**0.89**	**0.85**	0.50
	p											0.6337	0.4604	0.5137	**<.0001**	**<.0001**	**<.0001**	0.0020
TSS	r												**0.94**	0.33	0.06	-0.18	-0.15	-0.23
	p												**<.0001**	0.0791	0.7339	0.2800	0.3871	0.1803
VSS	r													0.44	-0.01	-0.27	-0.25	-0.35
	p													0.0138	0.9644	0.0973	0.1513	0.0396
TOC	r														0.15	-0.40	-0.51	**-0.78**
	p														0.4369	0.0302	0.0039	**<.0001**
pH	r															0.52	0.50	0.06
	p															**0.0006**	0.0021	0.7270
SC_{ln+1}	r																**0.97**	**0.77**
	p																**<.0001**	**<.0001**
CL^{-1}_{ln+1}	r																	**0.85**
	p																	**<.0001**

Screening Level Analysis of Current and Historical Data

Another analysis of water quality data was performed to compare measured concentrations of nutrients and Chl-a from ALUAA and historical surveys against screening levels. The 2010 Guidance for Assessing and Reporting Surface Water Quality in Texas (TCEQ, 2010a) lists screening levels for Chl-a, TP, PO_4-P, NO_3-N, and NH_3-N (numeric values in the header row of Tables 5-8 and 5-9). These screening levels were statistically derived by TCEQ from SWQM monitoring data for the entire state and represent the 85th percentile values for each parameter in various types of water bodies (e.g., freshwater streams and reservoirs). Under TCEQ's biennial assessment of the State's water bodies, a *concern* for water quality is identified if a screening level is exceeded greater than 20% of the time using the binomial method, based on the number of exceedences for a given sample size (TCEQ, 2010a). According to the binomial method for 10 samples, the water body has a water quality concern if 4 or more (i.e., 60^{th} percentile of the sample population) of the samples exceed the relevant screening level. The 50^{th} and 75^{th} percentiles of the datasets below along with the screening levels for freshwater streams are listed in Tables 5-8 and 5-9 and displayed graphically in Figures 5-14 – 5-23 simply as points of reference to demonstrate the frequency with which values in the Atascosa River exceeded the screening levels. It is not, however, the purpose of this report to consider whether the Atascosa River should be designated as a water body of concern for nutrients.

Chl-a values were well above the screening level of 14.1 µg/L at every station during 2010 – 2011 except 20764 and 17900, both in AU2107_02 (Figure 5-14; Table 5-8). TP and PO_4-P only exceeded screening levels consistently at Stations 17900 and 20762 (Figures 5-15 – 5-16). NO_2+NO_3-N was also strongly elevated at Station 17900 and moderately high at Station 20762 (Figure 5-17). Elevated nutrients at these two Stations are likely attributable to their locations below WWTF outfalls (Station 17900 is below the City of Pleasanton WWTF and Station 20762 is below the City of Poteet WWTF; Figure 2-5). NH_3-N was only slightly elevated at Station 20760 in the upper watershed but this is based on only two samples (Figure 5-18).

Historical nutrient and Chl-a data from 2000 – 2009 was spatially limited to the three downstream AUs. Chl-a values were elevated only at Stations 12980 (AU2107_01) 12982 (AU2107_03) but the values were less than have the magnitude of the Chl-a recorded in those AUs in the recent ALUAA survey (Figure 5-19; Table 5-9). The only nutrient that consistently exceeded screening levels was NO_2+NO_3-N at Station 17900, yet these values were also less than half the NO_2+NO_3-N values of the ALUAA survey (Figure 5-22).

The Chl-a values are surprisingly low at Station 17900 given the nutrient availability. The low Chl-a concentrations probably result from the dense canopy of the station limiting sunlight to the streambed (*see* Tables 4-4 – 4-6 for habitat assessment data) and insufficient travel time from the WWTF outfall to allow growth of phytoplankton to high concentrations. Deep pools mostly exposed to sunlight were present at Station 20773 (AU2701_01) and immediately upstream of the sampling reach at Station 20762 (AU2701_03) and these habitat factors likely supported heightened Chl-a values at those stations (see *Monitoring Locations and Station Descriptions* in Chapter 3 of this report).

Table 5-8 Nutrient and Chl-a screening levels for freshwater streams and the 50th and 75th percentile values from ALUAA data, 2010 – 2011. Values in exceedence of the screening levels are bold. Screening levels are listed below their respective parameter.

AU	Station	Percentile	*n*	Chl-a (µg/L) 14.1	*n*	TP (mg/L) 0.69	*n*	PO_4-P (mg/L) 0.37	*n*	NO_2+NO_3-N (mg/L) 1.95	*n*	NH_3-N (mg/L) 0.33
2107_01	**20773**	75%ile	10	***32.2***	10	0.62	10	0.34	10	0.24	10	0.14
		50%ile		***17.0***		0.38		0.27		0.03		0.05
	12980	75%ile	10	***61.4***	10	0.66	10	0.31	10	0.25	10	0.05
		50%ile		***88.7***		0.69		0.29		0.16		0.05
2107_02	**20764**	75%ile	7	14.0	7	0.62	7	0.32	7	0.32	7	0.12
		50%ile		6.1		0.40		0.29		0.18		0.05
	17900	75%ile	10	2.8	10	***3.64***	10	***3.40***	10	***15.55***	10	0.09
		50%ile		1.5		***2.84***		***2.67***		***4.26***		0.05
2107_03	**20762**	75%ile	10	***79.5***	10	***1.70***	10	***1.43***	10	1.48	10	0.05
		50%ile		***36.7***		***0.81***		***0.61***		0.18		0.05
	20761	75%ile	2	***52.2***	2	0.23	2	0.10	2	0.28	2	0.23
		50%ile		***36.9***		0.21		0.09		0.20		0.19
2107_04	**20760**	75%ile	2	***170.0***	2	0.55	2	0.21	2	0.03	2	0.35
		50%ile		***123.0***		0.50		0.18		0.03		0.33

[a] Screening level is for NO_3-N

Table 5-9 Nutrient and Chl-a screening levels for freshwater streams and the 50th and 75th percentile values from select historical data, 2000 – 2009 in the Atascosa River. Values in exceedence of the screening levels are bold. Screening levels are listed below their respective parameter.

AU	Station	Percentile	*n*	Chl-a (µg/L) 14.1	*n*	TP (mg/L) 0.69	*n*	PO_4-P (mg/L) 0.37	*n*	NO_2+NO_3-N (mg/L) 1.95	*n*	NH_3-N (mg/L) 0.33
2107_01	**12980**	75%ile	38	***17.8***	44	0.47	27	0.23	44	0.31	27	0.23
		50%ile		9.4		0.33		0.20		0.12		0.20
2107_02	**17899**	75%ile	16	1.0	8	0.43	11	0.27	13	1.78	11	0.27
		50%ile		0.2		0.30		0.14		1.62		0.14
	17900	75%ile	12	0.3	5	***0.96***	7	0.29	9	***4.30***	7	0.29
		50%ile		0.2		0.49		0.22		***2.68***		0.22
2107_03	**17898**	75%ile	15	4.9	10	0.16	12	0.09	12	0.31	12	0.09
		50%ile		0.2		0.12		0.06		0.05		0.06
	12982	75%ile	33	***25.1***	36	0.22	36	0.08	9	0.27	36	0.08
		50%ile		***20.5***		0.13		0.04		0.05		0.04

[a] Screening level is for NO_3-N

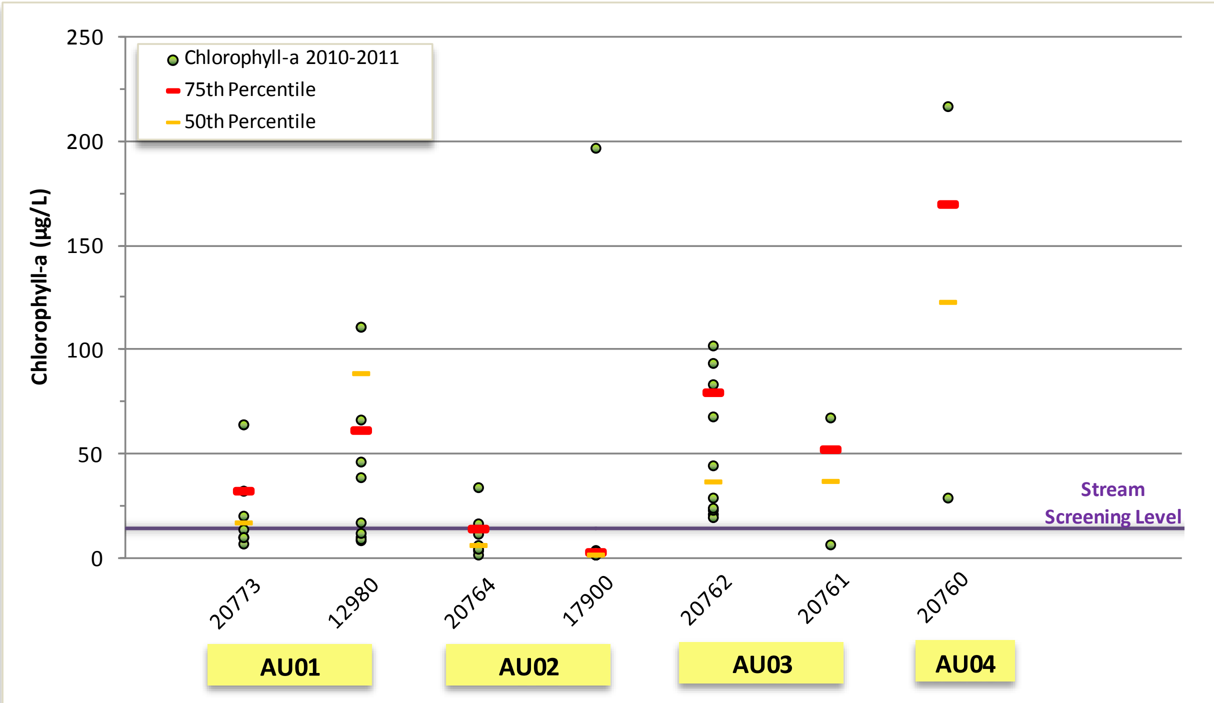

Figure 5-14 Chl-a from ALUAA project data 2010 - 2011, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

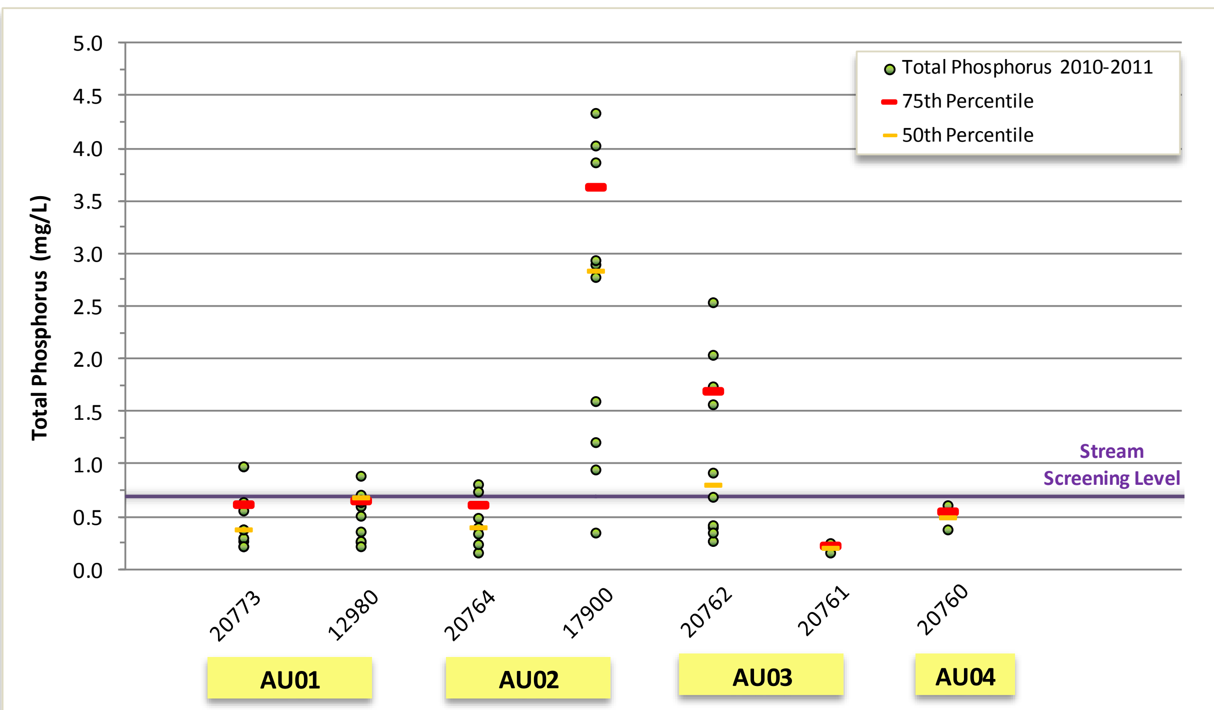

Figure 5-15 TP from ALUAA project data, 2010 - 2011, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

