TECHNICAL JUSTIFICATION FOR A SITE-SPECIFIC TEMPERATURE CRITERION FOR THE HARVEY COUCH PLANT RECEIVING WATERBODIES

Prepared for

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EXECUTIVE SUMMARY

Overview

Entergy Arkansas currently owns and operates the Harvey Couch Plant (Couch Plant) located in northeast Lafayette County, Arkansas, approximately 2 miles east of Stamps, AR. During periods of power generation in warm weather (July, August, September), discharge temperatures exceed the National Pollutant Discharge Elimination System (NPDES) permit limit of 86°F (30°C). Under the current plant operations temperature exceedances are mitigated by pumping groundwater from the Sparta Aquifer to the heated discharge thereby cooling the discharge to comply with permit limits.

The Couch Plant discharges into an unnamed tributary. The watershed run-off is primarily from forested and agricultural land with a small amount of urban run-off from the City of Stamps. The Couch Plant is the only point source in the basin.

This study was undertaken to evaluate a site-specific temperature criterion, as provided in Section 2.308 in the Arkansas Department of Environmental Quality (ADEQ) (2002), for the unnamed tributary to allow discontinued use of groundwater to cool the discharge. This document does not propose to remove designated uses or establish subcategories of designated uses with less stringent criteria, but rather is intended to support a less stringent temperature criterion in the unnamed tributary by showing that existing temperature exceedances do not impair designated uses.

The specific water quality criteria of concern for this study is the 86°F (30°C) temperature criterion for Typical Gulf Coastal Ecoregion streams (APCEC, 2002 page A-34.)

Technical Approach

The purposes of this study were to:

1. Determine what aquatic life uses are currently being achieved in the receiving water body,
2. Identify the causes of any impairments of the aquatic life uses,

3. Evaluate what aquatic life uses can be attained based on the physical, chemical and biological characteristics of the receiving water body,
4. Evaluate if designated uses, particularly the seasonal Gulf Coastal Fishery use, are existing or attainable uses under the present pattern of temperature exceedances in the receiving waterbody, and
5. Modify the existing temperature criterion while still protecting all designated uses in the receiving water bodies.

Physical (temperature), chemical and biological sampling was conducted at selected locations within the unnamed tributary and Lake June. The objectives of the sampling were to

1. Survey the aquatic life (fish and benthic macroinvertebrates) present in the lotic segments of the receiving water body,
2. Measure the maximum effluent temperatures in the effluent during July and August weather conditions without the addition of groundwater for cooling,
3. Measure the temperature change in the discharge after it passes through the lotic segments of the receiving waterbody.

Results and Findings

The temperature, chemical and biological monitoring conducted during 2003 indicates

1. Maximum Outfall 002 temperatures often exceed 30°C in the absence of power generation due to ambient heating of the treatment pond system.
2. Maximum Outfall 002 temperatures are comparable to maximum surface temperatures in Lake June.
3. The temperature regime in the unnamed tributary reflects cooling of the discharge as it approaches a new equilibrium determined by ambient conditions of temperature, humidity, wind and solar radiation in the unnamed tributary.
4. The Outfall 002 temperature is very near the equilibrium or natural temperature with expected differences between Outfall 002 and equilibrium temperature less than 5°F.
5. Mean and maximum temperatures in Lake June are higher than at the Lake June inflow (downstream end of the unnamed tributary).
6. Based on existing data, a well developed warm water fishery exists in Lake June.
7. Based on biological sampling, a diverse assemblage of benthic macroinvertebrates and fish are present in the unnamed tributary.

Conclusions and Recommendations

The essential features of this evaluation are summarized in Table ES.1. The following conclusions and recommendations are based on the study findings.

1. The thermal regime of the receiving waterbody is primarily controlled by ambient atmospheric conditions and solar input rather than by heating due to power generation.
2. The receiving waterbody is suitable for the propagation of fish and other forms of aquatic life and is attaining its designated aquatic life use in the presence of temperature exceedances at Outfall 002.
3. No designated uses are impaired due to the current level of temperature exceedances at Outfall 002.
4. A year-round site-specific temperature criterion of 35.0°C is proposed for the unnamed tributary between Outfall 002 and the lake inflow with no delta 5°F limitation. This criterion is near the maximum temperature attained at Outfall 002 during 2001 through 2003.
5. A site-specific temperature criterion of 35.0°C will allow Entergy to eliminate groundwater pumping from the Sparta Aquifer for the purposes of cooling its discharge while maintaining designated uses in the unnamed tributary and Lake June.
6. The "no action" option will result in continued pumping of Sparta aquifer groundwater for purposes of cooling the discharge.
7. Information obtained during the summer of 2003 indicates that the Plant will be able to consistently meet the proposed criterion.

Table ES.1. Use attainability summary table.

Receiving water body name: Unnamed tributary to Lake June
Stream Location: Physiographic Region – Gulf Coastal Planning Segment – 1A County – Lafayette
Section: NE Quarter, Section 16 Range: 23 W Township: 16S
Watershed size at study site: 4.1 mi^2
Type of discharge: Industrial
Designated uses: • Fisheries, Seasonal Gulf Coastal fishery • Secondary contact recreation • Domestic water supply • Industrial water supply • Agricultural water supply
Proposed changes in designated uses: None
Current temperature criterion: 86°F (30°C) for unnamed tributary
Proposed temperature criterion: 95.0°F (35.0°C) for unnamed tributary, No delta 5°F limitation

1.0 INTRODUCTION

Entergy Arkansas currently owns and operates the Harvey Couch Plant (Couch Plant) located in northeast Lafayette County, Arkansas, approximately 2 miles east of Stamps, AR (Figure 1.1). The Couch Plant consists of two gas/petroleum fired units. Units I and II are rated at capacities of 30 and 125 Megawatts (MW), respectively. Unit II (125 MW) operates intermittently throughout the year to supply power during summer periods of peak demand. Unit I (30 MW) operates primarily when Unit II undergoes maintenance outages and occasionally during high summer loads. Between January 1, 2000 and November 30, 2003 Unit II operated 30% of the time (a total of 434 days) while Unit I operated 22% of the time (309 days).

During periods of power generation in warm weather (July, August, September), discharge temperatures often exceed the National Pollutant Discharge Elimination System (NPDES) permit limit of 86°F (30°C). Under the current plant operations temperature exceedances are mitigated by pumping groundwater from the Sparta Aquifer to the heated discharge thereby cooling the discharge to comply with permit limits. An average of approximately 50 million gallons of ground water was pumped for this purpose annually during 2001 through 2003. The capacity of the groundwater cooling system is limited such that only one power unit can be operated during very hot weather. In addition, groundwater quality in some of the production wells has shown significant increases in total dissolved solids (TDS) and chlorides. This decrease in groundwater quality has prompted Entergy to consider drilling additional groundwater wells off-site to meet its needs for production and discharge cooling purposes.

The United States Geological Survey (USGS) records indicate that the plant's groundwater wells tap the Sparta Aquaifer (Figure 1.2) which is experiencing unsustainable rates of water withdrawal (McKee, et al 2004; SGDC 2002; UCWBC 2004). Continued use of groundwater for cooling purposes may be undesirable from the stand point of groundwater conservation.

This study was undertaken to obtain information to evaluate a site-specific temperature criterion for the receiving waterbody to allow discontinued use of groundwater to cool the discharge.

This report is organized as follows:

Executive Summary – This section provides a brief overview of the background, technical approach, sampling results, conclusions and recommendations of the study.

Section 1 – Introduction – This section describes general characteristics of plant operation and the motivation for the study.

Section 2 – Background information – This information includes descriptions of the wastewater process (A detailed description of the wastewater process is provided in Appendix A), watershed, waterway, applicable water quality criteria and designated uses, NPDES permit limits and an overview of the NPDES monitoring data.

Section 3 – Technical approach – This section describes the technical approach to the study including applicable regulations.

Section 4 – Field survey – This section provides methods and results of the field survey including temperature monitoring and chemical and biological sampling.

Section 5 – Evaluation of temperature regimes in the receiving waterbodies - This section discusses temperature regimes in the receiving waterbodies in relation to the discharge of effluent from the Couch Plant.

