TMDL INVESTIGATION

OF

WATER QUALITY IMPAIRMENTS

TO

STONE DAM CREEK

FAULKNER COUNTY, ARKANSAS

MAY 1997
WQ-97-05-01

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INTRODUCTION

The total maximum daily load (TMDL) process was established by Section 303(d) of the Clean Water Act and promulgated in 40 CFR 130.7(b). A TMDL is a process where parameters which result in an impairment are identified and quantified, and an implementation program is developed to remediate the impairment. The primary steps in the TMDL process include: (1) identification of water quality limited water bodies, (2) priority ranking and targeting such waters for TMDL activities, (3) development of TMDL, implementation of control actions, and assessment of water quality-based control actions.

Data collected at the ambient water quality monitoring station on Stone Dam Creek (ARK51), indicated periodic levels of ammonia-nitrogen which exceeded acute toxicity values for aquatic life uses. In 1994, Stone Dam Creek was listed as high priority on the 303(d) list of Water Quality Limited Water bodies and targeted for investigation in FY 1995-1996.

Stone Dam Creek is the receiving stream of the City of Conway municipal wastewater treatment facility (WWTF), Snap-On Inc., Delta Express store number 3059, and Conway Asphalt Company. A TMDL investigation was conducted in order to determine the level of impact these discharges are having on the water quality and aquatic inhabitants of the receiving stream. This investigation was conducted on July 8-10, 1996 and consisted of water quality sampling, fish and macroinvertebrate collection, and the deployment of Hydrolab continuous dissolved oxygen recorders. Sampling was done in Stone Dam Creek, in a tributary to Stone Dam Creek and in a reference stream.

HISTORICAL DATA

Waterway Description

Stone Dam Creek has its origin in the southwest corner of the City of Conway and flows south-southwest for approximately one mile before leaving the city and turning in a south-southeasterly direction. It then flows for another two miles, bordered by pasture land, before receiving the effluent from the Conway WWTF. The creek then flows for another mile through pasture land before entering Lake Conway. The watershed size of Stone Dam Creek is approximately 9 mi^2 at its confluence with Lake Conway and the stream gradient is 10-15 feet/mile. The substrate composition of the creek consists of mud and silt, with an abundance of in-stream habitat in the

form of beaver dams, tree tops, other woody debris and over-hanging vegetation available to macroinvertebrates and fish.

Stone Dam Creek is in the Arkansas River Valley ecoregion and is classified as a perennial Arkansas River Valley fishery due to the discharge provided by the WWTF. The dissolved oxygen standard for this stream for the primary and critical seasons are 5 mg/L and 3 mg/L, respectively.

Designated beneficial uses of Stone Dam Creek, in addition to the previously mentioned fishery use, consist of secondary contact recreation and source water for domestic, industrial, and agricultural uses.

Little Cypress Creek was chosen as a reference stream for this study. This creek originates in southwestern Faulkner County and flows west through pastures and sparsely wooded areas for approximately nine miles to Palarm Creek. Palarm Creek then flows another mile to Lake Conway. The watershed size of Little Cypress Creek is approximately 10 mi^2 upstream of the sample station LCC01. The stream gradient is 10-15 feet/mile. The substrate composition of the creek consists of gravel-to-sand with some mud/silt pockets. The riparian zone was generally 10 to 20 feet wide and provides a good canopy cover over most of the sample area.

Previous Studies

The results of the water chemistry analyses from the ambient water quality station ARK 51 were retrieved for the period of January 1991- November 1996. This station was also used during this study as station SDC 04. The findings from the ARK 51 data will be addressed in the data results section of this report. Discharge Monitoring Reports (DMR) were also retrieved for those six years for the facilities discharging into Stone Dam Creek. The evaluation of this data did not reveal any significant periods of excursion from permit limitations. The NPDES permit limits for these dischargers are listed below.

	NPDES Permit #	BOD mg/L	TSS mg/L	F/C col/100ml	COD mg/L	O/G mg/L	CHRONIC TOXICITY	NH3-N mg/L
Conway	AR0033359	10	15	200 Apr.-Sept. 1000 Oct.-Mar.			Required	none
Snap-On Inc.	AR0043150	none	15	none	50	10	none	none
Delta Express #3059	AR0045071	none	20	none	50	10	none	none
Conway Asphalt	AR0043214	none	35	none	50	10	none	none

In 1980, ADPC&E conducted a Stream Assimilative Capacity Study on Stone Dam Creek in order to determine allowable effluent limits for the City of Conway for the purpose of maintaining water quality standards. Stone Dam Creek below the discharge of the Conway WWTF was found to be heavily impacted with sludge from the WWTF. According to the modeling performed at the time of the study, treatment levels of 5 mg/L BOD_5, 1 mg/L NH_3-N, and saturated dissolved oxygen at 30°C would not maintain a critical season dissolved oxygen level of 5 ppm in the stream, which was the water quality standard at that time. This study concluded by recommending that the current discharge limits of 10 mg/L BOD_5 and 15 mg/L total suspended solids be maintained and that procedures be started to have Stone Dam Creek classified as an intermittent stream.

In 1981, the City of Conway submitted a request for the reclassification of Stone Dam Creek as an intermittent stream. The request was based on the inability of the Conway WWTF to meet the 5 mg/L D.O. standard.

In November of 1984, ADPC&E conducted an additional Stream Assimilative Capacity Study on Stone Dam Creek in order to determine allowable effluent limits for the City of Conway for the purpose of maintaining water quality standards. At the time of this study, the overall water quality of Stone Dam Creek was regarded as poor since dissolved oxygen levels fell below 3 mg/L and ammonia concentrations exceeded 10 mg/L downstream of the effluent from the Conway WWTF. According to modeling performed during this study, Conway's WWTF should have limits of 10/15/6/5 (BOD_5, TSS, NH_3, effluent D.O.) to maintain an instream dissolved oxygen concentration of 1 mg/L (intermittent stream standard). These new limits were suggested since the current discharge limits of 10 BOD_5 and 15 TSS were set without regard to the impact of ammonia. However, the Arkansas Game & Fish Commission indicated that Stone Dam Creek was not a significant fishery; therefore the existing discharge limits of 10 BOD_5 and 15 TSS remained in place without ammonia limits.

Major revisions to Arkansas WQS occurred in 1988, which reclassified Stone Dam Creek and changed the dissolved oxygen standards. Due to the magnitude of the discharge from the Conway WWTF, Stone Dam Creek is designated as a perennial Arkansas River Valley fishery and the minimum dissolved oxygen standards became 3 mg/L and 5 mg/L for critical and primary seasons.

CURRENT STUDY

Data Acquisition

The Stone Dam Creek survey was initiated on the morning of July 8, 1996 when continuous dissolved oxygen meters were deployed at three of the six stream stations on Stone Dam Creek. Also on the 8th of July, fish and macroinvertebrate community samples were collected at two stations. One biological sampling station was located downstream of the City of Conway WWTF with the other located in a reference stream, Little Cypress Creek. Physical habitat assessments

were completed in conjunction with the biological sampling. On July 9, fluorescein dye was used to establish time of travel on Stone Dam Creek, while other members of the team collected water quality samples. Fluorescein dye was not used in Little Cypress Creek because there was obviously no flow. The continuous dissolved oxygen meters deployed on the 8th were retrieved on July 10, 1996.

Parameters

In addition to the biological samples, the water samples were analyzed for dissolved oxygen, temperature, pH, flow, chlorides, total organic carbon (TOC), five day biochemical oxygen demand (BOD5), total suspended solids (TSS), total dissolved solids (TDS), ammonia nitrogen (NH_3N), nitrite+nitrate nitrogen (NO_2 + NO_3), orthophosphorus, and total phosphorus. The dissolved metals sampling included aluminum, boron, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, vanadium, and zinc.