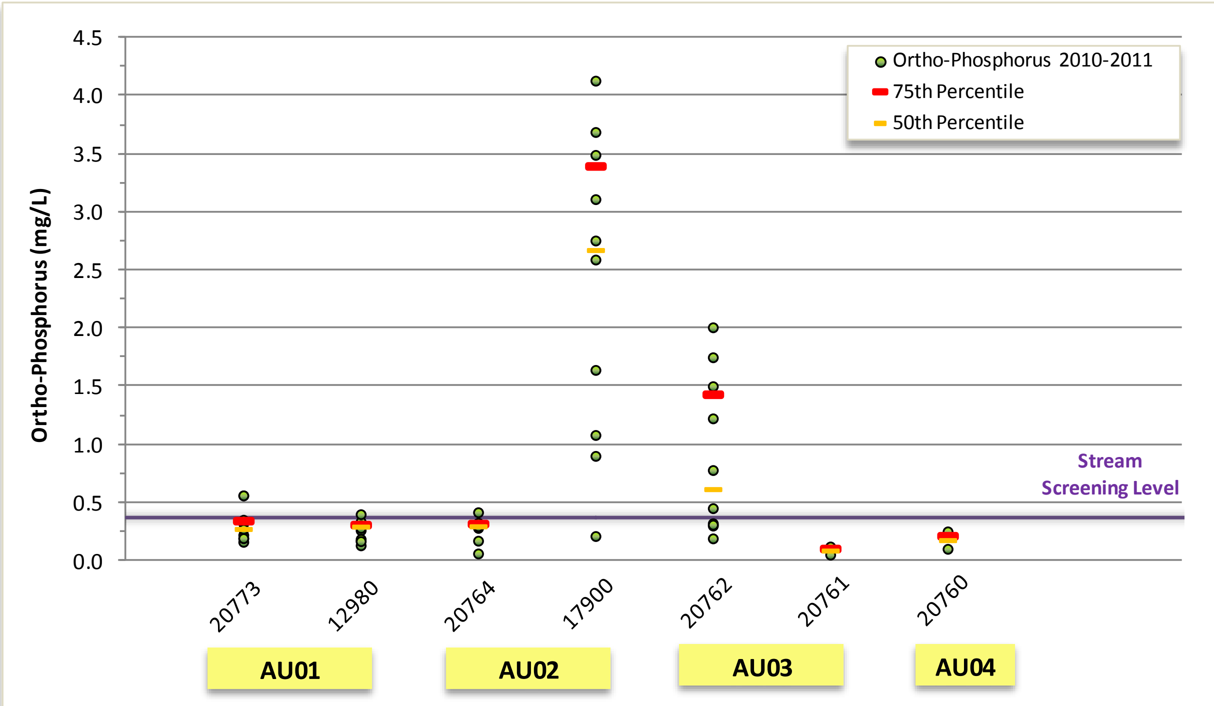

Figure 5-16 PO_4-P from ALUAA project data, 2010 - 2011, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

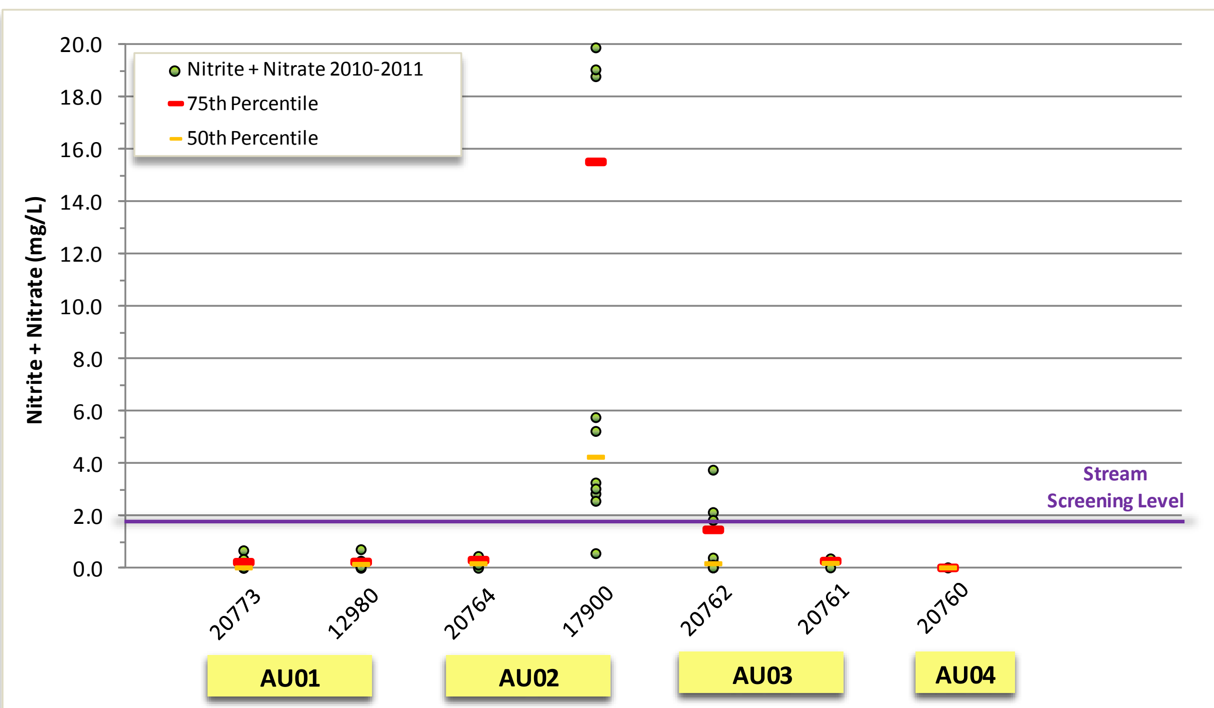

Figure 5-17 NO_2+NO_3-N from ALUAA project data, 2010 - 2011, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

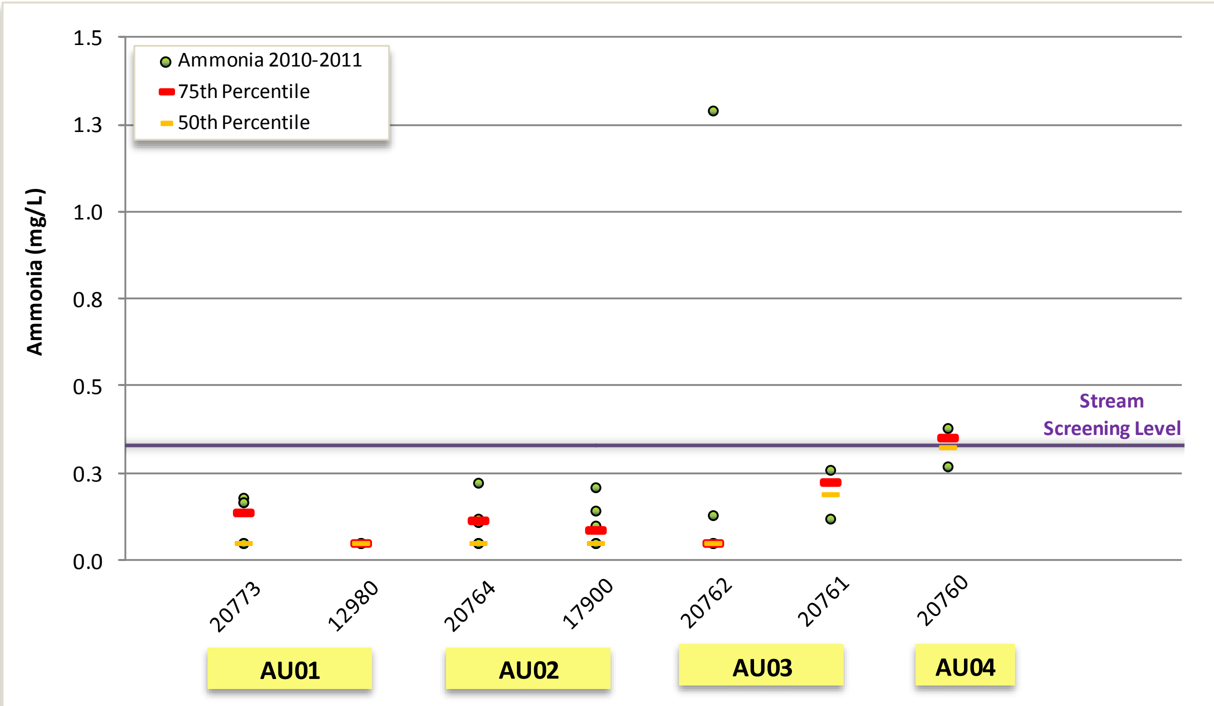

Figure 5-18 NH_3-N from ALUAA project data, 2010 - 2011, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

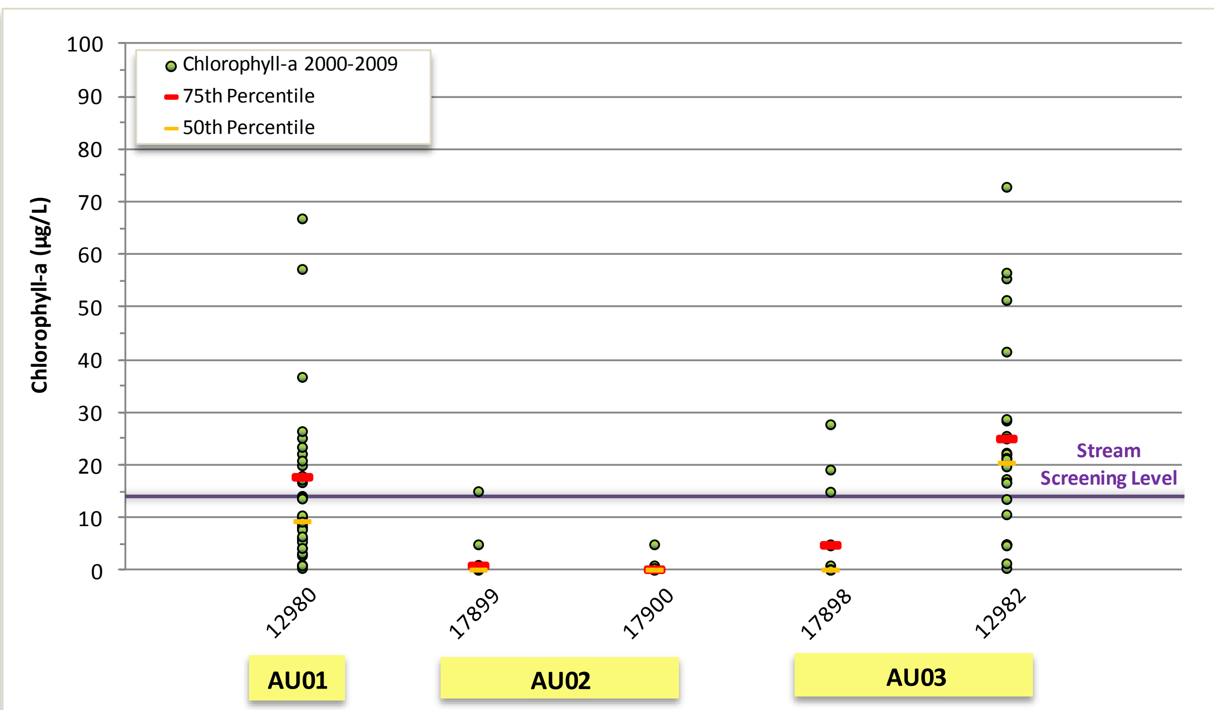

Figure 5-19 Chl-a from select historical data, 2000 - 2009, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