Section 6 – Evaluation of existing and attainable uses - This section discusses attainment of uses with respect to existing temperature regimes and habitat.

Section 7 – Proposed site-specific temperature criterion - This section presents the proposed site-specific temperature criterion and a synopsis of the justification for the proposed change.

Section 8 – Alternative evaluation - This section discusses the "no action" alternative to site-specific criterion.

Section 9 – Benefits of site-specific criterion - This section discusses the benefits of the site-specific criterion.

Section 10 – Conclusions - This section presents a summary of major findings of the field survey and the conclusions supporting a modification of the temperature criterion.

Tables referenced in the text are placed within the text while figures are placed at the end of the section in which they are first referenced.

The essential features of this evaluation are summarized in Table 1.1

Table 1.1. Use attainability summary table.

Receiving waterbody name: Unnamed tributary to Lake June
Stream Location: Physiographic Region-Gulf Coastal Planning segment-1A County-Layfayette
Section: NE Quarter, Section 16 Range: 23W Township: 16S
Watershed size at study site: 4.1 mi^2
Type of discharge: Industrial
Designated uses: • Fisheries, Seasonal Gulf Coastal fishery • Secondary contact recreation • Domestic water supply • Industrial water supply • Agricultural water supply
Proposed changes in designated uses: None
Current temperature criterion: 86°F (30.0°C) for unnamed tributary
Proposed temperature criterion: 95.0°F (35.0°C) for unnamed tributary; No delta 5°F limitation

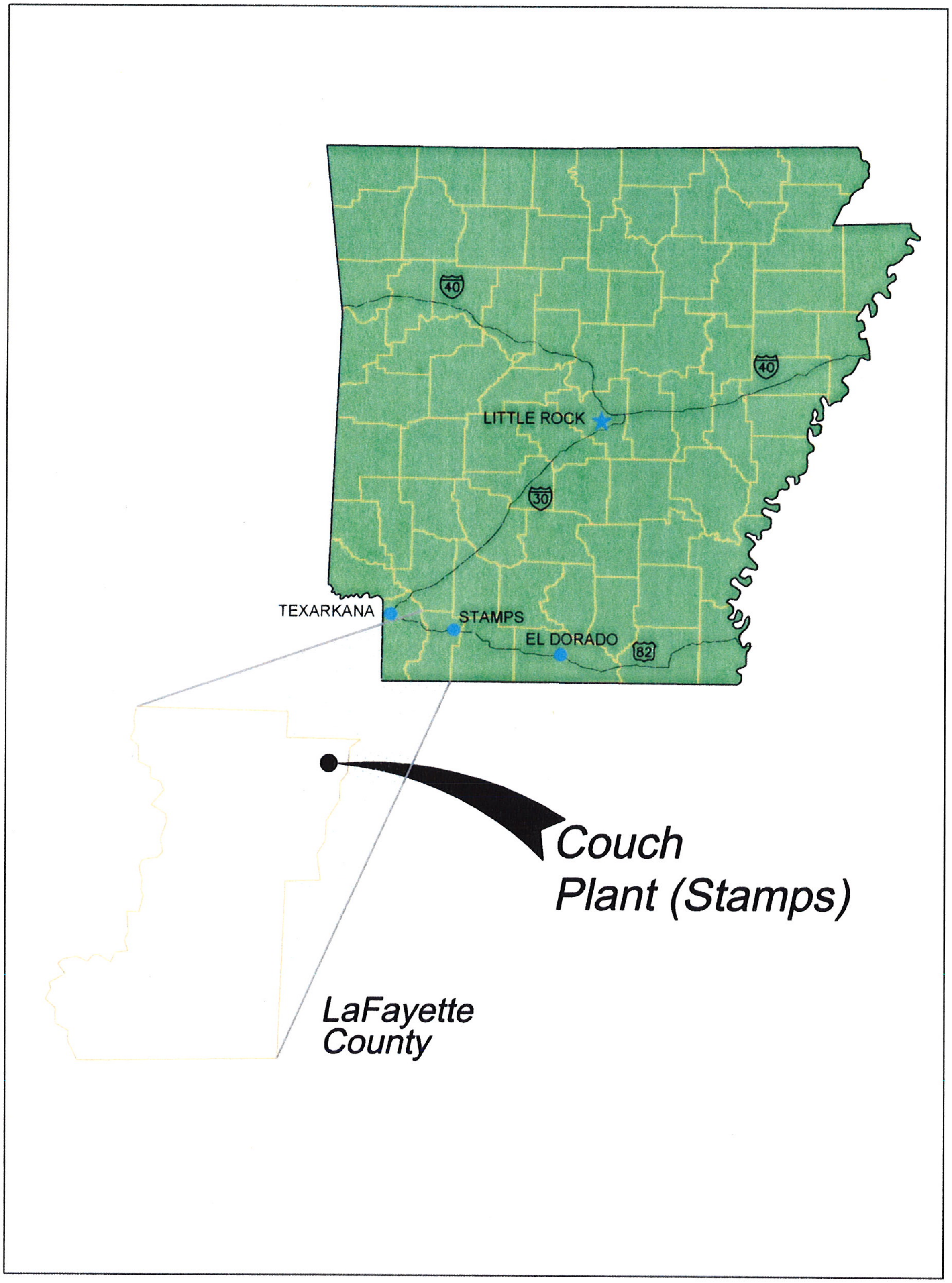

Figure 1.1. Location map showing location of the Couch Plant in Lafayette County, Arkansas.

Figure 1.2. Boundary and extent of Sparta Aquifer in Arkansas (Modified from McKee et al, 2004).

2.0 BACKGROUND

2.1 Wastewater Process

The Couch Plant uses water from the Sparta aquifer for plant operations. A water flow diagram is provided in Figure 2.1. The two sources of water discharged from the plant under NPDES Permit No. AR0000493 are low volume wastewater and cooling tower blowdown. The sources and treatment of this discharge water are discussed in Appendix A.

All sources of water used at the Couch Plant are from one of six active wells. The well water is first aerated to precipitate iron. The precipitate is collected in settling basins that also act as storage basins for reserve water capacity. Cooling water makeup and miscellaneous service water is supplied directly from the settling basin. Continuous evaporator blowdown is directed to the floor drain system. The floor and yard drainage enters the Power Block Pond. The discharge from the Power Block Pond makes up internal Outfall 02A.

The recirculating cooling water system at the Couch Plant is designed to dissipate the waste heat associated with power production. A cooling tower serves each unit. During the cooling process a portion of the recirculating water is evaporated causing an increase in the dissolved solids of the remaining water. To control this concentration and maintain system chemistry, water is discharged from the cooling system as blowdown and replaced with higher quality makeup water provided by the plant's water wells. Blowdown from both units is discharged from the cool side of the tower into the Cooling Tower Pond. Discharge from the Cooling Tower Pond makes up internal Outfall 02B.

Effluent from internal Outfalls 02A and 02B are combined in the mixing pond. The combined effluent then flows into a constructed wetlands treatment system which discharges through Outfall 002 under NPDES Permit No. AR0000493 (Figure 2.1). Measurements and samples required by the NPDES permit are taken at a weir constructed at Outfall 002. Following the weir, groundwater is metered as needed into the flow to maintain temperature of the discharge below the permitted level.

Prior to November 2001, low volume waste and cooling tower blowdown were discharged via separate outfalls. In November 2001, the NPDES permit was modified to allow discharge of both waste streams through Outfall 002. Although the plant has experienced temperature and heavy metal exceedances since the issuance of the first NPDES permit (February 1, 1998), only the discharge and compliance history of the present Outfall 002 is considered in this investigation.

Under the proposed site-specific temperature criterion, temperatures will be measured at Outfall 002 instead of after the addition of well water as indicated in Figure 2.1.

2.2 Watershed and Waterway Description

The Couch Plant discharges into an unnamed tributary that flows into Lake June (Figure 2.2). The watershed area for Lake June is approximately 6.3 mi^2. The watershed run-off is primarily from forested and agricultural land with a small amount of urban run-off from the City of Stamps. The Couch Plant is the only point source in the basin.