Collection, Preservation and Measurements

Water quality grab samples were collected, preserved, and analyzed according to the 18th Edition of Standard Methods for Examination of Water and Wastewater. Analysis was conducted under ADPC&E's existing Quality Assurance Program. Dissolved oxygen and stream temperature were measured using an Orion Model 840 portable dissolved oxygen meter, which was calibrated according to the manufacturers instructions prior to use. Three Hydrolab continuous dissolved oxygen recorders were used to determine diurnal variation in the dissolved oxygen concentration in the Stone Dam Creek study area. One meter was deployed just below the discharge of the Conway WWTF in Stone Dam Creek, another was placed approximately one half mile below the outfall and downstream of the confluence of Stone Dam Creek and the unnamed tributary. The third meter was deployed in Little Cypress Creek. Stream pH was measured using an Orion Model 230A portable pH meter, which was calibrated using buffer solutions of pH 4 and 7. Stream flow was measured using a Marsh-McBirney Model 2000 Flow Mate meter by obtaining a representative number of velocities and depths across suitable stream locations. Water grab samples were taken in Stone Dam Creek above the Conway WWTF outfall, at the WWTF outfall, downstream of the outfall at the beginning of the natural channel, in the unnamed channelized tributary and at the Highway 65 bridge approximately one mile below the WWTF outfall (Figure 1). Grab samples were also collected from Little Cypress Creek.

Biological samples were collected in Stone Dam Creek from a point just upstream of its confluence with the unnamed tributary upstream to the discharge of the City of Conway's WWTF. In Little Cypress Creek, biological samples were collected upstream of the county road south of Beryl. Macroinvertebrates were collected using a Turtox Indestructible benthos net. An attempt was made to sample similar structure and habitat at each location so that data collected would be comparable. The fish community was sampled by use of a Smith-Root Model 15-B DC backpack electrofisher. Riffle areas were sampled by driving the fish into a seine, while the

fish in the pools were collected by electroshocking favorable habitat areas. The smaller specimens and those unidentifiable in the field were preserved in a ten percent (10%) formalin solution and returned to the lab for identification.

Station Description

A total of six water chemistry stations were established on Stone Dam Creek, with an additional station located in Little Cypress Creek as a reference. The station descriptions are as follows:

Station

SDC01A- Stone Dam Creek approximately ¾ miles above the Conway WWTF effluent ditch at the county road bridge.

SDC01E- Conway WWTF effluent at the head of the effluent ditch.

SDC02- Stone Dam Creek at the north-east corner of WWTF holding ponds where effluent ditch meets natural channel.

SDC01T- Unnamed tributary, approximately 300 m upstream from its confluence with Stone Dam Creek.

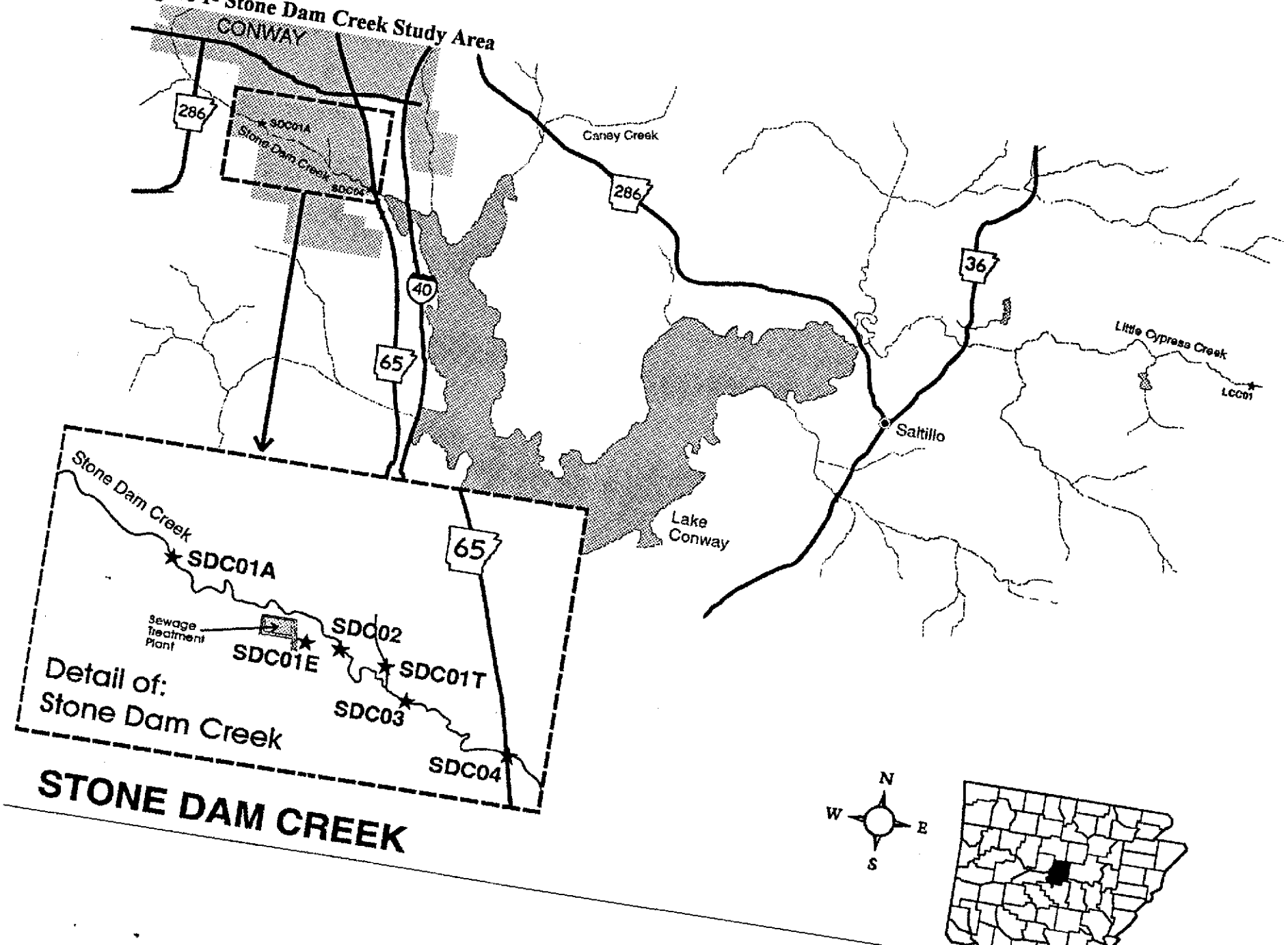
SDC03- Stone Dam Creek at the county road bridge, below its confluence with the unnamed tributary.

SDC04- Stone Dam Creek at Highway 65 bridge above Lake Conway (Ambient Monitoring Station ARK 51).

LCC01- Little Cypress Creek at the Beryl Road bridge, approximately three miles south of the City of Beryl.

Water quality sampling was performed at all stations. The biological assessments (fish and macroinvertebrates) were performed at stations LCC01 and SDC02. Hydrolab continuous dissolved oxygen meters were deployed at LCC01, SDC02, and SDC03. Figure 1 provides a map of the location of sampling stations.

Figure 1- Stone Dam Creek Study Area



DATA RESULTS

Diel Dissolved Oxygen and Temperature

Hydrolab Recorder multi-parameter water quality sampling meters were used to measure the diel fluctuation of both D.O. and temperature. On July 8, 1996, meters were placed downstream of the Conway WWTF at SDC02 and further downstream at SDC03 in Stone Dam Creek and at LCC01 in the reference stream. All samplers were deployed for approximately 48 hours collecting data in five minute intervals. Table 1 is a summary of the temperature and D.O. data collected.