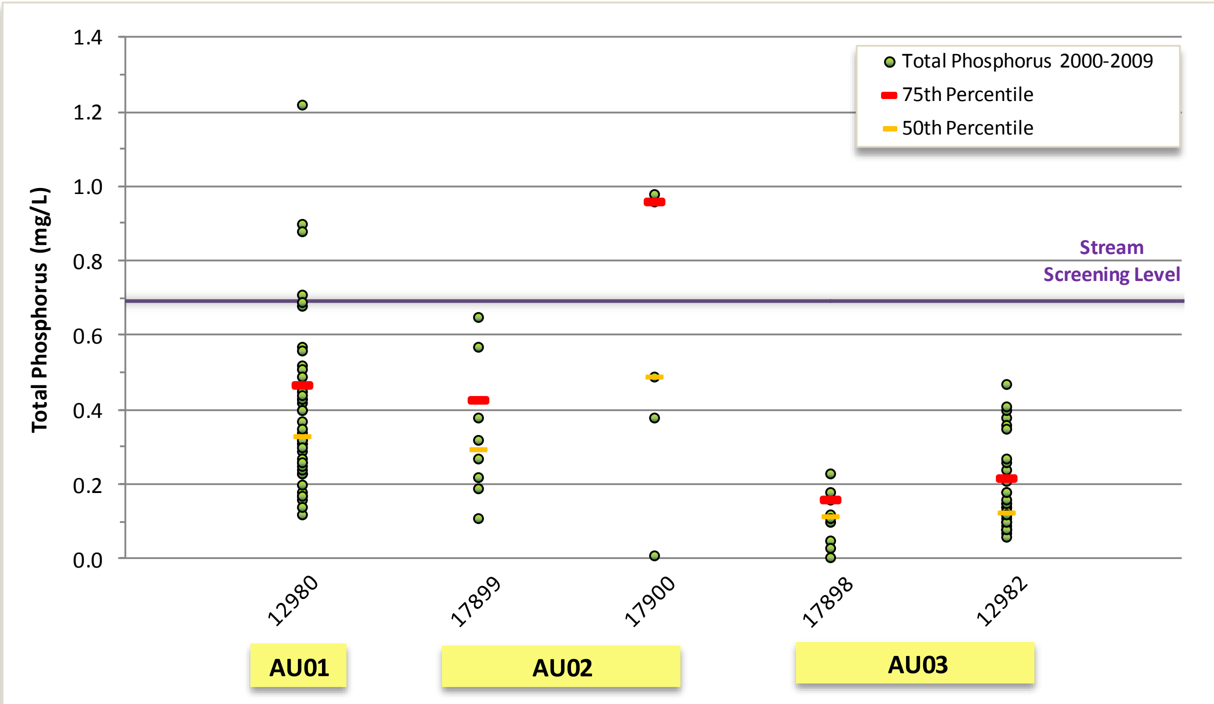

Figure 5-20 TP from select historical data, 2000 - 2009, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

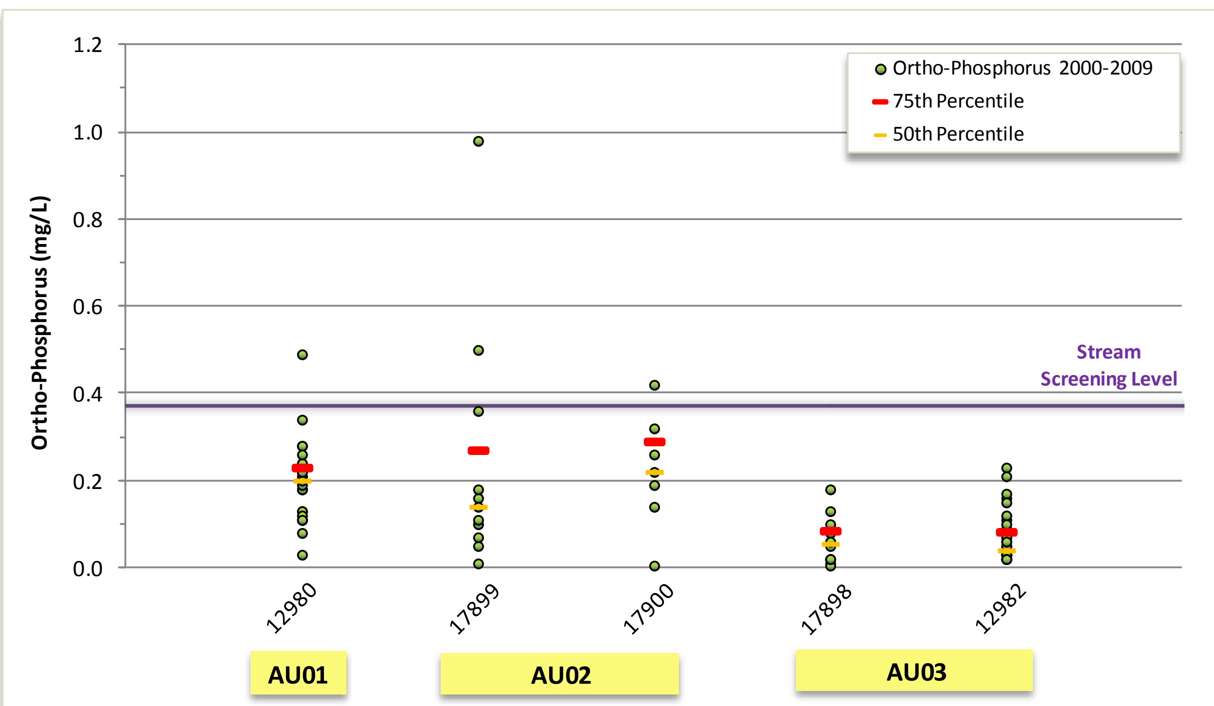

Figure 5-21 PO_4-P from select historical data, 2000 - 2009, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

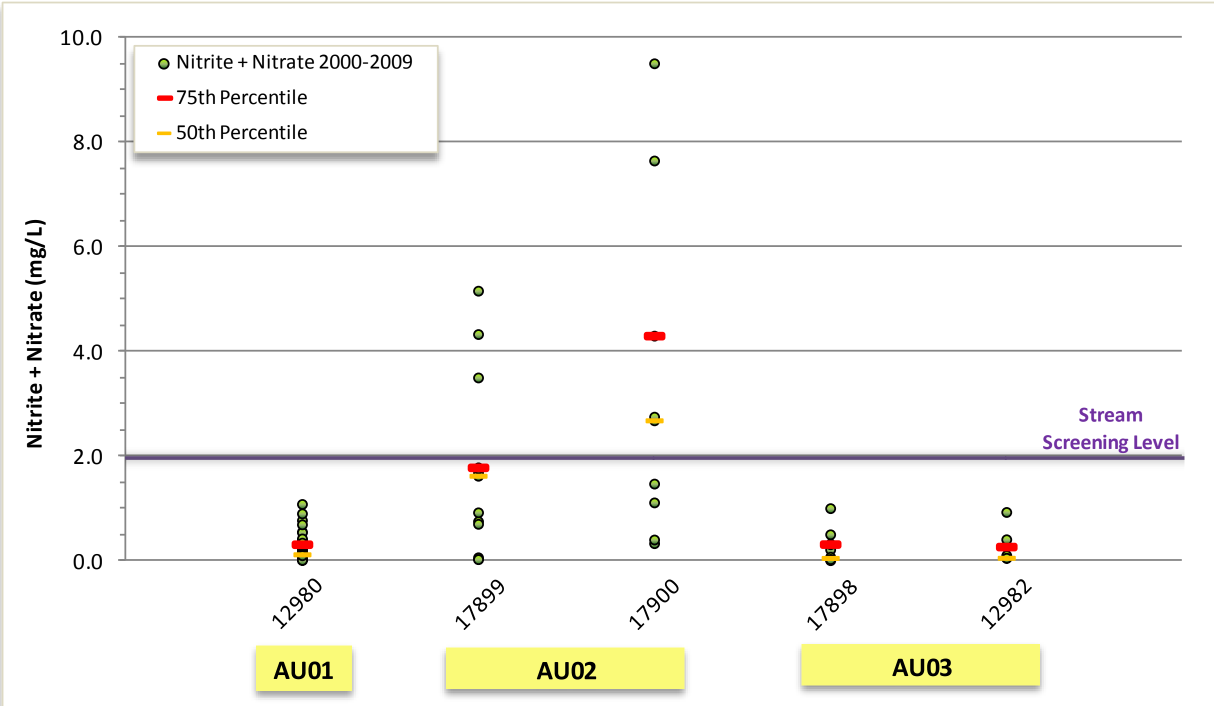

Figure 5-22 NO_2+NO_3-N from select historical data, 2000 - 2009, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

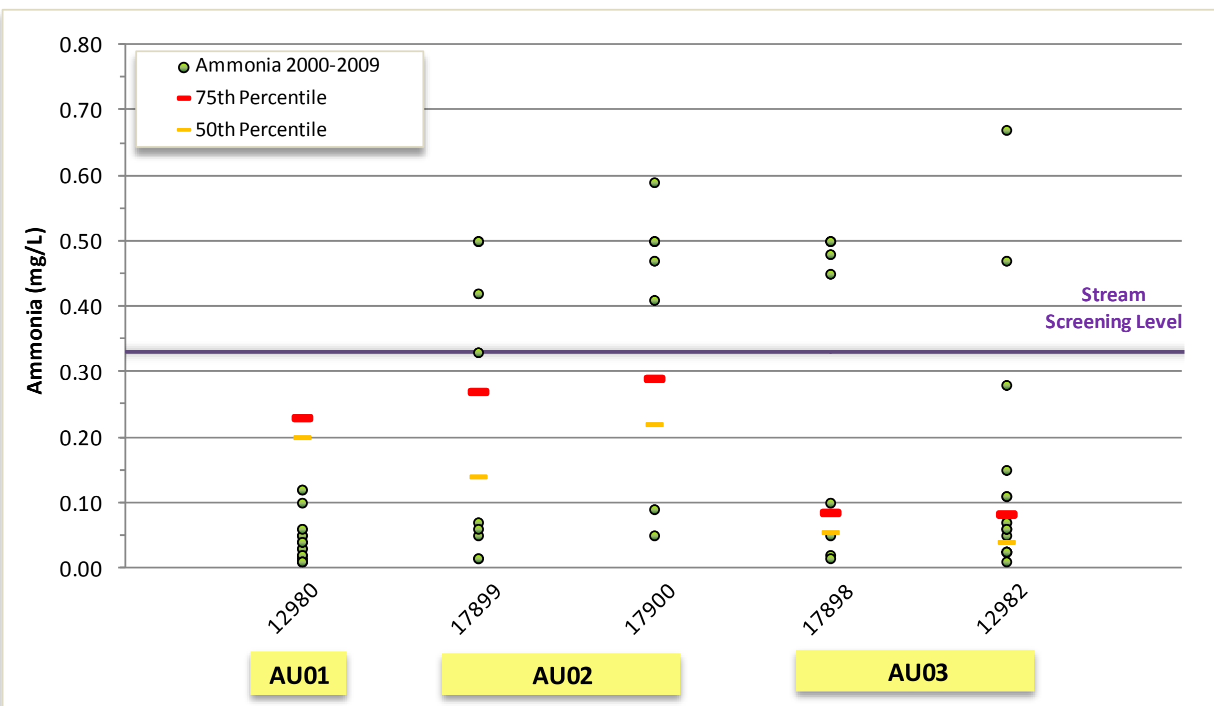

Figure 5-23 NH_3-N from select historical data, 2000 - 2009, screening levels, and 50th and 75th percentile marks for stations in the Atascosa River

Diel Surveys with Current and Antecedent Hydrology

Diel data exists for the ALUAA project from 2010 – 2011 at Stations 20773 and 12980 in AU2107_01, 10764 and 17900 in AU2107_02, 20762, 20761, and 20760 in AU2107_03, and Station 17142 in AU2107_04. Diel data are represented in the Ecomm data by four stations covering 2002 – 2004. They are Station 12980 in AU2107_01, Stations 17899 and 17900 in AU2107_02, and Station 17898 in AU2107_03. Thus, all but Station 12980 in the Ecomm study were located in and around Pleasanton, TX. When diel DO results are laid over hydrographs from USGS gages 08208000 and 08207500 it is possible to analyze diel DO in the context of coincident and antecedent hydrology. In the lower two AUs of the ALUAA survey, diel DO minimum values dropped below the criteria of 3.0 mg/L when flows were most depressed throughout the watershed during summer 2011 (Figure 5-24). In contrast, low diel DO averages occurred during periods of both high and low flows (Figure 5-25). In the upper half of the watershed only Station 20762 (AU2107_03) had enough readings to show a pattern that both diel DO minimums and averages dropped as flows diminished, at least according to the hydrograph of USGS 08207500 (Figures 5-26 – 5-27). Although this gage is located in a stretch of the river that is impacted by the Pleasanton WWTF discharges, it is an indicator of the general wetness or dryness of the upper watershed. The diel DO values at Stations 20761 (AU2107_03), 20760 (AU2107_03), and 17142 (AU2107_04) were well below the criteria. According to landowners and TIAER field staff these locations are best described as ephemeral, containing water only after significant rain events. Rain had indeed fallen within two weeks of the March 2010 survey, and Tropical Storm Hermine dropped > 6 in. of rain in the northwestern portion of the watershed prior to the September 2010 survey. Yet in both instances flows rapidly diminished to nearly nothing in AU2107_04 by the time probes were deployed. Thus, low DO values are a reflection of negligible flow and pooled conditions at these stations. Flows prior to and during the Ecomm study in 2002 – 2004 were generally higher than in 2010 – 2011 and there were more frequent precipitation events (Figures 5-28 – 5-29). Patterns in diel DO are not evident in the Ecomm graphs except that DO values were higher during winter and spring samples independent of hydrology. This is to be expected given cooler temperatures from October – April.