Outfall 002 (Point A) feeds the main inflow to Lake June via Point C (Figure 2.3). Conversations with agency personnel (Drew Wilson, District Fisheries Biologist, Arkansas Game and Fish Commission, Hope Regional Office, April 8, 2003) indicate that most, if not all, of the inflow to Lake June enters from the area east of Highway 53 (Figure 2.2). Field observations conducted during the summer of 2003 did not indicate the presence of any sources of inflow between points A and C or north of the swampy backwater area east of Highway 53 (Figure 2.3).

The receiving waterbody, which is located in the Gulf Coastal Ecoregion (Planning Segment 1A), can be considered as two somewhat distinct segments as described below.

2.2.1 Unnamed Tributary

This segment begins at Outfall 002 (Point A) and extends to the railroad bridge at Point C (Figure 2.3). This portion of the receiving stream is swampy and sluggish with a watershed area of 4.1 mi^2. The receiving stream in the vicinity of Point C represents the primary inflow to Lake June during the dry season. Accordingly, Point C will be referred to as the "lake inflow". Field observations indicate that the portion of the unnamed tributary from the Outfall 002 (Point A) to Point B has little shading from overstory vegetation, while the portion of the unnamed tributary from Point B to the lake inflow (Point C) has significant shading from overstory vegetation. Except during periods of high run-off, stream flow is probably composed primarily of plant discharge.

2.2.2 Lake June

Lake June represents the lentic portion of the receiving waterbody. Lake June has a watershed area of 6.3 mi^2, including the watershed area of the unnamed tributary (Figure 2.2). In the vicinity of the lake inflow (Point C), the receiving stream transitions from a sluggish lotic system to the shallow swampy backwater of Lake June.

Lake June was constructed in the 1940's for the purpose of supporting logging operations. The Arkansas Game and Fish Commission (AGFC) has leased and managed the lake since 1957. The location of Point D in Figure 2.3 suggests that the point is located on dry land. However, the backwater area of the lake is far more extensive than indicated in Figure 2.3. As shown in the photograph taken near Point D (Figure 2.4) substantial aquatic habitat exists in this area of Lake June.

2.3 Water Quality Criteria and Designated Beneficial Uses

2.3.1 Designated Uses: Unnamed Tributary

Regulation No. 2 (APCEC 2002) lists the following designated uses for streams in the Gulf Coastal Plain with a watershed area of < 10 mi^2:

- Seasonal Gulf Coastal fishery
- Secondary contact recreation
- Domestic water supply
- Industrial water supply
- Agricultural water supply

The watershed area of the lotic segment of the receiving waterbody is 4.1 mi^2. The distribution of flows from Outfall 002 during January 1, 2001 through December 10, 2003 is shown in Figure 2.5. These data indicate that flows are typically <1 cfs (99% of the measured flows are <1 cfs). These stream characteristics indicate that this segment should support a

Seasonal Gulf Coastal fishery during the primary season (water temperatures below 22°C; mid September through May; APCEC 2002).

2.3.2 Designated Uses: Lake June

Regulation No. 2 (APCEC 2002) lists the following designated uses for lakes and reservoirs:

- Fisheries
- Secondary contact recreation
- Primary contact recreation
- Domestic water supply
- Industrial water supply
- Agricultural water supply

Conversations with agency personnel (Drew Wilson, District Fisheries Biologist, Arkansas Game and Fish Commission, Hope Regional Office, April 8, 2003) revealed that the AGFC performs biannual electroshocking and shoreline seining surveys focusing primarily on largemouth bass abundance and reproduction. Shoreline seining has shown the presence of young-of-the-year largemouth bass as well as sunfish, threadfin/gizzard shad, silversides, topminnows and darters. Drew Wilson characterized the largemouth bass population as "good" based on electroshocking catch per unit effort (82 black bass per hour, compared with 111 black bass per hour in samples from Dierks Reservoir.) The lake is heavily fished by the local population. In addition, AGFC regularly stocks largemouth bass and channel catfish. This information clearly indicates an existing fishery use for Lake June.

Because the fishery use is an existing, unimpaired use, and because temperature exceedances at Outfall 002 are not likely to affect other uses (recreation and domestic/agricultural/industrial water supply), Lake June can be considered as meeting all of its designated uses. Accordingly, no further discussion of Lake June use attainment will be presented in this document.

2.3.3 Water Quality Criteria

The specific water quality criteria of concern for this study is the 86°F (30°C) temperature criterion for Typical Gulf Coastal Ecoregion streams and the 89.6°F (32°C) temperature criterion for lakes and reservoirs (APCEC 2002, page A-034). An additional limitation in Regulation No. 2 (APCEC 2002, page 5-1) states that "Heat shall not be added to any waterbody in excess of the amount that will elevate the natural temperature, outside the mixing zone, by more than 5°F (2.8°C) based upon the monthly average maximum daily temperatures measured at mid-depth or 3 feet (whichever is less) in streams, lakes or reservoirs". It is anticipated that, under current operating schemes, the discharge will not exceed the natural temperature by more than 5°F. However, this study will recommend that the limitations no longer apply as part of the site-specific criterion.

2.4 NPDES Permit Limits

The present discharge from the Couch Plant is through Outfall 002 and is regulated by NPDES Permit No. AR0000493. Prior to November 2001, low volume waste and cooling tower blowdown were discharged via separate outfalls. In November 2001, the NPDES permit was modified to allow discharge of both waste streams through Outfall 002. Although the plant has experienced temperature and heavy metal exceedances since the issuance of the most recent NPDES permit (February 1, 1998), only the discharge and compliance history of the present Outfall 002 is considered in this investigation.

Permit limits were established for this discharge to protect the designated uses in the receiving stream. NPDES permit parameters and limits are summarized in Table 2.1. Due to the intermittent nature of generation, low volume waste produced via internal Outfall 02A dominates most wastewater discharges from Outfall 002. Specified temperature measurements are daily. Oil and grease, phosphorus, free chlorine and pH measurements are from weekly grab samples. Copper, lead and zinc measurements are from monthly 24 hr composite samples.

2.5 NPDES Monitoring

2.5.1 NPDES Monitoring: Chemical Parameters and Temperature

Mean, minimum and maximum values obtained for the permitted parameters based on Discharge Monitoring Reports (DMRs) from November 2001 through September 2003 are presented in Table 2.1. In general, this facility has been in compliance with all parameters except temperature and metals.

Table 2.1. Summary of NPDES permit limits and Discharge Monitoring Report (DMR) values for Couch Plant Outfall 002 (NPDES Permit Number AR0000493) November 2001 through December, 2003.

Parameter	NPDES Permit Limits		Reported DMR Values		
	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Daily Minimum
Temperature (°F/°C)	NA	86/30	70.7/21.5	91/32.8	52/11.1
pH	NA	6/9[1]	7.7	8.8	6.6
Oil and Grease	10	15	1.1	2.9	NA
Total Phosphorus (mg/L As P)	5	5	0.9	2.7	NA
Total Recoverable Copper (ug/L)	12	24	7.6	51	0
Total Recoverable Zinc (ug/L)	116	232	7.4	54	0
Total Recoverable Lead (ug/L)	3.8	7.6	1.6	40	0

Note: 1=Minimum/Maximum limits; NA=not applicable

Exceedances of the temperature limit of 86°F were noted in the DMR reports in July and August of 2002 and July of 2003. Figure 2.6 indicates that temperatures at Outfall 002 typically exceed the permit limit of 86°F (30°C) during the months of July and August. Temperature exceedances were recorded during July and August of 2001 and 2002 even though groundwater was used to cool the final discharge in 2002. Per the provisions of Consent Administrative Order LIS 010-039-002 (Modification No. 2) the discharge at Outfall 002 was allowed to exceed 86°F without the addition of groundwater. The potential for aquatic life impairment due to temperature exceedances is the focus of this study and will be discussed in later sections.

Outfall 002 has exceeded the NPDES permit limit for total recoverable copper (Table 2.1). The plant's treatment system was upgraded during 2000 and 2001 to increase the effectiveness of metal treatment. The plant has identified problems with the chemical treatment for metals during low-flow, non-generation periods. However, copper concentrations in the effluent are not likely to be influenced by the temperature regime of the outfall.