Table 1- Diel D.O. and Temperature Summary

Station ID	Sample Date	Dissolved Oxygen (mg/L)			Temperature (°C)		
		Max	Min	M.D.F.*	Max	Min	M.D.F.
LCC01	7/8/96	2.5	0.9	1.6	27.7	26.1	1.6
	7/9/96	2.8	1.1	1.7	27.2	24.7	2.5
	7/10/96	2.4	2.0	0.4	24.7	23.4	1.4
SDC02	7/8/96	4.0	3.1	0.9	30.2	28.7	1.5
	7/9/96	3.8	2.8	1.1	29.3	28.1	1.2
	7/10/96	3.3	2.5	0.7	28.7	27.8	0.9
SDC03	7/8/96	13.9	4.2	9.7	33.7	28.9	4.8
	7/9/96	10.0	2.6	7.4	29.9	27.3	2.6
	7/10/96	6.7	2.4	4.3	28.2	26.8	1.5

*Maximum Daily Fluctuation

Dissolved oxygen concentrations in Stone Dam Creek below the Conway WWTF (SDC02) ranged from 2.5 mg/L to 4.0 mg/L with D.O. saturation values between 32.8% and 53.7%. Water temperatures at this site ranged from 27.8°C to 30.2°C. At SDC03 (below the confluence of the unnamed tributary) D.O. concentrations ranged from 2.4 mg/L to 13.9 mg/L with D.O. saturation values from 31.1% to over 100%. Temperatures at this site ranged from 26.8°C to 33.7°C. The elevated dissolved oxygen concentration and extensive daily D.O. fluctuation at this station may be the result of photosynthetic activity. This meter was located several hundred

meters downstream of the Conway WWTF, and was placed in an area of very little canopy cover and very low water velocity. Dissolved oxygen concentrations in the reference stream LCC01 ranged from 0.9 mg/L to 2.8 mg/L with D.O. saturation levels between 11.4% and 34.9%. Water temperatures at LCC01 ranged from 23.4°C to 27.7°C. Figure 2 depicts the diel D.O. and temperature data from LCC01. It should be noted that the highest D.O. levels are occurring late in the evening after nightfall. This increase in dissolved oxygen is likely to be a result of oxygen diffusion into the water column due to the corresponding decrease in the water temperature, the shallow water level and the low flow condition in the stream. The maximum daily D.O. fluctuations for the three sites ranged from 0.35 mg/L on July 10 at LCC01 to 9.72 mg/L on July 8 at SDC03. Figures 2, 3, and 4 represent the D.O. and temperature data from these stations.