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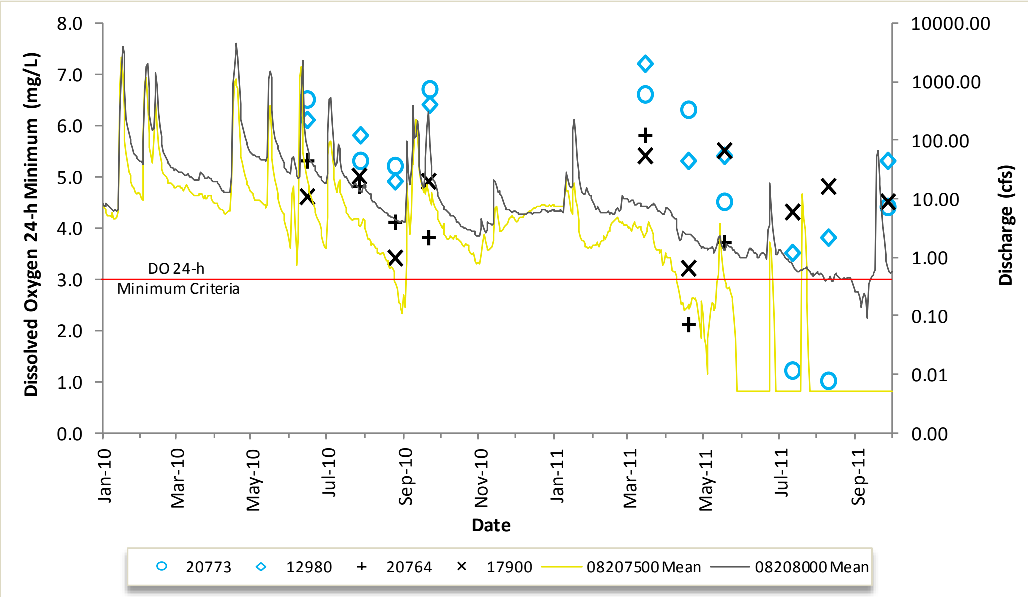

Figure 5-24 24-hr DO minimums from ALUAA data for AUs 2701_01 (blue) and 2701_02 (black) and hydrographs of daily mean discharge at USGS gages 08207500 and 08208000. Station 12980 is collocated with USGS gage 08208000 and Station 20674 is collocated with USGS 08207500. Red horizontal line represents the minimum 24-h DO criterion for high aquatic life use

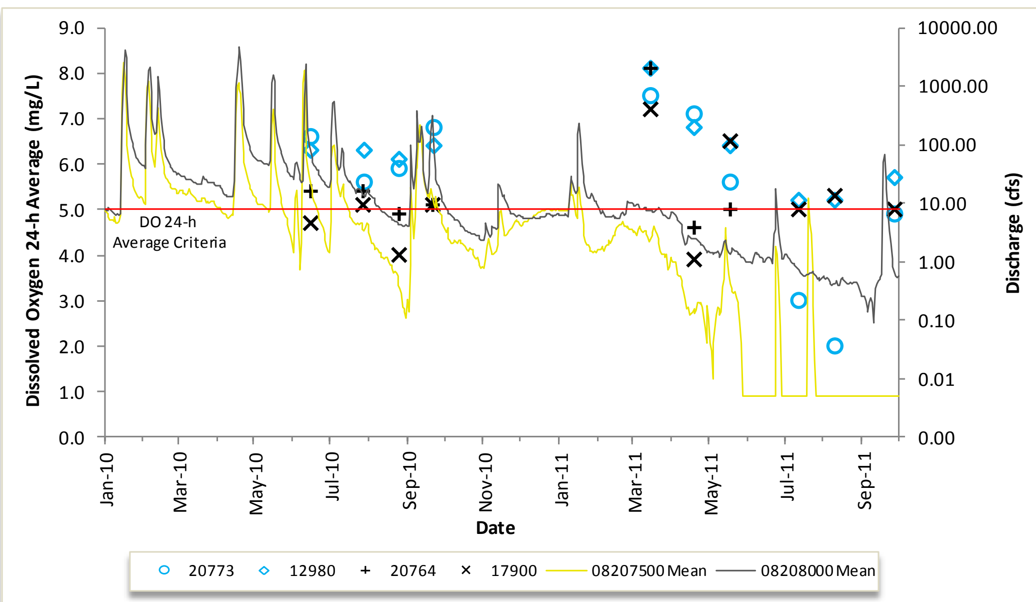

Figure 5-25 24-hr DO averages from ALUAA data for AUs 2701_01 (blue) and 2701_02 (black) and hydrographs of daily mean discharge at USGS gages 08207500 and 08208000. Station 12980 is collocated with USGS gage 08208000 and Station 20674 is collocated with USGS gage 08207500. Red horizontal line represents the average 24-h DO criterion for high aquatic life use.

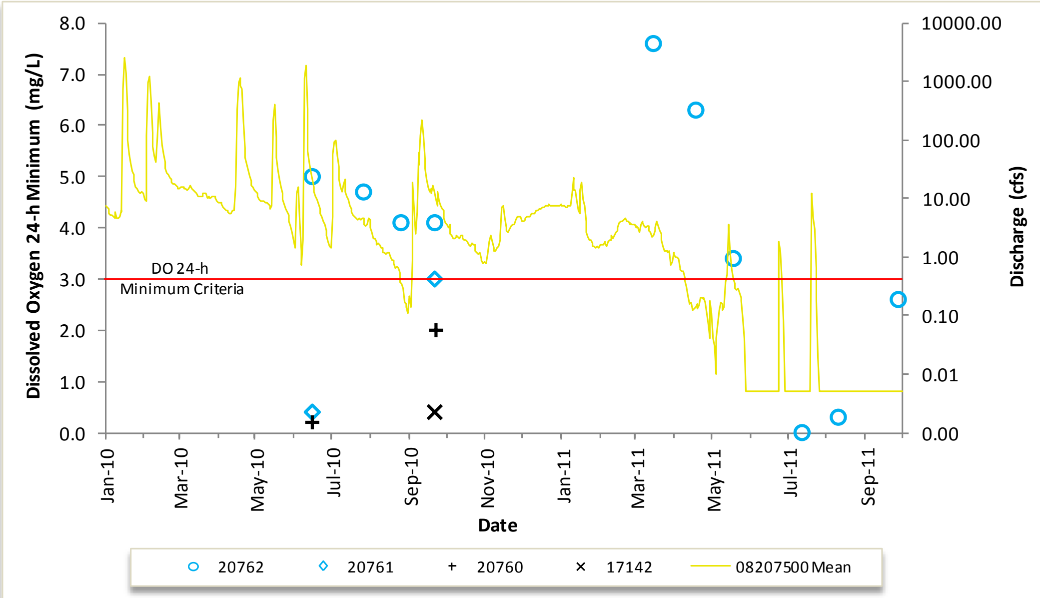

Figure 5-26 24-hr DO minimums from ALUAA data for AUs 2701_03 (blue) and 2701_04 (black) and hydrograph of daily mean discharge at USGS gage 08207500. Red horizontal line represents the minimum 24-h DO criterion for high aquatic life use.

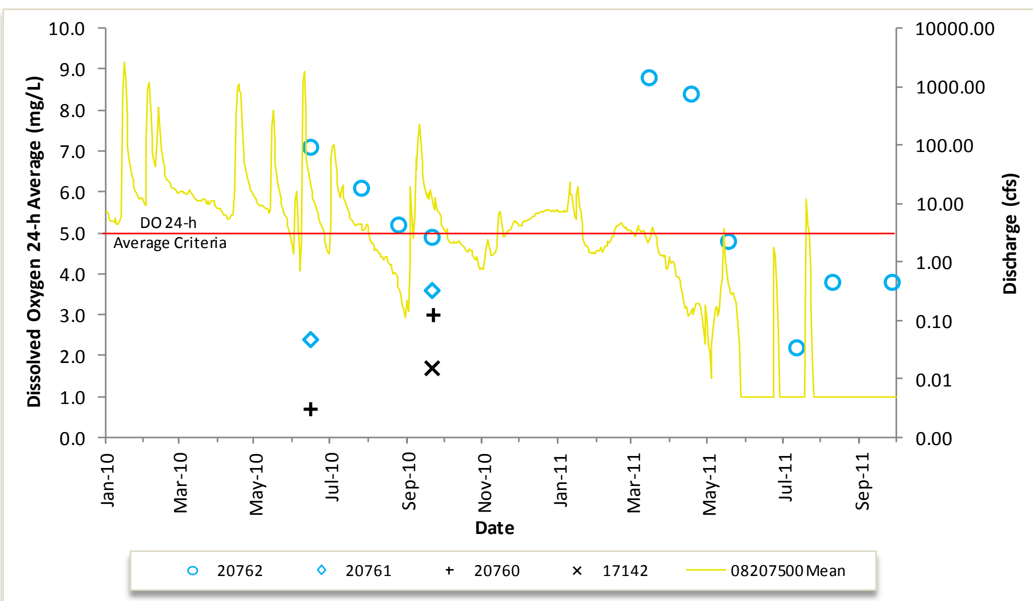

Figure 5-27 24-hr DO averages from ALUAA data for AUs 2701_03 (blue) and 2701_04 (black) and hydrograph of daily mean discharge at USGS gage 08207500. Red horizontal line represents the average 24-h DO criterion for high aquatic life use.

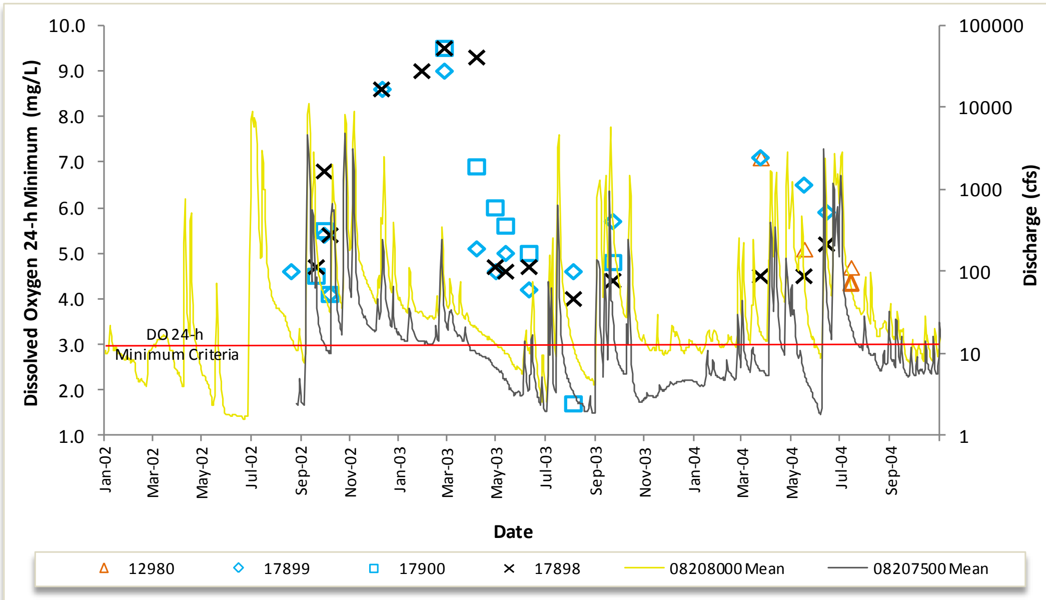

Figure 5-28 24-hr DO minimums from Ecomm data (2002 – 2004) for AUs 2701_01 (orange), 2701_02 (blue), and 2701_03 (black) and hydrograph of daily mean discharge at USGS gages 08207500 (black) and 08208000 (gold). Station 12980 is collocated with USGS gage 08208000. Red horizontal line represents the minimum 24-h DO criterion for high aquatic life use