Implications of copper exceedances regarding impairment of aquatic life are discussed in detail in Appendix B, which concludes that the total copper present in the receiving stream is largely unavailable to biota and rarely reaches toxic levels. This conclusion is supported by the lack of toxicity to invertebrates in chronic biomonitoring toxicity tests (Section 2.7) and by the presence of a diverse aquatic life community in the unnamed tributary (Section 6.1). Therefore exceedance of metals criteria should not be a factor in the study.

2.5.2 NPDES Monitoring: Toxicity Testing

Routine quarterly chronic biomonitoring was performed on Outfall 002 during 2003. No lethal or sub-lethal toxicity to *Ceriodaphnia dubia* was observed in any tests. However, the plant effluent was lethally toxic to *Pimephales promelas* during the test conducted in February 2003 (Tables 2.2 and 2.3). Patterns of mortality (e.g. interrupted dose response, high variability within replicates) strongly suggested pathogen related interference in the February test. Further evidence of pathogen interference was obtained through testing of samples after sterilization using ultraviolet (uv) light. These results are consistent with toxicity testing conducted on the Couch plant Outfall 005 which was operational before the entire discharge was consolidated into the present Outfall 002. Toxicity characterization conducted on Outfall 005 during 1999 indicated that pathogen interference was the likely sole cause of lethal toxicity in chronic *P. promelas* tests. The Arkansas Department of Environmental Quality (ADEQ) concurred with this interpretation and did not require a Toxicity Reduction Evaluation to be performed per the NPDES permit in force at the time.

Beginning in 2002, all routine testing using *P. promelas* was performed on uv sterilized and unsterilized samples in concurrent tests. Beginning with 2003, quarterly testing was resumed as a result of changes to the treatment process. Results of routine biomonitoring during 2003 (Tables 2.2 and 2.3) indicate:

- No episodes or lethal or sub-lethal toxicity to *C. dubia*, and
- Toxicity to *P. promelas* is attributable to pathogen interference as indicated by toxicity removal after uv light treatment.

The results indicate that the Outfall 002 effluent is not toxic to aquatic life.

Table 2.2. Summary of routine quarterly biomonitoring of Outfall 002 using *P. promelas* during 2003. Survival values are percent survival at day 7. Growth values are mean dry weight per individual fish. NA=not applicable.

Date	Uv Treatment?	Endpoint	Effluent Concentration (% Effluent)					
			0	32	42	56	75	100
2/13/03	No	Survival	98	8*	0*	4*	0*	0*
		Growth	0.319	NA	NA	NA	NA	NA
	Yes	Survival	98	100	100	100	98	96
		Growth	0.319	0.291	0.243*	0.268	0.319	0.264
6/12/03	No	Survival	94	86	100	92	94	90
		Growth	0.381	0.304	0.315	0.365	0.310	0.262*
	Yes	Survival	94	86	92	95	94	94
		Growth	0.381	0.355	0.331	0.351	0.355	0.319
9/4/03	No	Survival	94	100	98	90	98	100
		Growth	0.489	0.486	0.413	0.355	0.402	0.420
	Yes	Survival	94	98	96	98	100	98
		Growth	0.489	0.353	0.346	0.388	0.428	0.389
10/23/03	No	Survival	100	100	96	100	100	100
		Growth	0.516	0.487	0.451	0.453	0.403*	0.358*
	Yes	Survival	100	98	100	98	100	100
		Growth	0.516	0.472	0.457	0.468	0.519	0.457

*Significantly different from control (P<0.05).

Table 2.3. Summary of routine quarterly biomonitoring of Outfall 002 using *C. dubia* during 2003. Survival values are percent survival at end of test. Reproduction values are mean number of neonates per individual.

Date	Endpoint	Effluent Concentration (% Effluent)					
		0	32	42	56	75	100
2/13/03	Survival	100	100	100	100	100	100
	Reproduction	20.9	31.4	34.1	29.2	34.2	30.4
6/12/03	Survival	100	80	100	100	100	100
	Reproduction	26.8	18.4	31.4	31.7	32.2	26.1
9/4/03	Survival	90	90	90	100	100	80
	Reproduction	30.8	33.1	31.4	38.2	35.2	31.8
10/23/03	Survival	90	90	100	80	100	100
	Reproduction	22.1	26.1	27.6	21.9	28.4	26.0

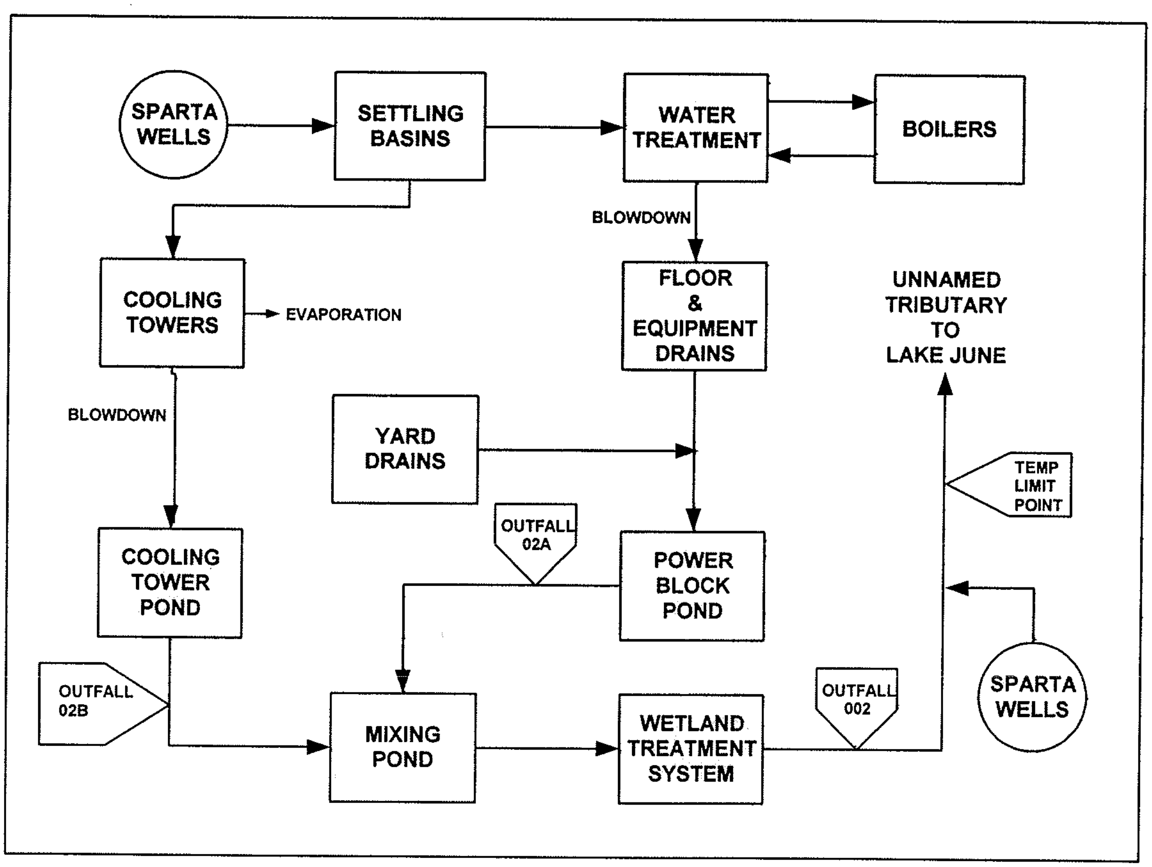

Figure 2.1. Flow diagram of Couch Plant.