Figure 2-Dissolved Oxygen and Temperature Fluctuation at LCC01

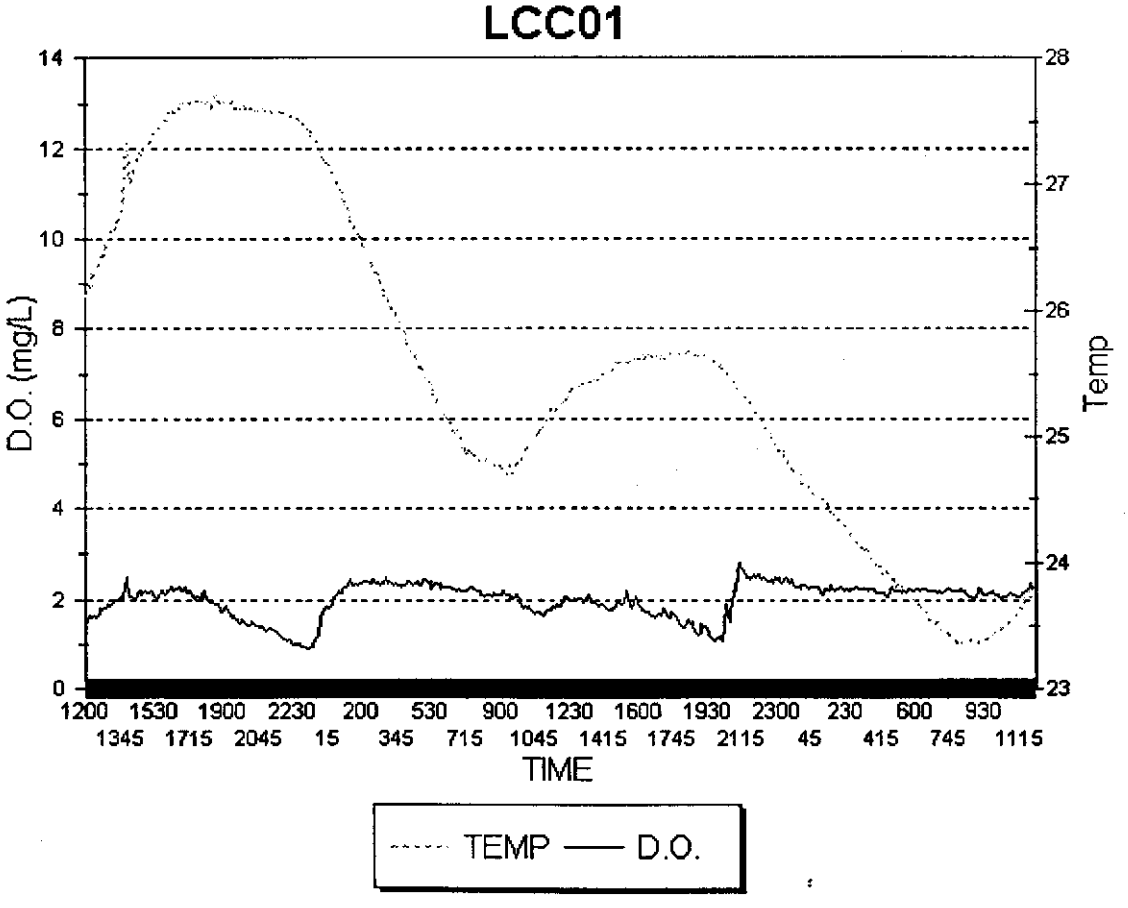


Figure 3-Dissolved Oxygen and Temperature Fluctuation at SDC02

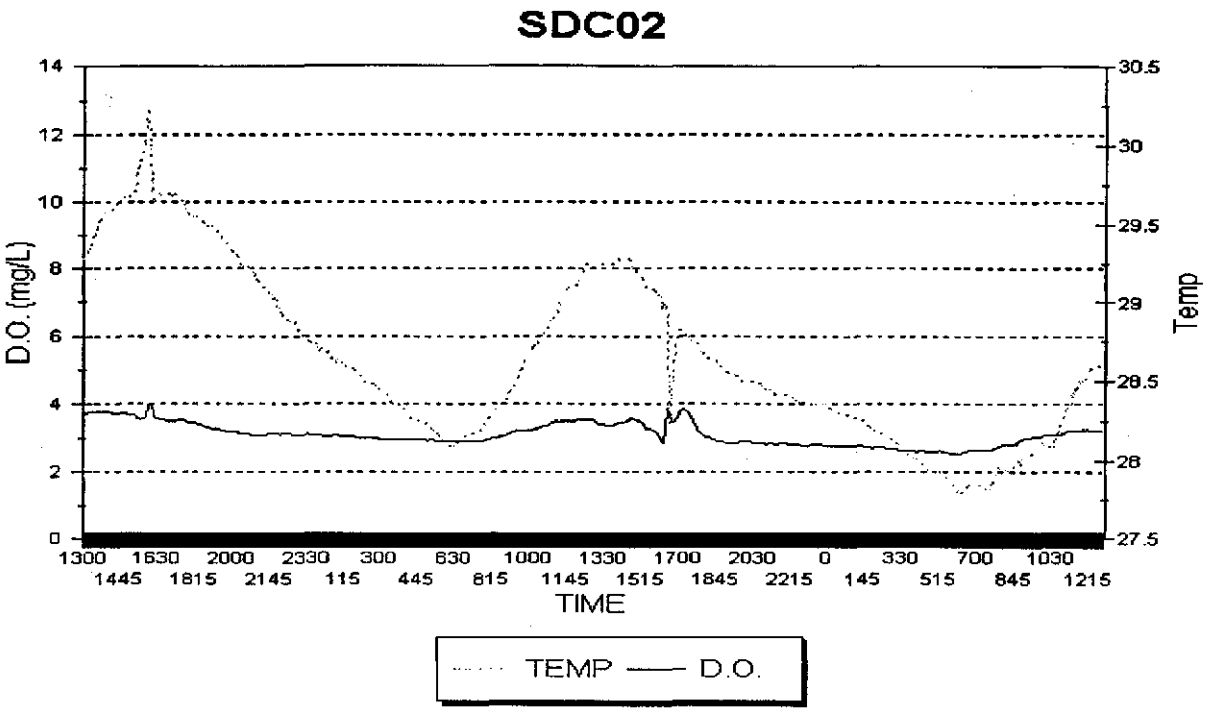
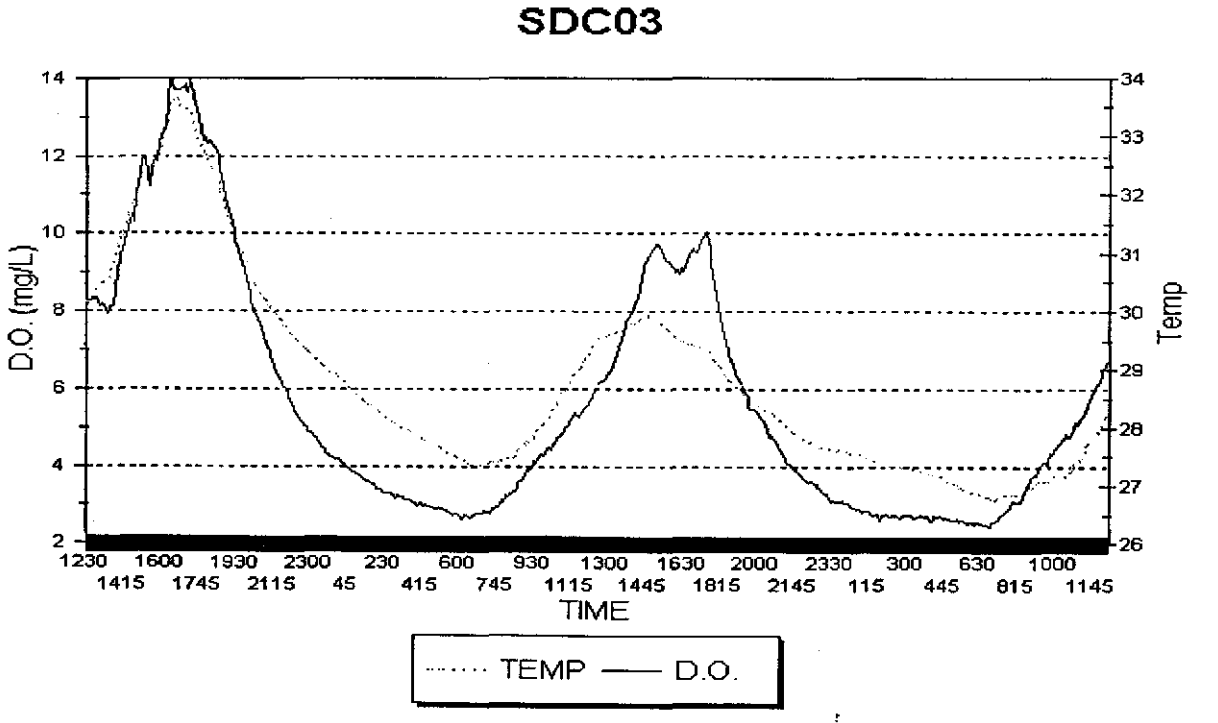


Figure 4- Dissolved Oxygen and Temperature Fluctuation at SDC03



pH and Flow

Average stream pH values measured during this survey were typical for streams in the Arkansas River Valley ecoregion with the exception of the Stone Dam Creek values. The pH values recorded by the Hydrolab continuous meters during this survey ranged from 6.62 to 7.00 at LCC01 and from 6.26 to 8.95 in Stone Dam Creek. The highest pH value recorded by the Hydrolabs (8.95) was at SDC03 on the afternoon of July 8th. This elevation of pH was associated with the photosynthetic activity during the afternoon. Instream flows in Stone Dam Creek above the WWTF and in Little Cypress Creek were very low during the course of the study. No-flow situations were observed at LCC01 and SDC01T. At SDC01A, upstream of the Conway WWTF discharge, the instream flow was 0.1 cfs. The discharge flow from the Conway WWTF was recorded as 4.8 MGD (7.4cfs). In-stream velocity and channel width made accurate flow measurement impossible downstream of the effluent discharge. Therefore, stream flow at SDC02, SDC03, and SDC04 downstream of the discharge were estimated to reflect the WWTF discharge flow of 7.4 cfs plus the background flow of 0.1 cfs

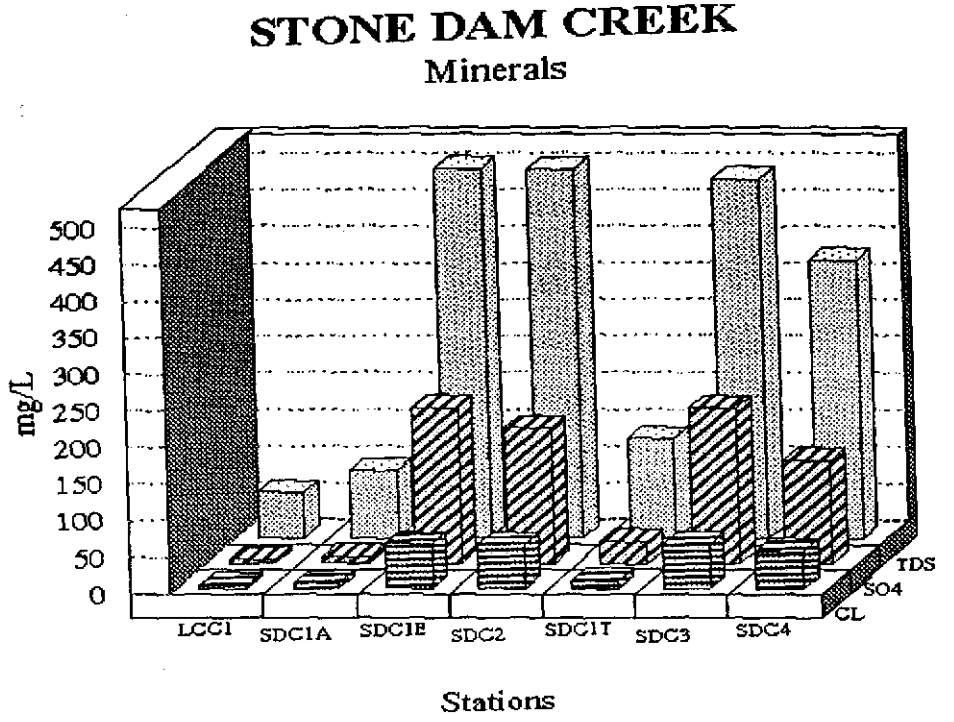
Chlorides, Sulfates, and Total Dissolved Solids

ADPC&E's routine water monitoring network has established one station on Stone Dam Creek at the Highway 65 bridge (ARK 51). Six years of monthly water quality data from this station was evaluated as a part of this survey. The six year mean for chlorides at ARK 51 was 31.2 mg/L, with a range from 3 mg/L to 67 mg/L. The 1983 ecoregion data indicates a "background" level of 5 mg/L for chlorides for small watershed streams. The water quality sample taken during this study at the ambient station ARK51 (SDC04) had a chloride concentration of 49.8 mg/L. In contrast, the upstream Stone Dam Creek sample at SDC01A had a chloride concentration of only 7.2 mg/L and the reference station LCC01 had a concentration of 3.8 mg/L. The analysis of the WWTF sample from SDC01E had a chloride concentration of 59.8 mg/L. This is an eight fold increase over the upstream, background Stone Dam Creek concentrations.

Similar increases were noted in the total dissolved solids. The mean value for TDS from the historical data from ARK51 was 242 mg/L with a range of 52 mg/L to 519 mg/L. The TDS concentration from this station during this survey was 379 mg/L. Ecoregion data indicated an average value of 46 mg/L for the streams with smaller watersheds. The upstream station SDC01A and the reference station LCC01 had TDS concentrations of 92 mg/L and 62 mg/L, respectively. The Conway WWTF effluent (SDC01E) had a TDS concentration of 503 mg/L. This is a five fold increase over background levels.