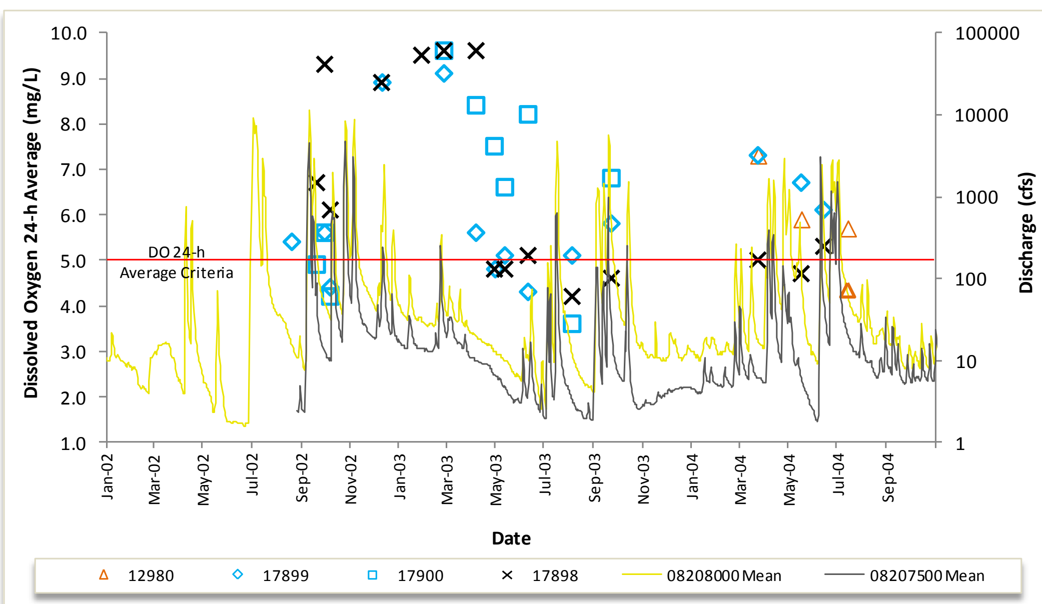

Figure 5-29 24-hr DO averages from Ecomm data (2002 – 2004) for AUs 2701_01 (orange), 2701_02 (blue), and 2701_03 (black) and hydrograph of daily mean discharge at USGS gages 08207500 (black) and 08208000 (gold). Station 12980 is collocated with USGS gage 08208000. Red horizontal line represents the average 24-h DO criterion for high aquatic life use.

Correlation Analysis of 24-hour DO from Diel Data

Pearson correlation analysis was used to explore the relationship of diel DO averages and minimums to Chl-a, Pheo-a, nutrients, and instantaneous flow (ln+1 transformed). ALUAA (2010 – 2011) and Ecomm (2002 – 2004) data from stations with robust diel data were used in the analysis (20773, 12980, 20764, 17899, 17900, 17898, and 20762). Three groupings of strong and significant correlations emerged (Table 5-10):

- Diel DO averages and minimums with Chl-a and Pheo-a at the two downstream Stations 20773 and 12980,
- Diel DO minimum with Chl-a, Pheo-a, and nutrients at the middle Station 20764,
- Diel DO averages and minimums with TP and PO_4-P at 17898 and 20762 above Pleasanton (AU2107_03).

The presence of deeper, sluggish runs and larger pools at Stations 20773 and 12980 in AU2107_01 are likely behind the correlations of diel DO with Chl-a and Pheo-a. Concentrations of Chl-a and Pheo-a were low at Station 20773 and high at Station 12980 relative to other stations in the watershed (Table 4-1) so the influence of these constituents on diel DO is not entirely dependent on their concentration. Deep pools and sluggish runs create an environment where diel patterns in DO are driven more by metabolic processes in phytoplankton than by physicochemical processes, such as, re-oxygenation through turbulence at the water-air interface. Concentrations of nutrients, Chl-a, and Pheo-a were also low to moderate at Station 20764 (relative to other Atascosa River stations) where diel DO minimums were strongly correlated with those constituents. Although Station 20764 had much less reliable flow than the AU2107_01 stations during the ALUAA survey, it was similar to them in this respect: sluggish runs and pools were common. Nutrients and concentrations of Chl-a and Pheo-a were also low to moderate at the AU2107_03 Stations 17898 and 20762. Unlike the correlations mentioned above, diel DO was not significantly correlated with Chl-a or Pheo-a, but only with TP and PO_4-P. Under anoxic conditions, sediment-bound phosphorus is released into the water column and this is likely the process behind the results for Station 20762 where diel DO minimums ranged 0.0 to 2.8 from July - September 2011 and TP and PO_4-P values more than doubled during that same period. This pattern is not true for the data from Station 17898 but only a few diel samples had TP or PO_4-P taken on the same day so the results may be corrupted somewhat by a low *n*.

Whatever response diel DO may have to hydrology in the Atascosa River, it is not stark or consistent across the watershed. The patterns are not clear when DO values are laid over hydrographs (Figures 5-22 – 5-27) nor did diel DO show significant correlations with instantaneous flow taken on-site during the days of the diel sampling events except at Station 12980 for 24-hr DO minimums (Table 5-10). These results suggest that the impacts of hydrology on DO are cloaked by the driving influence of photosynthesis and respiration processes.

Table 5-10 Correlation coefficients (r), significance (p), and *n* of selected parameters to 24-hour DO averages and minimums from diel samples for selected ALUAA (2010 – 2011) and Ecomm (2002 – 2004) stations. Moderate and strong r-values are bold and red, respectively. Highlighted *p*-values are significant (α = 0.05). Ecomm data is shaded.

AU	Station	DO		Chl-a (µg/L)	Pheo-a (µg/L)	TP (mg/L)	PO_4-P (mg/L)	TN (mg/L)	TON (mg/L)	Instant Flow[a]
2701_01	**20773**	24-h Avg	r	***-0.80***	***-0.73***	-0.28	-0.14	-0.28	-0.42	0.40
			p	0.006	0.016	0.434	0.691	0.435	0.228	0.254
			n	10	10	10	10	10	10	10
		24-h Min	r	***-0.86***	***-0.73***	-0.28	-0.18	-0.20	-0.36	0.50
			p	0.002	0.017	0.435	0.613	0.580	0.314	0.137
			n	10	10	10	10	10	10	10
	12980	24-h Avg	r	***-0.67***	-0.55	-0.59	-0.14	-0.54	-0.58	0.35
			p	0.034	0.096	0.075	0.697	0.110	0.078	0.320
			n	10	10	10	10	10	10	10
		24-h Min	r	***-0.86***	***-0.80***	-0.51	-0.14	-0.34	-0.46	***0.67***
			p	0.002	0.005	0.136	0.701	0.331	0.186	0.035
			n	10	10	10	10	10	10	10
2701_02	**20764**	24-h Avg	r	-0.34	-0.30	-0.34	-0.07	-0.39	-0.34	0.27
			p	0.460	0.511	0.449	0.882	0.389	0.454	0.565
			n	7	7	7	7	7	7	7
		24-h Min	r	***-0.82***	***-0.85***	***-0.86***	-0.51	***-0.87***	***-0.93***	0.51
			p	0.025	0.015	0.012	0.240	0.010	0.002	0.240
			n	7	7	7	7	7	7	7
	17899	24-h Avg	r	-0.05	-0.33	0.55	0.08	-0.04	0.21	0.13
			p	0.893	0.389	0.451	0.874	0.926	0.654	0.838
			n	9	9	4	6	7	7	5
		24-h Min	r	0.00	-0.35	***0.74***	0.15	-0.07	-0.15	0.45
			p	0.990	0.356	0.260	0.781	0.877	0.750	0.452
			n	9	9	4	6	7	7	5
	17900 Ecomm	24-h Avg	r	-0.47	-0.22	-0.10	0.22	***-0.64***	-0.29	-0.13
			p	0.168	0.545	0.869	0.639	0.123	0.528	0.810
			n	10	10	5	7	7	7	6
		24-h Min	r	-0.25	-0.23	-0.32	0.06	***-0.76***	-0.05	-0.18
			p	0.477	0.525	0.596	0.899	0.047	0.919	0.731
			n	10	10	5	7	7	7	6
	17900 ALUAA	24-h Avg	r	0.46	0.46	0.17	0.18	-0.03	0.06	-0.10
			p	0.176	0.182	0.692	0.672	0.932	0.861	0.791
			n	10	10	8	8	10	10	10
		24-h Min	r	0.44	0.43	-0.17	-0.16	-0.03	0.12	0.10
			p	0.206	0.211	0.686	0.697	0.944	0.736	0.782
			n	10	10	8	8	10	10	10
	17900 Ecomm & ALUAA	24-h Avg	r	0.08	-0.05	-0.25	-0.32	-0.29	-0.27	0.14
			p	0.745	0.850	0.413	0.252	0.259	0.286	0.617
			n	20	20	13	15	17	17	16
		24-h Min	r	0.08	-0.05	-0.32	-0.35	-0.22	-0.01	0.24
			p	0.753	0.847	0.280	0.199	0.406	0.973	0.362
			n	20	20	13	15	17	17	16

[a] Log-transformed (ln+1) instantaneous flow

Table 5-10 *Cont.*

AU	Station	DO		Chl-a (µg/L)	Pheo-a (µg/L)	TP (mg/L)	PO_4-P (mg/L)	TN (mg/L)	TON (mg/L)	Instant Flow[a]
2701_03	**17898**	24-h Avg	r	-0.35	-0.34	***-0.93***	***-0.83***	0.10	0.24	0.50
			p	0.271	0.277	0.003	0.006	0.820	0.536	0.171
			n	12	12	7	9	8	9	9
		24-h Min	r	-0.30	-0.40	***-0.82***	***-0.73***	-0.07	-0.03	0.58
			p	0.336	0.197	0.025	0.026	0.861	0.936	0.102
			n	12	12	7	9	8	9	9
	20762	24-h Avg	r	-0.07	***-0.61***	***-0.76***	***-0.72***	0.40	-0.29	0.18
			p	0.846	0.063	0.011	0.020	0.249	0.423	0.676
			n	10	10	10	10	10	10	8
		24-h Min	r	-0.22	***-0.62***	***-0.84***	***-0.82***	0.39	-0.27	0.25
			p	0.534	0.058	0.002	0.004	0.260	0.444	0.544
			n	10	10	10	10	10	10	8

[a] Log-transformed (ln+1) instantaneous flow

Biological Surveys

Nekton Analysis

Besides the ALUAA surveys, there are three historical nekton surveys in the Atascosa River watershed from the Ecomm study during 2002 – 2003 (Ecomm, 2005). Fish were collected by electrofishing and seine in August 2002, April 2003, and September 2003 as part of an impairment verification project contracted by the TCEQ.

The only station shared between this ALUAA project and Ecomm surveys was 17900. In the following analysis of historical data current nekton data from Station 17900 is included for comparison. Station 17898 was located in Pleasanton just downstream of Hunt Rd. and Station 17899 was located at the Leal Rd. crossing southeast of Pleasanton approximately 13 km (Figure 5-1). To enable appropriate comparisons, the raw sample data from Ecomm was processed in the current nekton metric spreadsheets used for the ALUAA project and approved by the TCEQ for determining ALU scores and ratings. Overall, scores were slightly lower in the ALUAA study than in the Ecomm survey but still maintained intermediate to marginally high ratings (Tables 5-11 [Ecoregion 31] and 5-12 [Ecoregion 33]). The percentage of the fish population at Station 17900 as pollution-tolerant individuals increased somewhat during the ALUAA project, ranging 40.4% – 66.7% compared to the Ecomm survey when they ranged only 36.2 – 36.6%. Increases in tolerant fish can indicate decreases in habitat or water quality such that species with narrow tolerances of impairment have difficulty maintaining their populations. The number of fish captured per unit of seine and electroshocking effort decreased dramatically—more than 50%—between the two surveys. Small discrepancies are expected among different field crews, but such a striking drop in fish numbers cannot be explained simply by changes in field personnel alone. All sampling in both surveys occurred between April and September, so season is not a likely explanation. The hydrograph of USGS gage 08208000 (Atascosa River near Whitsett; Figure 2-8) shows relatively stable flows for several years prior to the surveys of 2002 – 2003. In contrast, 2009 was a year of extremely low flows such that the gage at Whitsett indicated no flow for a brief period and USGS gage 08207500 near McCoy (several miles below Station 17900) went dry for many weeks (Figure 2-6).