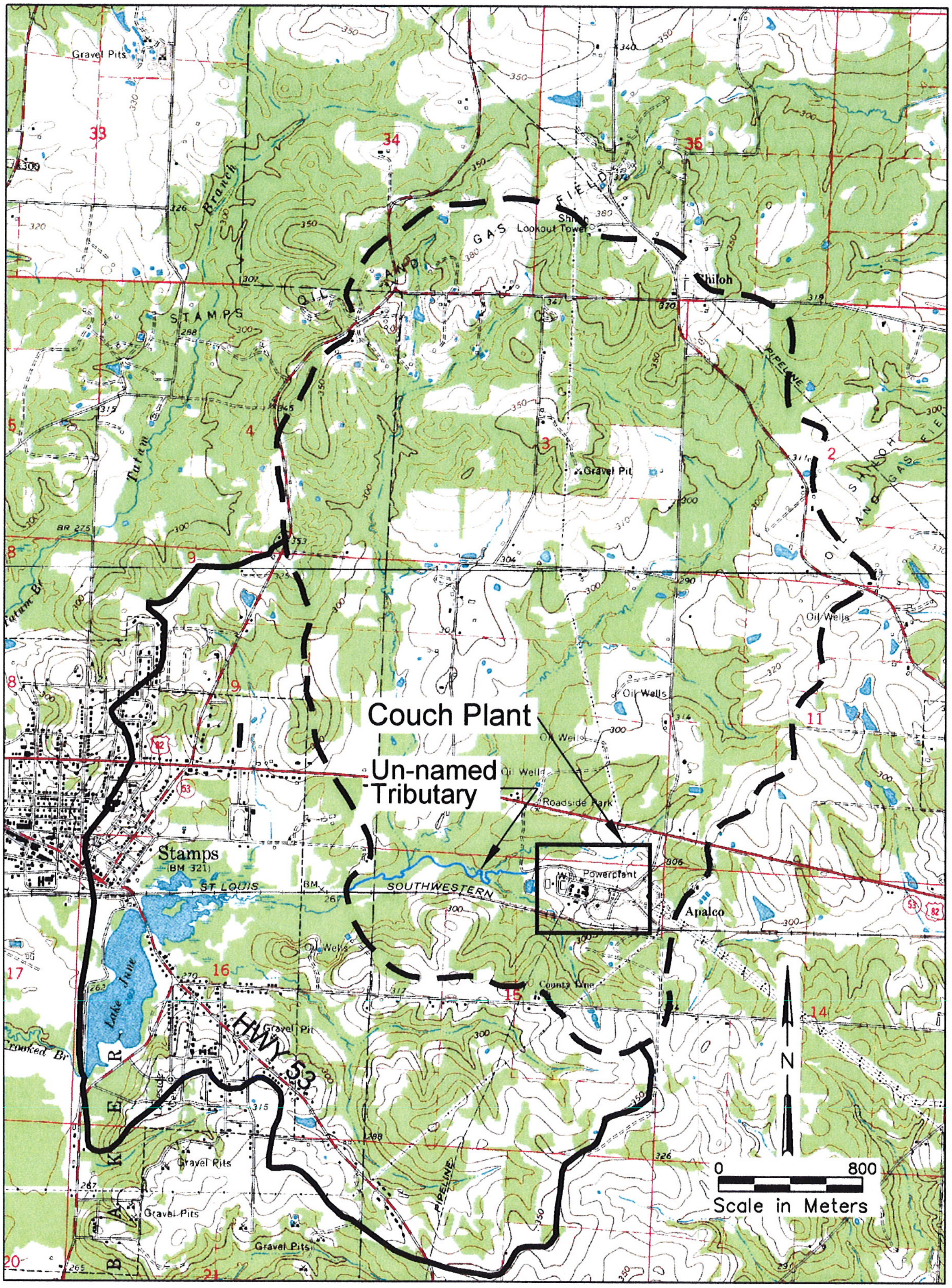

Figure 2.2. Map of study area showing location of Couch Plant and watershed boundaries of the unnamed tributary (dashed boundary) and Lake June (solid and dashed boundaries).

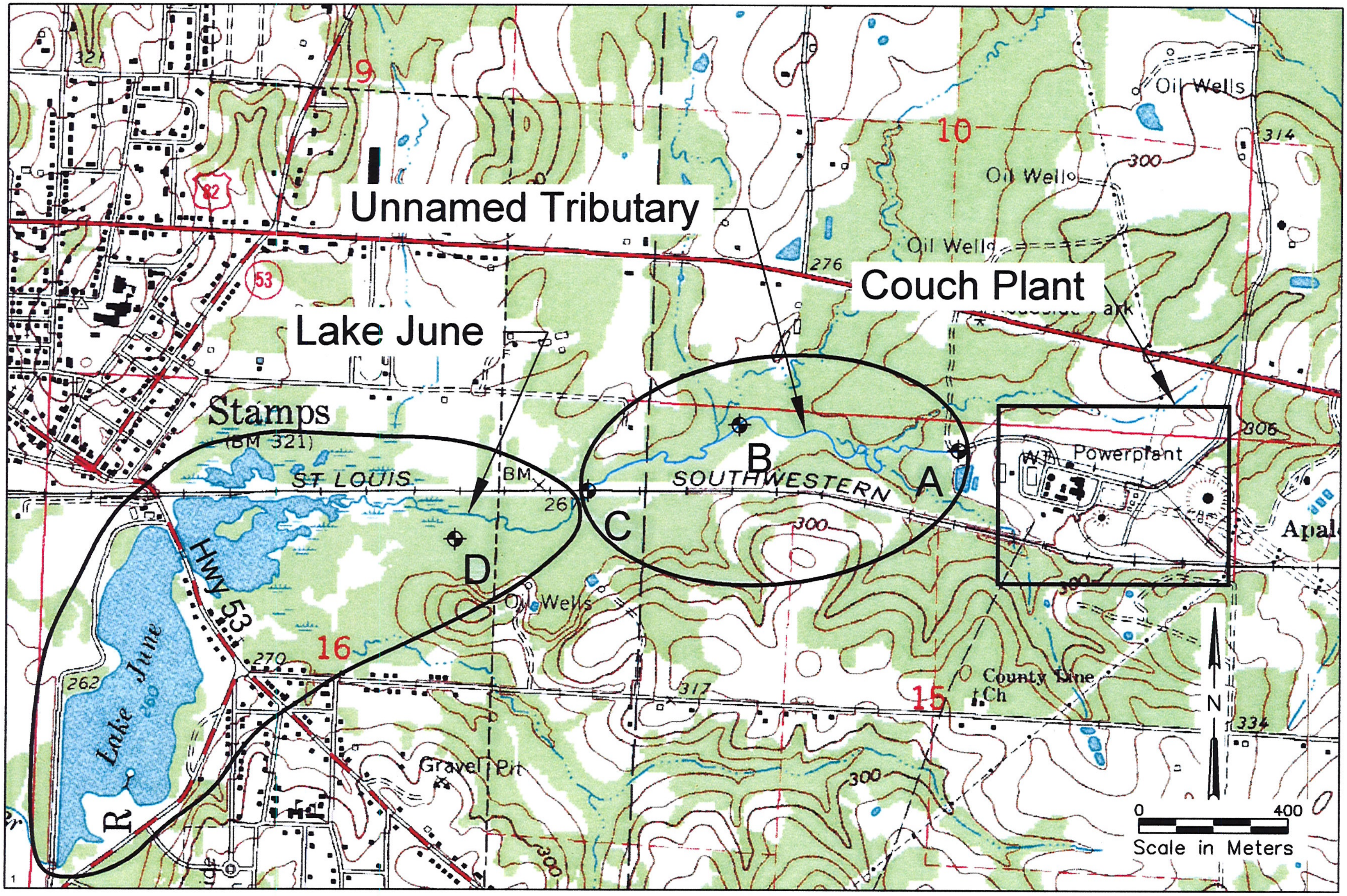

Figure 2.3. Map of study area. See text for description of Points A, B, C, and D.

Figure 2.4. Photograph of upper Lake June backwater in vicinity of Point D.