Sulfate concentrations in Stone Dam Creek were very high when compared with background ecoregion data. The summertime ecoregion average for the smaller watersheds surveyed was only 1 mg/L. The upstream station SDC01A and the reference LCC01 had sulfate concentrations of 8.7 mg/L and 4.9 mg/L, respectively; compared to the SDC01E concentration of 211 mg/L. This is reduced to 183.6 mg/L downstream at SDC02 and is further reduced to 140.8 mg/L at SDC04. The five years of data from ARK51 had a mean sulfate concentration of 65.1 mg/L ranging from 5 mg/L to 192 mg/L. Figure 5 depicts the concentrations of TDS, sulfates, and chlorides sampled during this study. The water quality data collected during this study is included as Appendix-A.

Figure 5



BOD, TSS, and Nutrients

BOD concentrations from the six years of data from ARK51 had an average concentration of 4.8 mg/L. These concentrations over this time frame ranged from 1 mg/L to a maximum value of 28.4 mg/L. The BOD concentration during the current study from SDC01E was only 2.8 mg/L compared to 1.9 mg/L and 0.7 mg/L at LCC01 and SDC01A, respectively.

Total suspended solids (TSS) data from ARK 51 had values ranging from 1 mg/L to 363 mg/L with an average concentration of 23.0 mg/L. During this survey the concentration at the WWTF outfall was very low at 1.5 mg/L. This is less than the SDC01A station and the reference station values of 4 mg/L and 31 mg/L, respectively. The highest TSS concentration (31 mg/L) was recorded at LCC01. This elevated TSS value was algal in nature and can be attributed to the nutrient loading from the surrounding pasture-land and the lack of flow in the creek. The TSS concentration in the tributary at SDC01T was 20.5 mg/L. The tributary is a man made shallow channel with a mud/silt substrate. The elevated TSS value at this station was the result of resuspended solids caused by wind action. At SDC04, an algal bloom resulted in the TSS concentration of 15.5 mg/L. The ecoregion data indicates an average concentration of 6 mg/L for the smaller watersheds assessed..

An analysis of the nutrient data from ARK 51 does not reveal any definable pattern in ammonia or nitrate concentrations. In the last six years the highest ammonia concentration was 19 mg/L, the lowest was 0.05 mg/L and the mean was 6 mg/L. This data from ARK 51 does indicate a history of

sporadic elevated ammonia levels in Stone Dam Creek although this was not seen during the course of this study. The ammonia concentrations at ARK51 from January 1991 to November 1996 are depicted in Figure 6. They range from less than detection levels to 18 mg/L with frequent values greater than 10 mg/L. Assuming a pH value of over 7.5, which regularly occurs in the lower, pooled sections of Stone Dam Creek (maximum values are >8.0), and a maximum temperature of 30 , which is common in June, July and August, acute toxicity values have been regularly exceeded in this stream. The data collected during the six years previous to this study indicates that chronic toxicity conditions existed in approximately 50% of the monthly samples taken downstream of the Conway WWTF at ARK51. In Stone Dam Creek during this study, the ammonia concentration at the above station SDC01A was below the detection limit of 0.05 mg/L. At the discharge of the City of Conway, SDC01E, the ammonia concentration was 2.1 mg/L. This was reduced to 2.06 mg/L below the effluent at SDC02 mg/L and further reduced to below detection at the last station SDC04. Nitrate concentrations from the ARK 51 data averaged 3.0 mg/L. Over the period of six years, the maximum recorded concentration of nitrate-nitrogen was 13.9 mg/L, with the lowest recorded value of 0.17 mg/L. During the 1996 study on Stone Dam Creek, the highest nitrate-nitrogen concentration was 13.4 mg/L at the discharge of the City of Conway. Background concentrations at the reference station LCC01 and the upstream station SDC01A were 0.14 mg/L and 0.15 mg/L, respectively. Concentrations at SDC04, the station just upstream from Lake Conway, remained elevated with nitrate-nitrogen concentrations of 10.6 mg/L. Total phosphorus concentration in the WWTF effluent was 3.86 mg/L. This is a major increase over the concentrations in the reference stream and at SDC01A. These stations had concentrations of 0.12 mg/L and 0.04 mg/L, respectively. Historical data from ARK 51 produced a maximum total phosphorus concentration of 6.56 mg/L and a mean of 3.0 mg/L over the six year period. Figure 7 depicts the concentrations of nutrients sampled during this study.

Dissolved Metals

Samples were analyzed from each of the water quality sampling stations for dissolved metals. A laboratory failure occurred during the course of this study which resulted in the sample taken at SDC04 not being analyzed. Some metals were elevated in the discharge. Zinc was found in the discharge at SDC01E at the concentration of 25.5 μg/L. This contrasts with the concentrations at LCC01 and SDC01A of 4.2 μg/L and 5.4 μg/L, respectively. The zinc concentrations downstream of the effluent remained elevated at SDC02 which had a concentration of 25.8 μg/L and at SDC03 with a zinc concentration of 26 μg/L. Aluminum was detected at SDC01E at a concentration of 24.9 μg/L and similar concentrations were maintained at the downstream stations. The background level in Stone Dam Creek was found to be below the detection limit of 16.0 μg/L at SDC01A. As with aluminum, background concentrations for nickel were below the detection limitations for the Departments laboratory. However, a concentration of 14.7 μg/L nickel was detected at SDC01E, 14.8 μg/L at SDC02, and 14.6 μg/L at SDC03. Boron was also elevated in the effluent sample nearly 28 fold over the background concentration of 24.1 μg/L. This high concentration of boron was present at the other stations downstream of the discharge. At the discharge, a concentration of 662.6 μg/L boron was found, while further downstream at SDC03, 585 μg/L was detected. These high concentrations of boron being discharged by the City of Conway are likely due to certain types of

Figure 6- Ammonia Concentrations at ARK 51 1991- Nov. 1996

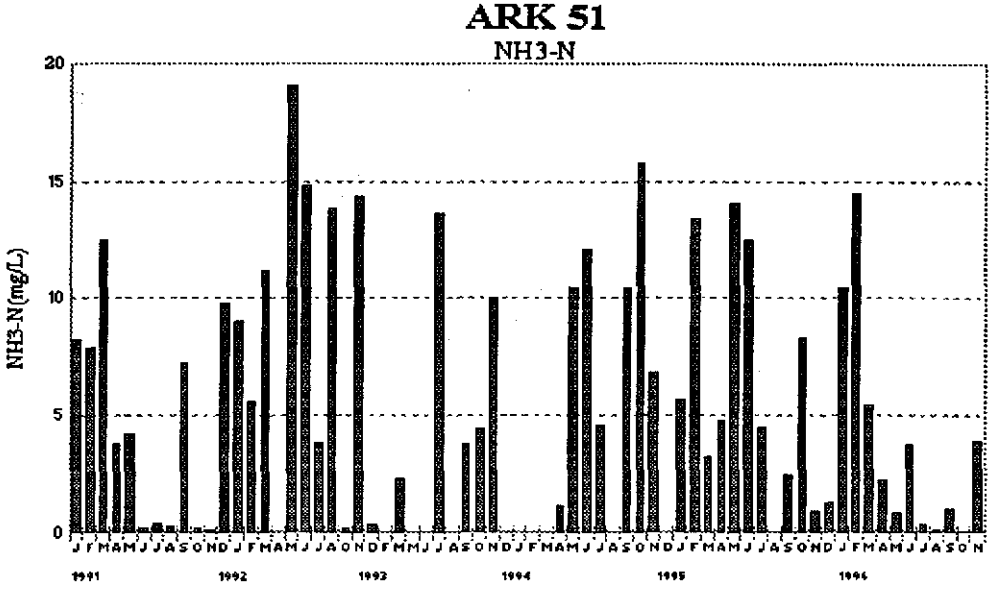
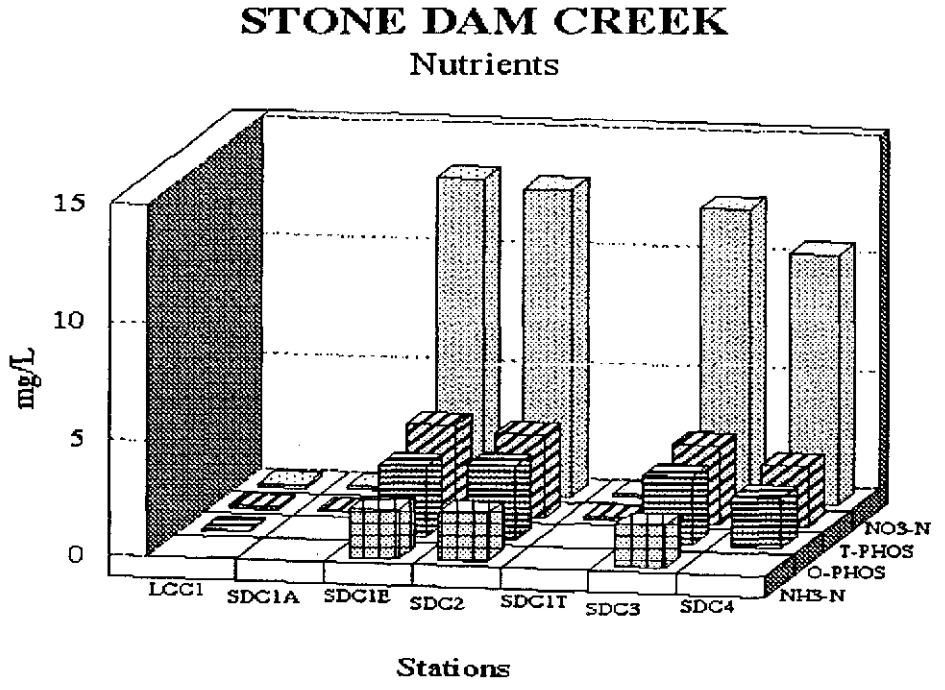