Table 5-11 IBI metrics (Ecoregion 31) for Ecomm (2002 – 2003) and Station 17900 from the ALUAA study data (2010 – 2011). Station 17900 is the only station shared between the surveys.

ECOREGION 31	**17899**	**17899**	**17899**	**17898**	**17898**	**17898**
Parameter	21-Aug-02	8-Apr-03	24-Sep-03	19-Aug-02	7-Apr-03	25-Sep-03
# Fish Species	16	9	10	15	17	12
# Native Cyprinid Species	4	2	2	2	3	3
# Benthic Species[a]	2	0	1	2	2	2
# Sunfish Species	6	4	3	5	7	3
% Tolerant Species[b]	29.1	37.7	16.8	45.8	72.7	17.6
% Omnivores	9.3	1.9	11.1	10.2	0.7	8.8
% Invertivores	85.0	94.3	87.7	82.5	94.7	89.7
% Piscivores	5.7	3.8	1.2	7.3	4.6	1.4
# / Seine haul	22.3	5.8	26.0	21.0	91.3	44.3
# / Min Electrofishing	6.2	1.2	5.9	3.4	11.0	29.3
% Non-native Species	0.9	0.0	0.0	2.3	0.3	0.0
% With Disease/Anomaly	0.0	0.0	0.0	0.0	0.0	0.0
Score	**43**	**33**	**35**	**38**	**45**	**41**
Rating	**Excep.**	**Inter.**	**Inter.**	**High**	**Excep.**	**High**

ECOREGION 31	**17900**	**17900**	**17900**	**17900**	**17900**	**17900**
Parameter	20-Aug-02	8-Apr-03	24-Sep-03	27-Jul-10	20-Apr-11	13-Jul-11
# Fish Species	12	11	11	7	13	11
# Native Cyprinid Species	2	3	2	1	2	1
# Benthic Species[a]	1	1	0	0	2	1
# Sunfish Species	5	5	5	4	5	5
% Tolerant Species[b]	36.2	42.9	36.6	66.7	63.9	40.4
% Omnivores	11.6	1.8	14.8	0.0	6.6	6.4
% Invertivores	85.5	75.0	75.4	91.1	60.7	80.9
% Piscivores	2.9	21.4	9.9	8.9	32.8	12.8
# / Seine haul	14.5	5.5	7.7	3.5	2.1	1.8
# / Min Electrofishing	3.4	1.5	6.4	1.3	1.9	1.7
% Non-native Species	2.2	0.0	1.4	0.0	3.3	0.0
% With Disease/Anomaly	0.0	0.0	0.0	0.0	0.0	0.0
Score	**31**	**41**	**36**	**31**	**33**	**39**
Rating	**Inter.**	**High**	**Inter.**	**Inter.**	**Inter.**	**High**

[a] Catfish, suckers, darters

[b] Excluding western mosquitofish (*Gambusia affinis*)

Table 5-12 IBI metrics (Ecoregion 33) for Ecomm (2002 – 2003) and Station 17900 from the ALUAA study data (2010 – 2011). Station 17900 is the only station shared between the surveys.

ECOREGION 33	**17899**	**17899**	**17899**	**17898**	**17898**	**17898**
Parameter	21-Aug-02	8-Apr-03	24-Sep-03	19-Aug-02	7-Apr-03	25-Sep-03
# Fish Species	16	9	10	15	17	12
# Native Cyprinid Species	4	2	2	2	3	3
# Benthic Invertivore Species	0	0	0	0	1	0
# Sunfish Species	6	4	3	5	7	3
# Intolerant Species	0	0	0	0	0	0
% Tolerant Species[a]	29.1	37.7	16.7	45.8	72.7	17.6
% Omnivores	9.3	1.9	11.0	10.2	0.7	8.8
% Invertivores	85.0	94.3	87.8	82.5	94.7	89.7
% Piscivores	5.7	3.8	1.2	7.3	4.6	1.4
# / Seine haul	22.3	5.8	26.0	21.0	91.3	44.3
# / Min Electrofishing	6.2	1.2	5.9	3.4	11.0	29.3
% Non-native Species	0.9	0.0	0.0	2.3	0.3	0.0
% With Disease/Anomaly	0.0	0.0	0.0	0.0	0.0	0.0
Score	**40**	**34**	**36**	**37**	**42**	**40**
Rating	**Inter.**	**Limited**	**Inter.**	**Inter.**	**High**	**Inter.**

ECOREGION 33	**17900**	**17900**	**17900**	**17900**	**17900**	**17900**
Parameter	20-Aug-02	8-Apr-03	24-Sep-03	27-Jul-10	20-Apr-11	13-Jul-11
# Fish Species	12	11	11	7	13	11
# Native Cyprinid Species	2	3	2	1	2	1
# Benthic Invertivore Species	0	0	0	0	0	1
# Sunfish Species	5	5	5	4	5	5
# Intolerant Species	0	0	0	0	0	0
% Tolerant Species[a]	36.2	42.9	36.6	66.7	63.9	40.4
% Omnivores	11.6	1.8	14.8	0.0	6.6	6.4
% Invertivores	85.5	75.0	75.4	91.1	60.7	80.9
% Piscivores	2.9	21.4	9.9	8.9	32.8	12.8
# / Seine haul	14.5	5.5	7.7	3.5	2.1	1.6
# / Min Electrofishing	3.4	1.5	6.4	1.3	1.9	1.5
% Non-native Species	2.2	0.0	1.4	0.0	3.3	0.0
% With Disease/Anomaly	1.4	0.0	0.0	0.0	0.0	0.0
Score	**31**	**42**	**39**	**32**	**34**	**40**
Rating	**Limited**	**High**	**Inter.**	**Limited**	**Limited**	**Inter.**

[a] Excluding western mosquitofish (*Gambusia affinis*)

Although flows recovered somewhat in 2010, drought in 2011 reduced many portions of the Atascosa River to dry riverbed or baseflow levels. Invertebrates, with their short life spans, are more resilient to such harsh hydrology, but fish are entirely dependent on water availability and can suffer deleterious impacts from drought. Thus, interrupted flow during and immediately preceding the 2010 – 2011 nekton surveys may be to blame for lower numbers of fish captured with seines and electroshocking. Field staff also noted an increase in turbidity and siltation at Stations 20773 and 12980 since previous studies in 2006 – 2009. Attempts to identify the sources of this turbidity and siltation were unsuccessful. The impact of siltation on fish communities can be significant as it reduces the relative percentage of coarse substrate and buries instream cover for fish that are dependent on cover for predator avoidance.

Invertivores and piscivores were strongly dominant in the ALUAA study and herbivores were never collected (Appendix E). The same population structure was in place during the Ecomm survey. These observations are not surprising given the lack of habitat available for the establishment of plant and algae communities. Dense canopy cover limits sunlight radiation to the streambed and sandy substrates do not provide good attachment points. Functional diversity in biological communities is a trademark of most healthy aquatic systems, but food webs in the Atascosa River are relatively monolithic: dominated by a few very common and abundant species largely tolerant of adverse conditions.

Macroinvertebrate Analysis

As with fish, the only historical macroinvertebrate data available in the Atascosa River watershed were from the 2002 - 2003 Ecomm survey (Ecomm, 2005). The method of benthic macroinvertebrate collection was comparable to the present study: 5-minute kicknet samples in riffles, snags, and leafpacks. The raw data from the Ecomm survey was run through the current TCEQ-approved system for determining B-IBI ratings and ALU scores so that comparisons could be made with the current ALUAA study data. Station 17898 was located in Pleasanton just downstream of Hunt Rd. and 17899 was located at the Leal Rd. crossing southeast of Pleasanton approximately 13 km. The only station sampled in the 2002 – 2003 study that overlapped the current study was Station 17900 and current data from that station is presented alongside historical data for comparison. Station 17900 was one of the most taxonomically rich in both the 2002 – 2003 and 2010 – 2011 studies (Table 5-13 and Appendix F). The ALUAA study results showed an increase since the 2002 – 2003 Ecomm study in richness and the percent of individuals as Elmidae, the riffle beetle family, at Station 17900 as well. These metrics are probably intertwined since there were several Elmidae in the recent study not identified in the Ecomm survey. As their name implies, riffle beetles prefer riffle habitats and although they are commonly found in riffles with cobble/gravel substrate, the majority of those collected in the ALUAA study were taken from snag habitat in shallow runs and sandy riffles. Flows were slightly lower during 2010 – 2011 than in 2002 – 2003 (Figures 2-6 and 2-8) which might have resulted in increased riffle habitat as shallow runs evolved into sandy-bottom riffles. Indeed, riffles doubled in number at several stations between the April 2011 and July 2011 surveys (Tables 4-5 and 4-6). Thus, diminishing discharge can be an advantage to benthic macroinvertebrate populations up to a threshold beyond which disconnected pools and dry riverbed limit invertebrate community diversity.

Table 5-13 B-IBI metrics for Ecomm (2003 – 2004) and Station 17900 from the ALUAA study data (2010 – 2011). Station 17900 is the only station shared between the surveys.

	17899	**17899**	**17899**	**17898**	**17898**	**17898**
Parameter	21-Aug-02	8-Apr-03	24-Sep-03	19-Aug-02	7-Apr-03	25-Sep-03
Taxa richness	10	10	15	13	10	12
EPT taxa abundance[a]	2	2	6	2	1	3
HBI	4.8	6.2	4.0	6.1	6.0	5.0
% Chironomidae	22.2	0.0	0.0	59.5	22.9	17.8
% Dominance[b]	22.2	48.1	21.6	59.5	26.3	33.6
% Dominant FFG[c]	37.9	52.8	43.2	38.5	57.6	36.1
% Predators	37.9	52.8	26.1	38.5	12.6	21.7
Ratio of intolerant:tolerant taxa	0.9	0.1	3.8	0.2	0.4	1.3
% of total Trichoptera as Hydropsychidae	100.0	0.0	100.0	0.0	100.0	100.0
# of non-insect taxa	1	5	1	3	4	2
% Collector-gatherers	18.9	7.5	43.2	31.2	14.3	36.1
% Elmidae	11.1	3.8	8.1	0.0	0.0	0.0
Score	**23**	**19**	**28**	**17**	**23**	**22**
Rating	**Inter.**	**Limited**	**Inter.**	**Limited**	**Inter.**	**Inter.**

	17900	**17900**	**17900**	**17900**	**17900**	**17900**
Parameter	20-Aug-02	8-Apr-03	24-Sep-03	27-Jul-10	20-Apr-11	13-Jul-11
Taxa richness	16	11	20	19	24	24
EPT taxa abundance[a]	6	4	6	6	3	4
HBI	4.1	4.8	3.0	4.6	5.4	5.2
% Chironomidae	4.8	0.9	0.9	9.1	27.4	0.8
% Dominance[b]	31.7	34.9	20.4	26.3	27.4	59.1
% Dominant FFG[c]	36.7	47.1	42.9	38.9	31.0	62.0
% Predators	26.6	20.5	42.9	25.5	28.6	14.1
Ratio of intolerant:tolerant taxa	2.9	0.9	7.2	0.8	0.4	0.3
% of total Trichoptera as Hydropsychidae	100.0	100.0	100.0	100.0	94.1	100.0
# of non-insect taxa	3	1	3	2	7	5
% Collector-gatherers	36.7	16.4	29.9	20.0	31.0	13.1
% Elmidae	9.6	0.0	0.9	20.6	17.7	10.3
Score	**29**	**25**	**35**	**28**	**27**	**30**
Rating	**High**	**Inter.**	**High**	**Inter.**	**Inter.**	**High**

[a] Ephemeroptera, Plecoptera, and Trichoptera

[b] % of total comprised of the three most abundant taxa

[c] % of total comprised of the most dominant functional feeding group

Scores for the Hilsenhoff biotic index (HBI) ranged 3.05 – 4.79 during the Ecomm survey and 8 years later jumped to 4.6 – 5.2 during the ALUAA survey. The HBI is a measure of the pollution tolerance of macroinvertebrate communities based on their congregate tolerance values with increasing values indicating increasing pollution tolerance. The metric is traditionally interpreted to mean that increases in score at a sampling site suggest increases in organic pollution at that location due to increases in the relative abundance of pollution-tolerant organisms. However, shifts in habitat caused by climate, landuse, and hydrology can also increase the relative abundance of pollution-tolerant species in a system because they are not only resistant to impacts from pollution but are also hardy to alterations in their physical habitat. Analyses in this report suggest that such habitat factors are, in fact, behind the increase in HBI scores.