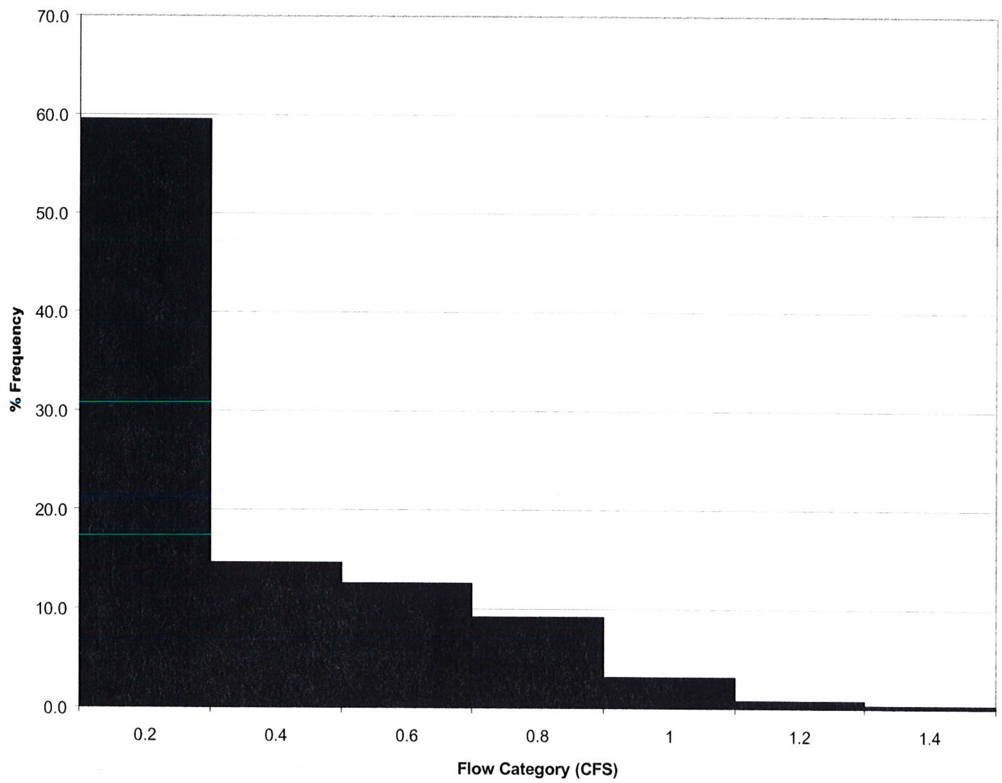

Figure 2.5. Distribution of daily flows (cfs) from Outfall 002 during January 2, 2001 through December 10, 2003.

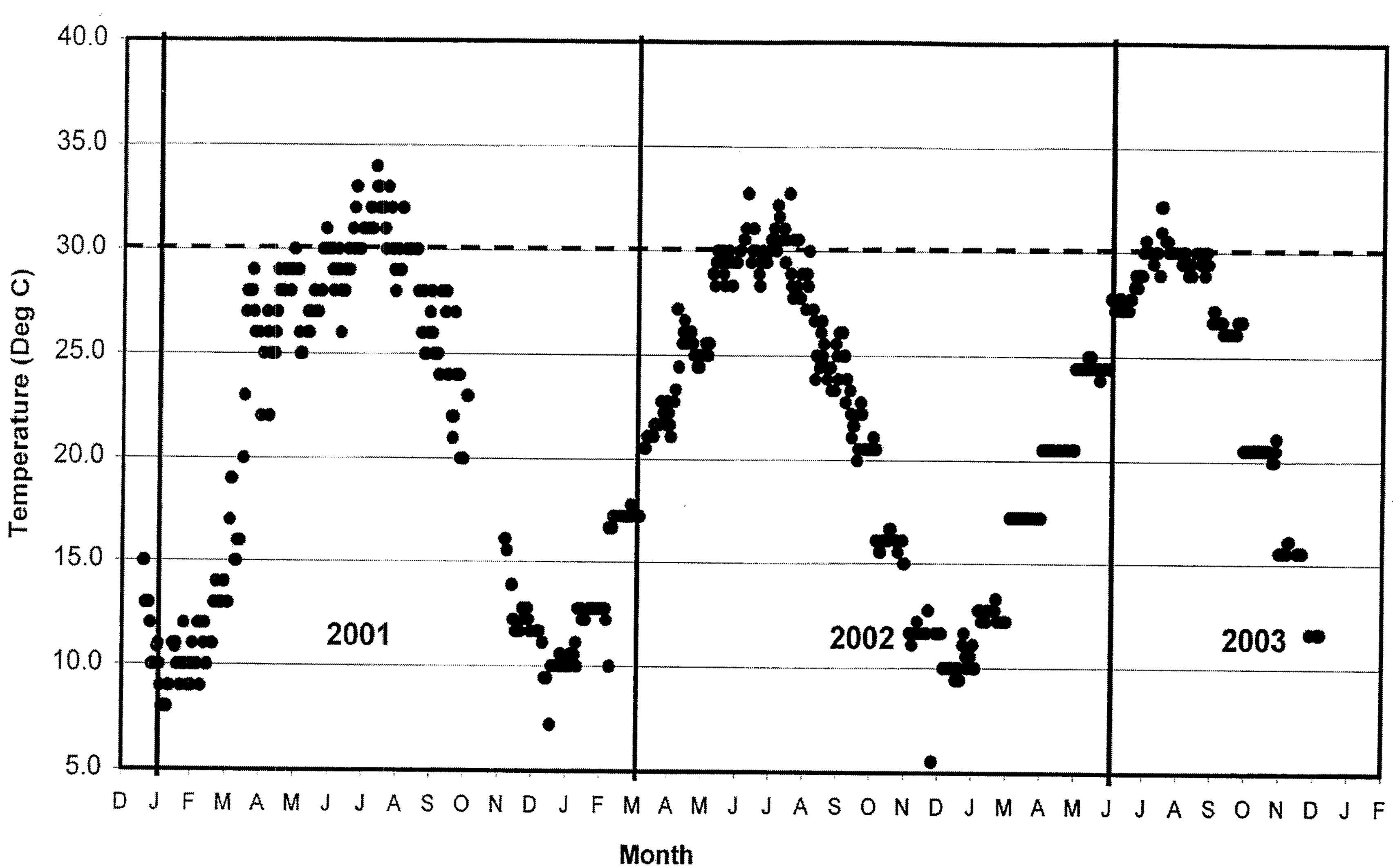

Figure 2.6. Daily temperatures recorded at Outfall 002, January 1, 2001 through December 10, 2003.

3.0 TECHNICAL APPROACH

3.1 Applicable Regulations

Section 2.308 in ADEQ (2002) provides that numerical site-specific criteria may be established based on:

- 304(a) Guidance,
- 304(a) Guidance modified to reflect site conditions (e.g. water effects ratio), or
- Other scientifically defensible study.

The approach followed herein will be to evaluate a site-specific temperature criterion through "other scientifically defensible" methods.

This document does not propose to remove designated uses or establish subcategories of designated uses with less stringent criteria. Rather, the information presented herein is intended to support a less stringent temperature criterion by showing that existing temperature exceedances do not impair designated uses. However, to provide this support, many of the same issues involved in a Use Attainability Analysis as described by USEPA (1994; Chapter 2) must be addressed. These issues include:

- What are the designated uses?
- Are the designated uses attainable?
- What are the existing uses?
- Are downstream uses protected?

Support for the criterion modification would be indicated if:

- A seasonal fishery and associated aquatic life exists in the affected segments of the receiving waterbody,
- Discharge and receiving water body temperatures are similar to expected ambient summertime temperatures, and
- Downstream use are protected as indicated by minimal thermal impacts to downstream waterbodies.

3.2 Objective

The purposes of this study are to:

1. Determine what aquatic uses are currently being achieved in the receiving water body,
2. Identify the causes of any impairments of the aquatic life uses,
3. Evaluate what aquatic life uses can be attained based on the physical, chemical and biological characteristics of the receiving water body,
4. Evaluate if designated uses, particularly the seasonal Gulf Coastal Fishery use, are existing or attainable uses under the present pattern of temperature exceedances in the receiving waterbody, and
5. Modify the existing temperature criterion while still protecting the designated uses in the receiving water bodies.

ADEQ staff were contacted regarding the feasibility of a site-specific temperature criterion for the Couch Plant receiving waterbody. After reviewing data describing the temperature regimes in the unnamed tributary and Lake June, the staff indicated that the data appeared to justify a site-specific criterion given further documentation of aquatic life during the "primary season".

An investigation was undertaken to:

- Survey the aquatic life (fish and benthic macroinvertebrates) present in the lotic segments of the receiving water body,
- Measure the maximum effluent temperatures in the effluent during July and August weather conditions without the addition of groundwater for cooling, and
- Measure the temperature change in the discharge after it passes through the lotic segments of the receiving waterbody.