Figure 7- Nutrient Concentrations in the Study Area



cleaning agents either used at the facility or discharged into the system. Although elevated concentrations of sodium are to be expected in WWTF effluent, a rather high value of 117.8 mg/L was detected in the City of Conway discharge. None of the dissolved metals were found in toxic concentrations during this study. All metals data can be found in Appendix A.

AQUATIC MACROINVERTEBRATES

Methods

Aquatic macroinvertebrates were collected at sites LCC01 and SDC02 on July 8, 1996. Habitat data was also recorded. These methods are employed to perform rapid bioassessments in which collecting occurs for five minutes. All available microhabitats within the site are sampled to collect the maximum number of taxa from the greatest number of niches.

In the lab, all organisms, organic and inorganic material were placed in a dissecting pan. A 10 cm (4 in.) ring was placed in the pan to delimit a subsample and all organisms were removed from the ring until the ring was depleted of organisms. This process was continued until 100 organisms were removed. In cases where additional organisms remained in the ring after removal of 100 organisms, the additional organisms were placed in the subsample to reduce biasing the sample. In instances where < 100 organisms were collected, the entire sample was used to derive scores.

RBA scores from multi metric analyses are derived for each site. Each site's score is compared to the reference site score to determine percent comparable estimate (%CE) which determines the impairment status. Impairment categories are found in Table 2.

Table 2. Percent Comparable Estimate Categories to Determine Impairment.

Biological Condition	%CE	Attributes
No significant impairment	> 83%	Comparable to reference
Slight impairment	54-79%	Community structure less than reference. Taxa Richness lower and tolerant forms are more prevalent.
Moderate Impairment	21-50%	Obvious decline in community structure with loss of intolerant forms. EPT index reduced.
Severe Impairment	< 20%	Community dominated by 1 or 2 taxa, few taxa present.

Scores used for comparisons found in Table 2 are composite scores from five metrics. Taxa

richness, compares the number of taxa at each site, which is important to show diversity of the community. Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa abundances relate to the number of "intolerant" organisms. The Hilsenhoff Biotic Index (HBI), shows the tolerance level of the entire community to organic pollution in the water. The Community Loss Index (CLI) relates to the number of organisms found at the reference site but not at other sites. This form of rapid bioassessment (RBA) includes biological and physical evaluations from each site. Physical evaluations are necessary to ensure that each site can physically support the community structure found at the reference or "least impacted" site. Physical parameters are scored and scores are compared back to the reference. Sample sites with similar habitats are chosen so that a comparison can be made. A %CE for physical habitat (Table 3) was calculated to determine comparability of stations to the reference.

Table 3. Percent Comparable Estimates for Physical Assessments.

Assessment Category	%CE
Comparable to Reference	≥90%
Supporting	75-88%
Partially Supporting	60-73%
Non-Supporting	≤58%

Results

Physical metrics (CE=96%) showed SDC02 as capable of supporting a similar community to the one found at LCC01. Biological %CE showed no significant impairment (92%)(Table 4) between SDC02 (below the Conway WWTF effluent) and LCC01 (reference stream) in biological metrics. This score is lower due to the lower CLI metric score. Predators comprised almost 72% of the community at LCC01 compared to 54% at SDC02. Collectors were approximately 14% of the community at LCC01 and 35% at SDC02.

The reference site appears to have been experiencing more environmental stress during the critical season than SDC02 due to low flows and lower D.O. values. These environmental stresses could explain why only four taxa were common to both sites which resulted in the lower CLI score. The high percentage of predators at LCC01 is most likely due to two factors. The dominant factor may be the lack of flow between pools, which concentrates the organisms. As the predators consume the lower trophic organisms, the community dominance shifts to predators. The second factor could be the habitat sampled. Most of the predatory species from these sites are normally found clinging to vegetation, along root masses or along under-cut banks. These are the types of habitats associated with the sampling sites in the survey area. Taxa diversity at SDC02 was also greater, probably due to the sustained flow at this site. Flow is one of the most important environmental factors to support a diverse and healthy aquatic community. Two "intolerant"

Ephemeroptera taxa were found at SDC02 and not at the reference. This increased the diversity of this site. In contrast, organisms tolerant of organic pollution were more prevalent at SDC02 (HBI=2.8) than at LCC01 (HBI=3.0).

Without the WWTF discharge, Stone Dam Creek would be expected to be more similar to Little Cypress Creek during the critical season. However, Stone Dam Creek has an atypical flow regime due to the effluent discharge. Based on data collected at SDC02, the macroinvertebrate community was not being adversely affected by the City of Conway's sewage effluent during the study period. However, the low number of organisms collected was an area of concern and many of the metrics used may be suspect due to the low number of individuals in LCC01 and SDC02 (32 and 37, respectively). The RBA protocol calls for 100 individuals to be sampled from each site.

Table 4. Metrics from Selected Stream Sites in Little Cypress and Stone Dam Creeks.

Metric	LCC01	RBA Score	SDC02	RBA Score
	Raw Score	%CE Score	Raw Score	%CE Score
% Dominant Taxa	14	6	15	6
Taxa Richness	15	6	18	6
EPT Index	2	6	4	6
HBI	3.0	6	2.8	6
CLI	NA	6	0.6	4
Biological %CE and Total	NA	30	93	28
Physical %CE	NA	69	96	66

NA = not applicable since other sites are compared to this site

FISH COMMUNITY

On July 9, 1996 fish community surveys were conducted at the stations listed below:

Station Description

LCC01 Little Cypress Creek at Beryl Road bridge, approx 3 miles east of Saltillo. Faulkner County. (Sec 26, T5N, R12W).

SDC02 Stone Dam Creek upstream of unnamed tributary draining the City of Conway. West of I-30 frontage road approx ½ mile S of Brumley. Faulkner County. (Sec 24, T5N, R13W).