Riverine environments with heterogeneous benthic habitat (i.e., a range of substrate types and sizes and micro-hydrologies) and shallow, well-oxygenated water tend to support more diverse macroinvertebrate communities (Vinson and Hawkins, 1998). In contrast, sluggish, poorly-oxygenated water tends to support fewer macroinvertebrate taxa because the conditions limit survivability in all but a few taxa adapted to such conditions. Such streams usually exhibit high percent dominance, defined here as the portion of the community comprised of the top three most abundant taxa. Station 20764 provided the least beneficial habitat for macroinvertebrates as it contained only sand substrate with a bit of transient snag material and the station was subject to more frequent drying. Here macroinvertebrate richness was the lowest among the five stations sampled and dominance was the highest (Table 4-10). These conditions align with expectations from literature. However, Station 20762 had an average of 38% gravel-or-larger substrate and consistently one of the best riffle habitats among all the stations. Yet richness was low and dominance was high (Table 4-10). Hydropsychid caddisflies were strongly dominant at Station 20762, accounting for more than one-third of all the invertebrates collected from the Station (Table 4-10). Since the riffle never dried up during biological sampling and scouring floods were rare or nonexistent in 2010 - 2011, there has presumably been few disturbances to disrupt the community dynamics of the riffle and upset the dominance exhibited by the Hydropsychidae family. Thus, discrete biological community interactions, not prevailing environmental factors, may have produced the high dominance and low richness at Station 20762.

Correlation Analysis of Habitat with Nekton and Benthic Metrics

Native cyprinid fish were negatively correlated with instream cover in Pearson correlation analysis of habitat and nekton metrics using ALUAA and Ecomm datasets (Tables 5-14). This is somewhat surprising because native cyprinids tend to thrive in cobble/gravel substrates where cover is abundant. The red shiner, a native cyprinid fish, was ubiquitous during the ALUAA study and very abundant at several stations (*see* Table 4-8). It was overall the most abundant native cyprinid and probably skewed the results of the correlation because it does not exhibit the same dependence on cover that other native cyprinids do in the Atascosa River. Moderate and significant correlations were also found between the percent of riparian vegetation as shrubs and the relative abundance of invertivores and piscivores. Riparian as shrubs was also positively correlated with the number of non-insect invertebrate taxa in analysis of benthic metrics (Table 5-15). Terrestrial shrubs may indirectly support non-insect taxa populations (and the invertivorous fish that consume them) by leaf-litter subsidies to the stream which create food and habitat for select non-insect species but the correlation could also be coincidental, the result of other environmental factors that simultaneously support populations of shrubs and aquatic non-insect invertebrates. The only other significant and moderately-strong correlation in the analysis of habitat and biological metrics was between invertebrate richness and percent riparian as trees (Table 5-15). At all stations except 20762 (AU 2107_03), snags were the only major source of habitat for invertebrates because of the absence of coarse cobble substrate. Thus, the correlation between riparian tree density and invertebrate richness is expected to be significant. More rigorous and targeted sampling would be necessary to identify the precise relationships between riparian vegetation and aquatic life, but the correlations between riparian habitat, aquatic invertebrates, and fish in the present analysis speaks to the significant inter-relatedness of the terrestrial and aquatic components in the Atascosa River ecosystem. Correlations between habitat and biological summary indices were not evident in this analysis (Table 5-16).

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Table 5-14 Pearson correlation coefficients (r) and probabilities (*p* ; α = 0.05) for nekton and habitat metrics from ALUAA (2010 – 2011) and Ecomm data (2002 – 2003). Moderate and strong r-values are bold and red, respectively; significant *p*-values are highlighted and bold, respectively. The *n* for each regression pair is 23.

		Richness	# Native Cyprinids	# Benthic Species	# Invertivore Species	# Sunfish Species[a]	% Tolerant Individuals[b]	% Omnivore Individuals	% Invertivore Individuals	% Piscivore Individuals
Instream Cover	**r**	-0.19	***-0.71***	0.04	-0.09	-0.09	0.17	0.45	-0.48	0.32
	p	0.395	***0.0002***	0.859	0.676	0.681	0.434	0.032	0.021	0.132
% Gravel or Larger	**r**	0.31	-0.30	0.46	0.06	0.17	0.09	0.51	-0.29	0.05
	p	0.153	0.165	0.026	0.774	0.425	0.689	0.014	0.180	0.830
% Riparian as Trees	**r**	-0.45	-0.11	-0.02	0.26	-0.30	0.16	-0.37	0.07	0.15
	p	0.031	0.631	0.912	0.240	0.168	0.457	0.082	0.764	0.490
% Riparian as Shrubs	**r**	-0.10	-0.35	0.16	0.14	0.07	0.46	0.35	***-0.80***	***0.79***
	p	0.637	0.097	0.462	0.530	0.754	0.028	0.102	***<.0001***	***<.0001***
% Riparian as Grass	**r**	0.29	0.07	0.14	0.02	0.18	0.03	0.10	0.11	-0.21
	p	0.175	0.753	0.516	0.926	0.421	0.877	0.666	0.611	0.348
Canopy Cover	**r**	-0.46	-0.30	-0.31	0.06	-0.02	0.05	0.12	-0.33	0.34
	p	0.026	0.164	0.148	0.794	0.921	0.832	0.582	0.120	0.116

[a] Catfish, suckers, and darters
[b] Excluding western mosquitofish (*Gambusia affinis*)

Table 5-15 Pearson correlation coefficients (r) and probabilities (*p* ; α = 0.05) for benthic and habitat metrics from ALUAA data, 2010 – 2011. Moderate r-values are italic, respectively; significant and strongly significant *p*-values are highlighted and highlighted and bold, respectively. The *n* for each regression pair is 23.

		Richness	# EPT Taxa[a]	# Non-insect Taxa	% Dominance (3 Taxa)[b]	% Dominance (FFG)[c]	% Predator Individuals	% Collector-Gatherer Individuals
Instream Cover	**r**	0.05	-0.30	0.54	0.30	-0.09	-0.15	0.16
	p	0.838	0.163	0.009	0.160	0.692	0.506	0.465
% Gravel or Larger	**r**	-0.11	-0.40	0.22	0.16	-0.19	-0.23	0.16
	p	0.615	0.061	0.309	0.471	0.376	0.300	0.468
% Riparian as Trees	**r**	***0.75***	0.43	0.00	0.04	0.14	-0.36	-0.09
	p	***<.0001***	0.043	0.993	0.846	0.532	0.090	0.688
% Riparian as Shrubs	**r**	0.34	-0.05	***0.62***	0.50	0.44	-0.44	-0.41
	p	0.111	0.836	0.002	0.015	0.035	0.036	0.050
% Riparian as Grass	**r**	-0.42	-0.40	0.05	-0.07	-0.02	0.05	-0.11
	p	0.049	0.057	0.835	0.748	0.946	0.805	0.612
Canopy Cover	**r**	0.13	0.31	0.20	-0.01	0.11	0.08	-0.23
	p	0.556	0.157	0.363	0.949	0.624	0.717	0.301

[a] Ephemeroptera, Plecoptera, and Trichoptera taxa

[b] Dominance of the 3 most abundant taxa

[c] Dominance of the most abundant functional feeding group

Table 5-15 *Cont.*

		Ratio Intolerant / Tolerant Taxa	% Trichoptera as Hydropsychidae	% Chironomidae	% Elmidae Individuals
Instream Cover	**r**	-0.23	-0.40	0.06	-0.14
	p	0.284	0.056	0.771	0.524
% Gravel or Larger	**r**	-0.30	-0.37	0.54	-0.31
	p	0.161	0.087	0.008	0.143
% Riparian as Trees	**r**	-0.10	0.11	-0.26	0.58
	p	0.662	0.627	0.227	0.004
% Riparian as Shrubs	**r**	-0.32	0.04	-0.24	-0.10
	p	0.143	0.854	0.278	0.662
% Riparian as Grass	**r**	-0.19	-0.16	0.12	-0.33
	p	0.397	0.457	0.582	0.123
Canopy Cover	**r**	0.14	0.15	-0.59	0.11
	p	0.518	0.506	0.003	0.625

Table 5-16 Pearson correlation coefficients (r) and probabilities (*p* ; α = 0.05) for IBI (Ecoregions 31 and 33), B-IBI, and HBI from ALUAA (2010 – 2011) and Ecomm (2002 – 2003) surveys. Significant *p*-values are highlighted. The *n* for each regression pair is 23.

		IBI_{31}	IBI_{33}	B-IBI	HBI
Instream Cover	r	-0.42	-0.49	0.17	0.53
	p	0.045	0.017	0.427	0.010
% Gravel or Larger	r	-0.23	-0.37	-0.11	0.54
	p	0.282	0.078	0.613	0.007
% Riparian as Trees	r	0.00	0.07	0.30	-0.16
	p	0.984	0.737	0.158	0.473
% Riparian as Shrubs	r	-0.37	-0.40	0.12	0.39
	p	0.083	0.057	0.601	0.065
% Riparian as Grass	r	0.05	0.00	-0.27	0.35
	p	0.815	0.998	0.215	0.100
Canopy Cover	r	-0.03	0.01	0.37	-0.20
	p	0.878	0.963	0.079	0.370

Biological Metric Responses to Hydrology

It is notable that instantaneous flow values taken on-site during biological sampling were not strongly correlated with any biological metrics or indices except the number of EPT taxa and the ratio of intolerant to tolerant benthic species; the r-values of which were only moderately positive (Table 5-17). As EPT taxa and the ratio of intolerant to tolerant species increases, so should the B-IBI score but flow was not significantly correlated with B-IBI. Looking at antecedent flow conditions, according to hydrographs from USGS gage 0820800 near Whitsett, TX, and gage 08207500 near McCoy, TX, pulses of high flow were more frequent in the year prior to and during the Ecomm study (2002 – 2003) and during the first sampling event of the ALUAA in July 2010 than during the final two sampling events of the ALUAA (Figures 5-30 – 5-31). From late 2010 through 2011 streamflow gradually diminished throughout the watershed such that flow was low at the perennial AU 2107_01 Stations 20773 and 12980 and Station 20764 (AU 2107_02) was dry. In broad terms, compared to 2010 – 2011, the antecedent hydrology of the Ecomm survey was characterized by higher discharge, more dependable flows (i.e., no periods of drying), and more frequent pulses of high flows from precipitation. In addition to differences in hydrology, the watershed experienced considerable growth in natural gas exploration and extraction activity between 2009 and 2011. Despite these environmental changes between the Ecomm and ALUAA surveys, HQI, IBI, and B-IBI scores changed very little, fluctuating only slightly within the upper-intermediate to marginally-high range (Table 5-18). Some minor flux occurred in IBI and B-IBI scores from event to event while HQI scores held relatively steady. Thus, biological index scores may fluctuate relatively more within a single year than among years as populations respond to drying and rain events but over a decade, covering multiple generations of fish and invertebrates, aquatic life in the Atascosa River exhibit resilience to the harsh, unpredictable flow regime of the watershed. Discontinuity of flow from upstream to downstream is expected in years of average precipitation in most of the Atascosa River and the organisms that thrive there have demonstrated their adaption to the environment by their persistence through sluggish flow, frequent pooling, and the low dissolved oxygen that accompanies such flow conditions. Most of the fish and invertebrates in the Atascosa River are cosmopolitan species tolerant of harsh conditions that can quickly recolonize reaches rewetted after sustained periods of dryness. They are common in intermittent Texas streams subject to frequent drying and/or pooling.

In summary, aquatic communities, by definition, are highly dependent on discharge but no statistical analyses in this report demonstrate significant trends in fish and invertebrate populations in response to flow (except, of course, the absence of organisms at Station 20764 in July 2011 when the station went completely dry). Considering the stability of the biological communities in the Atascosa River over the last decade regardless of drought or high flows, perhaps Atascosa River populations are simply well adapted to the natural fluctuations of discharge in the intermittent to weakly-perennial hydrology of the system; as long as water is present the amount of water is not strongly consequential to the persistence of most species of fish and invertebrates in the river.

Table 5-17 Pearson correlation coefficients (r) and probabilities (*p* ; α = 0.05) for instantaneous flow and selected nekton and benthic metrics and indices from ALUAA project (2010 – 2011) and Ecomm surveys (2002 – 2003). Significant *p*-values are highlighted and the *n* for each regression pair is 21.