Physical (temperature), biological and chemical sampling was conducted at selected locations in the unnamed tributary and Lake June.

Studies designed to evaluate impacts of effluents on receiving waterbodies often include comparisons of downstream conditions with upstream locations or reference streams. In the case of the Couch Plant, no upstream aquatic habitat exists. Preliminary reconnaissance of the site indicated that the watershed area of the study site was <10 mi^2 while flows were 0.1 to 0.3 cfs in the absence of generation. Therefore, the flows originating from the plant were far in excess of those that would be expected given the watershed size of the receiving stream. A reference stream with similar flows would have required a watershed that was substantially larger than that of the plant's receiving stream and would have had distinctly different channel morphology and physical habitat. This expectation was verified through reconnaissance of surrounding streams such as Dorcheat Bayou and Bodcau Creek. Therefore, because a reference stream could not be located, a reference stream comparison approach was not used in this study.

4.0 FIELD SURVEY

In this section, the methods used and results from the field surveys are presented including ambient air temperatures, temperature monitoring, water quality sampling, and biological and habitat sampling.

4.1 Ambient Air Temperature

Air temperature data were obtained from the Southern Regional Climate Center (http://www.srcc.lsu.edu/) for weather reporting stations located in Texarkana, AR (located approximately 30 miles west of the Plant) and El Dorado, AR (located approximately 44 miles east of the Plant; Figure 1.1). Temperature data from these stations are summarized in Table 4.1. The data summary indicates that mean, minimum and maximum air temperatures were above normal during the monitoring period (July and August, 2003). Therefore, the results from this study should be considered conservative.

Table 4.1. Summary of air temperature (°C) data from Texarkana and El Dorado weather monitoring stations. DFN=deviation from normal.

Station	Month	Average Maximum		Average Minimum		Monthly Mean	
		Value	DFN	Value	DFN	Value	DFN
Texarkana	July	34.7	+1.0	23.4	+1.0	29.2	+1.0
	Aug	35.8	+1.9	23.6	+1.4	29.6	+1.7
El Dorado	July	33.3	-0.4	21.6	-0.2	27.4	-0.3
	Aug	34.2	+0.6	21.9	+0.9	28.1	+0.7

4.2 Temperature Monitoring

4.2.1 Methods

Recording temperature monitors (Optic StowAway™; Onset Computer Corporation; 470 MacArthur Blvd., Bourne, MA 02532) were placed in the unnamed tributary (Points A, B and C) and Lake June (Point D; Figure 2.3). Monitors recorded temperature at 0.25-hour intervals July 2, 2003 through September 3, 2003. Monitors at points A (Outfall 002), B, and C (Inflow) were placed in midchannel at mid-depth. The monitor placed at Point D (Lake June) was suspended at a depth of 1 ft. from a float. Monitors were retrieved and data downloaded at approximately 3-week intervals. Accuracy of temperature readings was verified by comparing monitor readings with a certified thermometer (Barnstead International/ERTCO, Product Number SRM934, Serial Number 1181).

In addition to continuous temperature monitoring, individual temperature measurements were taken near mid day on July 23, 2003 at the following points within the treatment pond system:

1. Inflow of power block pond
2. Outflow of power block pond
3. Inflow of cooling tower pond (Internal Outfall 02B)
4. Outflow of cooling tower pond
5. Outflow of mixing pond
6. Inflow of wetland
7. Outflow of wetland

Ambient air temperature at the time of these measurements was 93°F (33.9°C) under clear skies. The purpose of these measurements was to document temperature changes throughout the treatment pond system.

4.2.2 Results

During the monitoring period the plant operated Unit II and discharged continuously through Outfall 002 during July 2-3 and July 15-25, 2003. At no time during July 2, 2003 through September 3, 2003 was groundwater added to the Outfall 002 discharge.

The temperature monitor at Point B was dislodged from its attachment point each time the location was visited for routine maintenance. Limited data were obtained from this location. Similarly, the monitor at the lake inflow (Point C) was dislodged from its attachment between July 18 and July 22, 2003. Simultaneous data from Outfall 002 (Point A), the lake inflow (Point C) and upper Lake June (Point D) are available for July 2, 2003 through August 13, 2003. Simultaneous data for Outfall 002 and the lake inflow are available for July 2, 2003 through September 3, 2003.

Changes in temperature throughout the treatment pond system on July 23, 2003 are illustrated in Figure 4.1. Plots of continuous temperature measurements for Outfall 002 (Point A), Point B, the lake inflow (Point C) and upper Lake June (Point D) are provided in Figures 4.2, 4.3, and 4.4. The continuous temperature plots also indicate periods of power generation. Box and whisker plots comparing daily mean and maximum temperatures at Outfall 002, the lake inflow and upper Lake June are presented in Figures 4.5 and 4.6. Figures 4.1 through 4.6 indicate the following general patterns at Outfall 002, the receiving waterbody and the treatment pond system.

4.2.2.1 Treatment Pond System

- Heated effluent entering the power block pond and the cooling tower pond cools upon reaching the outlets of those ponds (Figure 4.1).
- Only minimal cooling takes place after the effluent leaves the power block pond and the cooling tower pond (Figure 4.1).

4.2.2.2 Outfall 002

- Temperatures at Outfall 002 during generation (when heated effluent was being produced as a result of power generation) typically exceeded 30°C. 67% of temperature measurements taken at Outfall 002 during power generation exceeded 30°C. (Figures 4.2 and 4.3)
- The maximum Outfall 002 temperature observed during generation was 34.2 °C.
- The majority of temperatures taken during periods of non-generation did not exceed 30°C. However 27% of temperatures recorded during periods of non-generation exceeded 30°C. (Figures 4.2 and 4.3)
- The maximum Outfall 002 temperature observed during non-generation periods was 32.9°C.

4.2.2.3 Lake Inflow

- Both maximum and mean temperatures at the lake inflow (Point C) were consistently lower than the respective temperatures at Outfall 002 (Figures 4.2, 4.3, 4.5 and 4.6.)
- 2% of temperature measurements at the lake inflow exceeded 30°C (Figures 4.2 and 4.3).
- The maximum temperature observed at the lake inflow was 33.4°C.

4.2.2.4 Upper Lake June

- Minimum temperatures in upper Lake June were similar to minimum temperatures measured in the lake inflow and lower than minimum temperatures measured in Outfall 002 (Figures 4.2 and 4.3)
- Maximum temperatures in upper Lake June were consistently higher than in the lake inflow (Figures 4.2, 4.3 and 4.5)
- Maximum temperatures in Lake June were within the range of Outfall 002 temperatures. Maximum Lake June temperatures were sometimes similar (7/2-3/03; 7/15-18/03) or greater (7/8-10/03) than Outfall 002 temperatures, while at other times maximum Lake June temperatures were lower than Outfall 002 temperatures (Figures 4.2 and 4.3).
- Overall mean daily temperatures in upper Lake June were slightly lower than in Outfall 002 while maximum temperatures were similar at the 2 locations (Figures 4.5 and 4.6).
- The maximum temperature observed in Lake June was 34.4°C which is higher than the water quality criterion for lakes (33°C; APCEC 2002) and resulted from normal atmospheric heating.

4.3 Water Chemistry

4.3.1 Methods

On July 2, 2003 *in situ* measurements were taken at Point A (Outfall 002), upper Lake June (Point D) and at selected locations in the backwater area of upper Lake June between Point D and immediately below the Highway 53 bridge across Lake June. Grab samples were also collected from Outfall 002 (Point A), Point B and the lake inflow (Point C) and analyzed for total and dissolved copper and zinc, calcium, magnesium, sodium, total alkalinity, dissolved organic carbon and total organic carbon. On July 23, 2003, September 3, 2003 and November 12, 2003 *in situ* measurements of temperature, dissolved oxygen (DO), conductivity and pH were made using a Hydrolab Minisonde® and Surveyor® water quality monitor. On November 12, 2003 grab samples were collected from a location immediately upstream of Reaches 1 and 2 in the unnamed tributary (see Section 4.4.1.2 for a description of the location of Reaches 1 and 2 in the unnamed tributary) and analyzed for total copper and total zinc.