Habitat Evaluation

Habitat evaluations were performed at all sites and were comprised of five parameters each consisting of three to seven variables. These parameters included: 1) habitat type; 2) habitat quantity; 3) quantity of substrate type based on fish use 4) quantity of in stream cover; and 5) sediment on substrate. Each parameter for substrate type and in stream cover was given a score depending on its abundance. The scores given to the substrate parameters were multiplied by a factor to adjust these scores based on how they relate to fish habitat quality. Habitat type length, depth and width measurements were estimated for each habitat type and recorded in feet. The sediment on substrate parameter was scored according to the amount of sedimentation. A total score for each habitat type was calculated by summing the scores for the substrate type, in stream cover and sediment on substrate. The scores from like habitat types were then averaged. The lengths of each habitat type were also summed giving a total length of habitat type sampled per sampling station. The total habitat type lengths were then divided by 100 and multiplied by the average habitat type score. This score is the Ichthyofauna Habitat Index (IHI). Table 5 summarizes the fish habitat evaluations and includes the IHI for all tributary stations sampled.

Table 5

Fish Habitat Evaluation

SITE	Riffle				Run				Pool			
	Number Sampled	Total Length	Average Habitat Score	IHI*	Number Sampled	Total Length	Average Habitat Score	IHI	Number Sampled	Total Length	Average Habitat Score	IHI
LCC01					2	105	54.3	57	5	430	45.8	196.9
SDC02	1	20	37	7.4	3	500	45.2	226	3	380	42.5	161.5

*Ichthyofauna Habitat Index - Total Length of habitat in hundredths multiplied by the Average Habitat Score.

Results

Fish community samples were collected at both stations on July 9, 1996. They were evaluated by comparing different metrics and basic community structures. The sample collected from Little Cypress Creek was used as reference site for comparison to the site located below the wastewater treatment facility in Stone Dam Creek, (SDC02). Also, a fish community survey conducted on Mill Creek, an Arkansas River Valley ecoregion reference stream, was used as a comparison.

There were 16 species of fish collected in the reference stream and only 10 species collected below the effluent. Appendix-B is a list of species collected from each site, the number of specimens per species collected, the percent community composition of each species, the diversity index (Shannon-Wiener log base 2) and similarity indices between the two sample sites. Appendix-C depicts the family comparisons between the study stations and the ecoregion station. Also compared are percent and total number of sensitive, key and primary trophic level species.

The fish community below the wastewater treatment facility, SDC02, was comprised of only ten species. The Centrarchids dominated the community comprising almost 89% of the total community. There was a large population of hybrid sunfish at this site. This may have been from stocking practices of the Arkansas Game and Fish Commission. Experimental stocking of hybrid sunfish in this lake has occurred. However, physical anomalies were also found in several individuals. Physical malformations and a high incidence of hybrid individuals is often an indicator of stressed communities. The remainder of the community in Stone Dam Creek was comprised of four stonerollers, one common carp, two yellow bullheads, four mosquitofish and three brook silversides. The green sunfish and the largemouth bass dominated the sunfish family, and the bluegill sunfish was subdominant. Almost all of the largemouth bass were young-of-the-year and were likely migrants to the areas. These three species comprised over 80% of the entire fish community and was the main factor influencing the low diversity index of 2.36 for the station.

This station is less than ½ mile upstream from the backwaters of Lake Conway, an Arkansas Game and Fish Commission lake with the primary purposes of public fishing and recreation. This lake is routinely stocked with and managed for a sportfish fishery, such as the three most dominant sunfish listed above. Thus, the migration of sportfish upstream into this tributary more than likely occurs regularly.

The stonerollers were collected from a short, artificial riffle area that was created by the placement of a culvert and fill material in the creek. There were not any sensitive species collected in Stone Dam Creek, and there were only two key species collected which comprised 10.5% of the community. The majority of the key species population was made up of longear sunfish. The channel morphology and substrate of Stone Dam Creek may be limiting the spawning of the non-migratory species, thus limiting their numbers. The creek channel was usually less than 20 feet wide with very steep banks and little to no shallow water areas. The bottom substrate was heavily silt covered, except in the small riffle area. The riparian area was limited to just a few feet of brush and tree cover over about one half of the sample area. This creek was deeply incised with steep, fairly unstable banks.

There were 16 species of fish collected at the Little Cypress Creek reference stream(LCC01). The Centrarchids comprised almost 56% of the total community. The bluegill sunfish was the dominant Centrarchid, comprising 42% of the family total. The longear sunfish and largemouth bass were subdominant sunfish comprising 29% and 17% of the family, respectively. The

Catostomids comprised 11% of the community, but were represented by a large population of young-of-year spotted suckers. The Cyprinids comprised almost 10% of the community and were represented by three species. One species of topminnow comprised almost 8% of the community. Approximately 6% of the community were primary feeders, and 6% were sensitive species. Thirty-four percent (34%) of the community were key species.

The habitat in Little Cypress Creek consisted of low- flow to no-flow step pools separated by shallow, non-flowing runs. The substrate was usually gravel-to-sand with some mud/silt pockets. The stream banks were generally vertical on one side and sloping to a small gravel/sand bar on the other. The vegetated riparian zone was generally 10 to 20 feet wide and provides a good canopy cover over most of the sample area.

There are several differences between these two communities and Mill Creek (Arkansas River Valley ecoregion reference stream). The Centrarchids comprised almost 90% of the community at SDC02, 56% in LCC01, and about 22% in Mill Creek. Also, the Cyprinid community comprised less than three percent (3%) of the community at SDC02, almost 10% in LCC01, and almost 29% in Mill Creek. The primary feeders comprised about eight percent (8%) of the community at LCC01 and over 25% of the community in Mill Creek, but less than three percent (3%) at SDC02. Sensitive species comprised only six percent (6%) of the community at LCC01 and a little more than 12% of the community in Mill Creek. None were collected at SDC02. Key individuals comprised over half the community in Mill Creek and almost 34% at LCC01, but only about 10% of the community in Stone Dam Creek. All of the comparisons listed above and the similarity indices indicate that the communities in Stone Dam Creek and Little Cypress Creek are not very similar. In addition, the diversity indices at the two sites illustrate a lack of diversity in Stone Dam Creek and a more diverse community in Little Cypress Creek. Neither were as diverse as the ecoregion reference stream community.

Several factors may be influencing the fish community in Stone Dam Creek. The proximity of the site to Lake Conway may be one reason for the increased sunfish population, and predation from these species may be depressing the Cyprinid population. However, habitat type more than likely had the greatest influence on the population. The lack of substantial riffle habitats limits the number of riffle species, and pool species were limited by the narrow steep-side, square-bottom pools. In addition, the heavy siltation in Stone Dam Creek was probably limiting the number of bottom dwelling species and decreasing the likelihood of in-stream spawning of less migratory species such as Cyprinids. Water quality influences are also indicated by the lack of sensitive species, high numbers of morphological anomalies and low species diversity. Fish species have been found to be more sensitive to ammonia toxicity than most invertebrates.

CONCLUSIONS

A review of the water chemistry analyses of permitted constituents in the City of Conway wastewater effluent discharge indicates an adequate removal of BOD and TSS; however, several of the non-permitted constituents show a substantial change in water quality due to the wastewater

discharge. There was an eight-fold increase in chloride concentrations, an eighty-nine fold increase in nitrate-nitrogen concentrations, a twenty-four fold increase in sulfate concentrations, and a six fold increase in the concentration of TDS from the upstream Stone Dam Creek station to the first station downstream of the City of Conway's effluent. Although ammonia concentrations were not greatly elevated in the Conway effluent during this study, a review of the data collected at the downstream station (ARK51) shows numerous concentrations to the contrary. The elevated ammonia concentrations at ARK51 most likely result in the impairment of the aquatic life community. Ammonia toxicity, drastically increases as water temperature and pH increase. During the hot summer months, the elevated nutrient contributions of Stone Dam Creek facilitates algal blooms which greatly increases afternoon pH values. At a pH of 9.0 and a water temperature of 30°C, acute ammonia toxicity occurs at 0.67 mg/L.