NEKTON		**Richness**	**# Native Cyprinids**	**# Benthic Species**	**# Sunfish Species[a]**	**% Tolerant Individuals[b]**	**% Omnivore Individuals**	**% Invertivore Individuals**	**% Piscivore Individuals**	**# Invertivore Species**
Instantaneous	**R**	-0.03	0.20	0.07	-0.22	-0.51	-0.22	0.22	-0.14	0.34
Flow	**P**	0.910	0.379	0.748	0.331	0.017	0.349	0.334	0.541	0.129

BENTHIC		**Richness**	**HBI**	**# EPT Taxa[c]**	**# Non-insect Taxa**	**% Dominance (3 Taxa)[d]**	**% Dominance (FFG)[e]**
Instantaneous	**R**	-0.21	-0.52	***0.63***	-0.55	-0.42	0.14
Flow	**P**	0.352	0.015	***0.002***	0.010	0.057	0.538
		% Predator Individuals	**% Collector Gatherer Individuals**	**Intolerant / Tolerant Taxa**	**% Trichoptera as Hydropsychidae**	**% Chironomidae**	**% Elmidae Individuals**
	R	-0.07	0.01	***0.65***	0.30	-0.25	-0.05
	P	0.749	0.964	***0.001***	0.183	0.284	0.842

INDICES		**B-IBI**	**IBI_{31}**	**IBI_{33}**
Instantaneous	**R**	0.22	0.47	0.56
Flow	**P**	0.342	0.031	0.008

[a] Catfish, suckers, and darters

[b] Excluding western mosquitofish (*Gambusia affinis*)

[c] Ephemeroptera, Plecoptera, and Trichoptera taxa

[d] Dominance of the 3 most abundant taxa

[e] Dominance of the most abundant functional feeding group

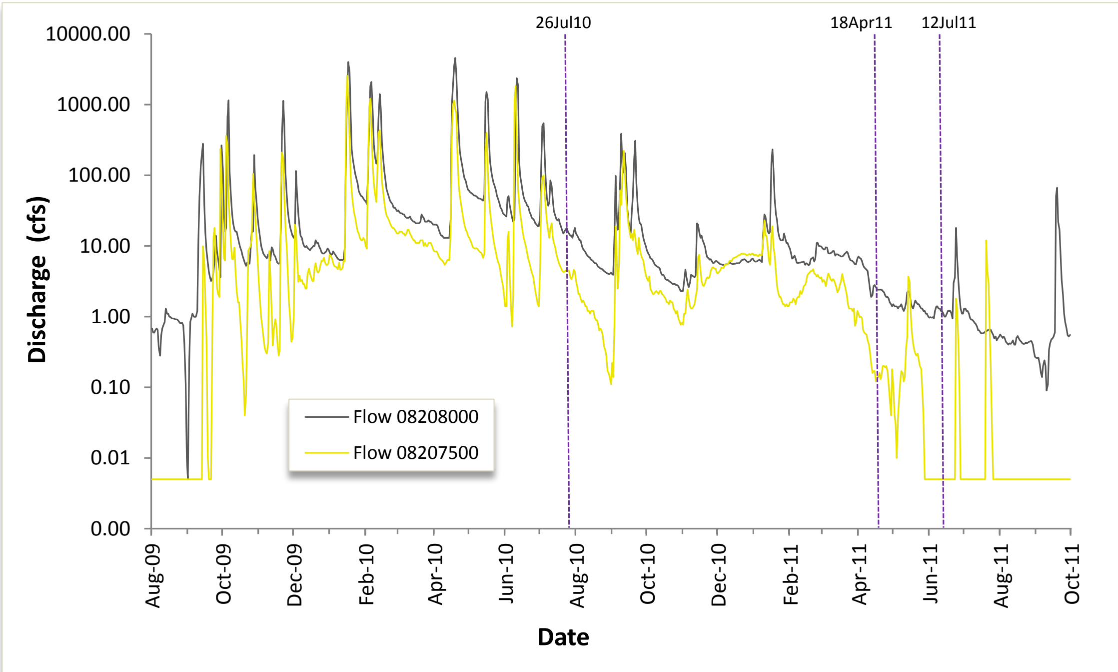

Figure 5-30 ALUAA biological sampling event start dates and flow at USGS 08207500 (collocated with Station 20764) and USGS 08208000 (collocated with Station 12980).

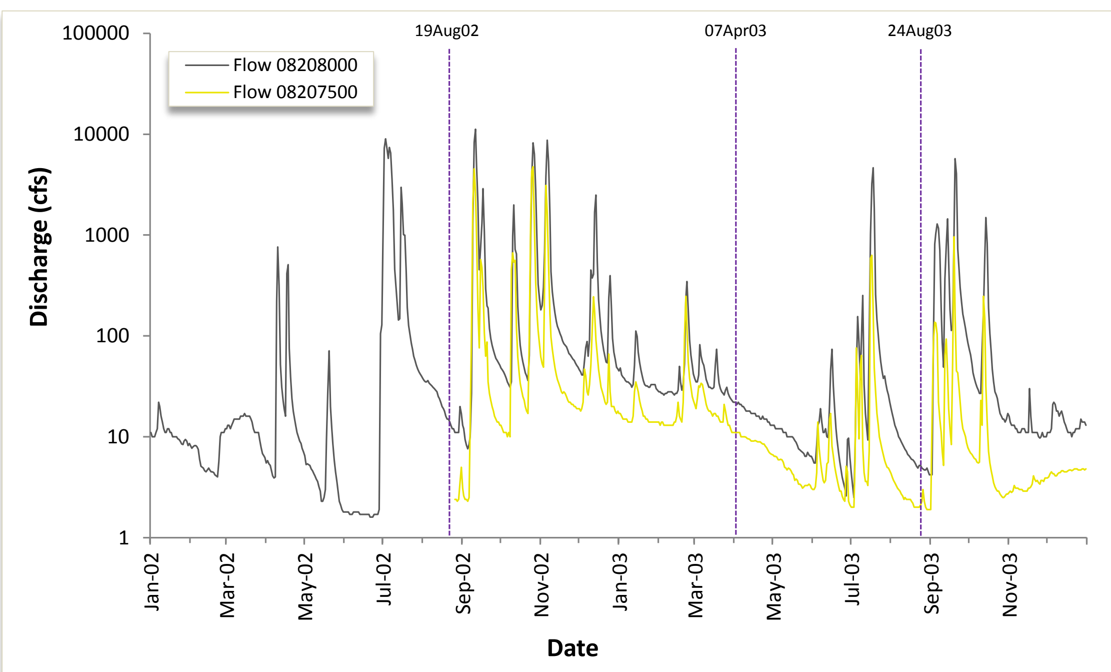

Figure 5-31 Ecomm biological sampling event start dates and flow at USGS 08207500 (when available) and 08208000.

Table 5-18 HQI, B-IBI, and IBI scores and ratings from the Ecomm and ALUAA surveys. IBI-31 and IBI-33 are based on criteria for Ecoregions 31 and 33, respectively.

Ecomm													
		August 2002				**April 2003**				**September 2003**			
AU	**Site**	HQI	B-IBI	IBI-31	IBI-33	HQI	B-IBI	IBI-31	IBI-33	HQI	B-IBI	IBI-31	IBI-33
2701_02	17898	19 Int.	17 Lim.	43 Exc.	40 Int.	18 Int.	25 Int.	33 Int.	34 Lim.	17 Int.	22 Int.	35 Int.	36 Int.
	17900	20 High	29 High	31 Int.	31 Lim.	15 Int.	23 Int.	41 High	42 High	16 Int.	35 High	36 Int.	39 Int.
2701_03	17899	18 Int.	23 Int.	38 High	37 Int.	16 Int.	19 Lim.	45 Exc.	42 High	16 Int.	28 Int.	41 High	40 Int.
ALUAA													
		July 2010				**April 2011**				**July 2011**			
AU	**Site**	HQI	B-IBI	IBI-31	IBI-33	HQI	B-IBI	IBI-31	IBI-33	HQI	B-IBI	IBI-31	IBI-33
2701_01	20773	19 Int.	30 High	41 High	42 High	18 Int.	31 High	34 Int.	34 Lim.	17 Int.	24 Int.	39 High	38 Int.
	12980	16 Int.	27 Int.	41 High	40 Int.	15 Int.	31 High	37 High	34 Lim.	17 Int.	28 Int.	39 High	38 Int.
2701_02	20764	17 Int.	22 Int.	37 High	38 Int.	17 Int.	23 Int.	35 Int.	36 Int.	-- --	-- --	-- --	-- --
	17900	17 Int.	28 Int.	31 Int.	32 Lim.	17 Int.	27 Int.	33 Int.	34 Lim.	18 Int.	30 High	39 High	40 Int.
2701_03	20762	18 Int.	29 High	35 Int.	34 Lim.	18 Int.	28 Int.	30 Int.	30 Lim.	19 Int.	30 High	33 Int.	30 Lim.

Lim. = Limited Int. = Intermediate High = High Exc. = Exceptional

Summary and Discussion

The Atascosa River (Segment 2107) is an intermittent to weakly-perennial, low-gradient stream containing many reaches that annually go dry during normal years of precipitation. The DO dynamics are thus more variable than in more stable perennial streams. Historical data suggested that aquatic life in the Atascosa River had minor to moderate impairments due to low DO concentrations. Data presented in this ALUAA report, in junction with historical data, confirm occasional departures from DO criteria and minor impairment to aquatic life but the remarkable stability of fish and invertebrate populations in the stream, in spite of highly variable flow conditions, demonstrates that the biotic community is well adapted to the variability.

Climate, flow regime, and metabolic processes interact to impact DO levels in the Atascosa River. The region receives only 29 in. of rainfall a year, on average, and has hot summers that strain water resources, especially during periods of drought such as in late 2010 through 2011. Rain events are infrequent but often torrential, especially during fall when tropical moisture drives the weather activity (e.g., Tropical Storm Hermine). Much of the upper Atascosa River is intermittent or ephemeral. If flows were not augmented by effluent from the Pleasanton WWTF the whole river might be classified as intermittent, perhaps with the exception of the lowermost AU. Even the lower reaches of the Atascosa River go dry once or twice every decade according to hydrographs and eye-witness accounts. Frequent breaks in flow continuity and pooling during warm summers severely depress DO and this problem is exacerbated at locations with abundant algae and aquatic plants, such as Station 20762, where production and respiration cycles become more energetic creating diel DO swings of increased magnitude (Table 4-3).

Suspected groundwater contributions to streamflow above Stations 12980 and 20773 and WWTF effluent above Station 17900 maintain very low but steady flow at those locations during all but the driest periods based on hydrographs and testimonies from landowners and field staff. In contrast, stations above Pleasanton in AU2701_03 and AU2701_04 are ephemeral except Station 20762 which probably benefits from effluent emanating from the Poteet WWTF. However, Station 20762 also ceased to flow within 24 hours of the July 2011 survey. Stations 20760 and 17142 in AU2107_04 are dry most of the year, being entirely dependent on rainfall runoff for their flow, and are unable to support fish and invertebrate populations. Station 20764 (AU2701_02) lies more than 10 miles downstream of the Pleasanton WWTF and above the major tributaries that feed AU2107_01 (Figure 5-1). Without these flow contributions the station went dry in July 2011 following several months of little or no rain. The strongest impact of groundwater and wastewater contributions on aquatic life is felt during periods of low precipitation when low but steady discharge sustains riffles and shallow runs that are prime habitat for many species of fish and macroinvertebrates.

The instream habitat and hydrology of the Atascosa River are not ideal for diverse and abundant fish and macroinvertebrate populations. Frequent drying interrupted by sudden, high-magnitude spates create a harsh environment for aquatic organisms that only the most tolerant and cosmopolitan species can exploit. Instream cover was extremely limited at most stations in the ALUAA survey. Riffles were sparse and with rare exception covered sand or gravel substrates and had only marginally-turbulent flow which reduced the potential for air-water mixing.

Instead of cobble, snags were the primary cover habitat for invertebrates and fish. In addition to poor substrate, during the ALUAA survey field staff noted increased turbidity and siltation, especially in the lower stations, compared to conditions witnessed in previous studies on the Atascosa River. Siltation limits habitat for fish and invertebrates that prefer cobble/gravel riffles and discourages the establishment of aquatic plants that would otherwise provide cover and food for a greater diversity of animal species. Siltation can also bury areas of cover for smaller fish that depend on instream cover to avoid predation. Some effort was made to locate the sources of turbidity and siltation but no immediately obvious sources could be found. A harsh flow regime, poor instream habitat, and recent increases in siltation pose major hurdles to development of rich and populous biotic communities. Nevertheless, populations of tolerant and cosmopolitan species of fish and invertebrates seem to be thriving under these conditions, resulting in stable scores for metrics and indices across a decade of sampling.

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