In addition, substantially elevated concentrations of other nutrients such as nitrates and phosphates result in increases in aquatic plant life which causes significant daily fluctuations in pH and D.O. in Stone Dam Creek. Within the reservoir backwater areas this process is likely more severe. Macroinvertebrate communities were very limited in both the reference site and in Stone Dam Creek although they both ranked very similar. Enduring pool conditions of low water levels, low D.O. values and limited habitat types were limiting factors in the reference stream. Habitat diversity was also limited in Stone Dam Creek; water flow was sufficient, but water quality was significantly different. Fish communities at both reference and study sites were also restricted by different habitat limitations, but indications are that ammonia toxicity has influenced the fish community in Stone Dam Creek.

RECOMMENDATIONS

It is recommended that the NPDES discharge permit for the City of Conway wastewater treatment facility include discharge limits on ammonia-nitrogen to preclude aquatic life toxicity and that routine monitoring for nitrate-nitrogen, total phosphorus and orthophosphorus be required.

APPENDIX-A
WATER CHEMISTRY

Stone Dam Creek Survey 7-9-96							
Station ID	**LCC01**	**SDC01A**	**SDC01E**	**SDC02**	**SDC01T**	**SDC03**	**SDC04**
Flow (cfs)	*	0.1	7.4	7.5	*	7.5	7.5
DO (mg/L)	3.2	3.5	3	3.3	5.1	5	10.7
pH (SU)	7	7.1	6.8	6.8	7.6	6.9	8
Water Temp (C)	25.1	29.5	29.5	29	30.5	29.5	31.1
BOD (mg/L)	1.9	0.7	2.8	2.9	2	2.7	5.5
NH3-N (mg/L)	<0.05	<0.05	2.1	2.06	<0.05	1.76	<0.05
CL (mg/L)	3.8	7.2	59.8	60	10.5	59.7	49.8
NO3-N (mg/L)	0.14	0.15	13.4	13	0.15	12.4	10.6
0-PHOS (mg/L)	0.03	<0.03	3.04	3.13	<0.03	2.92	2.15
T-PHOS (mg/L)	0.12	0.04	3.86	3.55	0.11	3.32	2.56
SO4 (mg/L)	4.9	8.7	211	183.6	29.9	211	140.8
TOC (mg/L)	6.7	9	11.3	11.4	10.2	11.5	12
TSS (mg/L)	31	4	1.5	1.5	20.5	8	15.5
TDS (mg/L)	62	92	503	502	135	489	379
Hardness (mg/L)	28	50	83	84	66	84	NA
Turbidity (NTU)	23	4	1.1	1.3	18	4.7	7.1
Dissolved Metals							
Al (ug/L)	63.5	<16.0	24.9	26.7	<16.0	26.9	NA
B (ug/L)	14.1	24.1	662.6	670.5	104.3	585	NA
Ba (ug/L)	26.5	25.9	5.4	6.1	30.3	9.2	NA
Be (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	NA
Ca (ug/L)	4.8	14.7	28.4	28.7	18.4	28.6	NA
Cd (ug/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NA
Co (ug/L)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	NA
Cr (ug/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NA
Cu (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	NA
Fe (ug/L)	282	180	89.5	87.8	83	105	NA
K (mg/L)	1.1	1.4	12.8	12.9	1.7	12.9	NA
Mg (mg/L)	4	3.2	3	3	4.8	3	NA
Mn (ug/L)	748	118	55	61.6	316	117	NA
Na (mg/L)	2.7	8.3	117.8	118.1	14.6	109.6	NA
Ni (ug/L)	<5.0	<5.0	14.7	14.8	<5.0	14.6	NA
Pb (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	NA
V (ug/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	NA
Zn (ug/L)	4.2	5.4	25.5	25.8	2.7	26	NA

* No Flow

APPENDIX-B
FISH COLLECTION

FAMILY & SPECIES	COMMON NAME	SEN	TFL	KEY	LCC01		SDC02	
					Num	% com	Num	% com
Cyprinidae	Minnows							
Campostoma anomalum	Stoneroller		P		12	6.38	4	2.21
Cyprinus carpio	Carp		P				1	0.55
Lythrurus umbratilis	Redfin shiner				3	1.60		
Notropis emiliae	Pugnose minnow				3	1.60		
Catostomidae	Suckers							
Erimyzon oblongus	Creek chubsucker				9	4.79		
Minytrema melanops	Spotted sucker	S		K	12	6.38		
Ictaluridae	Freshwater catfishes							
Ameiurus melas	Black bullhead				1	0.53		
Ameiurus natalis	Yellow bullhead			K	12	6.38	2	1.11
Aphredoderidae	Pirate Perches							
Aphredoderus sayanus	Pirate perch				6	3.19		
Cyprinodontidae	Killifishes							
Fundulus olivaceus	Blackspotted Topminnow				15	7.98		
Poeciliidae	Livebearers							
Gambusia affinis	Mosquitofish				9	4.79	4	2.21
Atherinidae	Silversides							
Labidesthes sicculus	Brook silverside						3	1.66
Centrarchidae	Sunfishes							
Lepomis cyanellus	Green sunfish				6	3.19	54	29.83
Lepomis gulosus	Warmouth sunfish				7	3.72	2	1.11
Lepomis macrochirus	Bluegill sunfish				44	23.40	38	20.99
Lepomis megalotis	Longear sunfish			K	30	15.96	17	9.39
Micropterus salmoides	Largemouth bass				18	9.57	56	30.94
Percidae	Perches							
Etheostoma whipplei	Redfin darter			K	1	0.53		
	TOTAL SPECIES				16		10	
	TOTAL NUMBERS				188		181	
	Effort (sec)				2661		2064	
	Catch/Effort				4.24		5.26	

APPENDIX-C
FISH COMMUNITY

COMMUNITY STRUCTURE (as percent total community)				
Family		LCC01	SDC02	Mill Creek
Cyprinidae		9.57	2.76	28.90
Catostomidae		11.17	0.00	6.90
Ictaluridae		6.91	1.06	11.20
Centrarchidae		55.85	88.83	21.40
Percidae		0.53	0.00	11.40
Total Species Collected		16	10	28
No. Sensitive Species		1	0	4
No. Sensitive Individuals		12	0	83
% Sensitive Individuals		6.38	0	12.24
No. Primary TFL		12	5	187
% Primary TFL		8.33	2.76	27.58
No. Key Individuals		55	19	344
% Key Individuals		33.69	10.5	50.74
Diversity Index		3.47	2.36	3.74
Species Similarity Index	LCC01		0.62	0.50
	SDC02			0.32
RelativeAbundance Similarity Index	LCC01		0.63	0.42
	SDC02			0.39

APPENDIX-D
MACROINVERTEBRATE COLLECTION

Taxa collected from Little Cypress and Stone Dam Creek				LCC01	SDC02
HBI	Feed	EPT	Taxa	# Coll.	# Coll.
3	COL	N	*Paelomenetes*		1
3	COL	N	Cambaridae (F)	1	
3	COL	N	*Orconectes*		3
2	COL	Y	*Siphlonurus*		2
3	SCR	Y	*Stenonema*		2
1	COL	Y	*Choroterpes*		1
2	COL	Y	*Caenis*	3	6
4	PRE	N	*Enellagma*	3	
4.5	PRE	N	*Ischnura*	5	5
1	PRE	N	*Boyeria*		1
4	PRE	N	*Nasiaeschna*		1
2.5	PRE	N	*Neurocoudulia*		5
5	PRE	N	*Perithemis*	4	
5	PRE	N	*Ranatra*	1	
2.75	PIE	N	*Tricocorixa*	1	
4	PRE	N	*Sialis*	2	1
3	FIL	Y	*Cheumatopsyche*	1	
3.4	SHR	N	*Peltodytes (A)*	2	
3	SCR	N	*Cyphon (L)*		1
2.5	PRE	N	*Berosus (L)*	2	
3.3	SHR	N	*Hydrochus (L)*	1	
4.7	PRE	N	*Chaoborus*		1
3.5	PRE	N	*Palpomyia*	1	
2.5	SHR	N	*Haematopota*		1
3	PRE	N	Chironomid 1		2
4	PRE	N	*Ablabesmyia*		2
2	PRE	N	*Psectrotanypus*	5	2
		Total		32	37