All chemical analyses were performed by American Interplex Laboratory (8600 Kanis Road, Little Rock, AR, 72204) which is an ADEQ certified analytical laboratory. All sampling was conducted by FTN Associates, Ltd (FTN) (3 Innwood Circle, Suite 220, Little Rock, AR 72211).

4.3.2 Results

Results of *in situ* measurements and analysis of grab samples are presented in Tables 4.2 through 4.5. DO measurements taken at Point B and/or the lake inflow on July 23, 2003 and September 3, 2003 were below the "critical" season ecoregion criterion of 2 mg/L for streams with watersheds <10 mi^2 (Tables 4.3 and 4.4). DO measurements taken in Reaches 1 and 2 (between Outfall 002 and Point B) on November 13, 2003 (Table 4.5) were less than the "primary" season ecoregion criterion of 5 mg/L.

DO concentrations are discussed in Appendix B which concludes that the DO measurements below ecoregion criteria are a natural feature of the Lake June system and consistent with the warm temperature and organic staining observed. Results of the fisheries surveys and aquatic life evaluation (Section 6.1) showing the attainment of aquatic life uses indicate that the DO regime in the Lake June system does not impair aquatic life.

Table 4.2. Summary of in situ measurements taken at Outfall 002 and locations in upper Lake June on 7/2/03.

Location		Parameter			
		Temperature (°C)	DO (mg/L) [% Saturation]	pH (S.U.)	Specific Conductance (uS)
Outfall 002		29.5	6.3 [82]	6.8	83
Upper Lake June		29.2	2.3 [30]	6.0	181
Hwy 53 Bridge	Surface	31.2	4.3 [58]	6.1	167
	1 m	27.0	1.7 [21]	6.0	183

Table 4.3. Summary of *in situ* measurements and analyses of grab samples collected on 7/23/03.

Parameter	Location		
	Outfall 002 (Point A)	Point B	Lake Inflow (Point C)
Temperature (°C)	30.4	ND	26.8
DO (mg/L)	7.5	ND	0.7
% DO Saturation	100	ND	9
pH (S.U.)	6.7	6.7	6.7
Total calcium (mg/L)	8.8	7.8	6.6
Total copper (ug/L)	13	27	5.7
Dissolved copper	7.7	13	< 5
Total magnesium (mg/L)	1.9	1.7	1.6
Total sodium (mg/L)	24	21	14
Total zinc (ug/L)	9.4	77	27
Dissolved zinc (ug/L)	6.5	55	23
Total alkalinity (mg/L)	57	45	25
Total organic carbon (mg/L)	3.6	6.5	7.2
Dissolved organic carbon (mg/L)	2.9	5.8	6.6

Table 4.4. Summary of *in situ* measurements taken on 9/3/03.

Parameter	Location		
	Outfall 002	Point B	Lake Inflow
Temperature (°C)	26.2	24.8	25.0
DO (mg/L)	4.5	0.6	1.0
% DO Saturation	56	7	12
pH (S.U.)	7.1	6.5	6.7
Specific Conductance (uS)	225	124	180

Table 4.5. Summary of *in situ* measurements and analyses of grab samples collected in Reaches 1 and 2 of unnamed tributary on 11/12/03.

Parameter	Reach 1	Reach 2
Temperature (°C)	15.1	15.6
DO (mg/L)	4.6	4.3
% DO Saturation	44	43
pH (S.U.)	6.9	6.7
Specific Conductance (uS)	189	179
Total copper (ug/L)	26	90
Total zinc (ug/L)	10	25

4.4 Biological and Habitat Sampling

4.4.1 Methods

All biological sampling was performed in the unnamed tributary between Outfall 002 (Point A) and Point B (Figure 2.3). Reconnaissance level sampling for macroinvertebrates was conducted on July 23, 2003 and August 13, 2003. More intensive Rapid Bioassessment Protocol (RBP) sampling was conducted on November 13, 2003. Flows from Outfall 002 were 0.51, 0.21 and 0.025 cfs, respectively, July 23, August 13, and November 13, 2003.

4.4.1.1 July 23 and August 13, 2003

Macroinvertebrates were collected using a square-frame kick net (0.5m diameter; 500u mesh) and fish sampling was conducted with a seine. Samples were collected in as many different habitats as could be identified throughout the segment. Macroinvertebrate samples were preserved in the field and transported to FTN in Little Rock, AR for positive identification. Macroinvertebrates for samples collected on July 23 and August 13 were identified to family level using Thorp and Covich (2001). All preserved specimens are archived at FTN Associates, Ltd, 3 Innwood Circle, Suite 220, Little Rock, AR 72211. Gastropods, oligochaetes, and decapods were not included in the enumeration or identification.

Fish were identified to species and counted in the field. Voucher specimens and fish that could not be positively identified in field were preserved and transported to FTN in Little Rock, AR for positive identification. Fish identification followed Robison and Buchanan (1988).

4.4.1.2 November 13, 2003

On November 13, 2003, two reaches (Reach 1 and 2) approximately 40 stream widths each in length (Figure 4.7) within the unnamed tributary were sampled for fish and macroinvertebrates using RBP (Barbour et al, 1999) per ADEQ (2000). Fish were killed and preserved upon capture with a DC current backpack shocker and transported to FTN for processing. Preserved specimens were identified to species, enumerated, weighed to the nearest 0.1 g, measured (total length) to the nearest mm and examined for external lesions, deformities or signs of disease.

Macroinvertebrate samples were obtained from representative habitats within each reach by collecting 12 individual samples with a square-frame kick net. All 12 samples were composited and preserved in the field. Each composite sample was sorted in the laboratory using a Caton grid until a 200 $\pm$20 organism subsample had been collected. Macroinvertebrate specimens were then identified to genus level using Merrit and Cummins (1999b). Dipterans and decapods were identified to family level. Gastropods and oligochaetes were not included in the enumeration or identification. All preserved specimens are archived at FTN.

Habitat assessment was performed per Appendix A-1 in Barbour et al (1999). Examples of the habitat field sheets used for the evaluations are provided in Appendix C (Habitat Assessment Field Sheet and Physical Characterization/Water Quality field Data Sheet) of this document. No discharge measurements were taken at either reach. All stream flow was assumed or originate from Outfall 002.

4.4.2 Results

4.4.2.1 Macroinvertebrates

Reconnaissance level sampling for macroinvertebrates conducted on July 23, 2003 and August 13, 2003 in the unnamed tributary indicated abundant macroinvertebrate life. Representatives of a combined total of 18 families of macroinvertebrates (excluding oligochaetes and gastropods) were collected on the two dates (Table 4.6). Invertebrate families collected were primarily from the orders Coleoptera, Hemiptera and Odonata.

Table 4.6. Summary of combined preliminary macroinverteberate collection performed on July 23, 2003 and August 13, 2003.

Table 4.6. Summary of combined preliminary macroinverteberate collection performed on July 23, 2003 and August 13, 2003.

Order	Family	Number of Individuals
Coleoptera	Elimidae	1
	Gyrinidae	4
	Hydrophilidae	3
	Dytiscidae	3
	Haliplidae	1
Decapoda	Cambaridae	7
Diptera	Chironomidae	2
	Tipulidae	1
Ephemeroptera	Heptageniidae	2
Hemiptera	Naurcoridae*	1
	Notonectidae	1
	Nepidae	1
	Gerridae	4
Megaloptera	Sialidae	2
Odonata	Gomphidae*	3
	Libellulidae	2
	Coenagrionidae	2
Trichoptera	Leptoceridae	1
	Total Number of Taxa (families)=18	41

*not found in RBP collections

RBP sampling conducted on November 23, 2003 included more extensive subsampling of the samples and genus-level taxonomic identification. A total of 29 macroinvertebrate taxa were identified in the subsamples (Table 4.7). Specimens that could not be identified to genus (due to damaged specimens), but constituted a separate family, were included as a separate taxon in Table 4.7.

The orders Coleoptera, Diptera, Hemiptera and Odonata comprised 66% of the total taxa identified and 67% of the total numbers identified. The families representing these orders in the unnamed tributary samples are known to inhabit primarily heavily vegetated lenthic habitats and/or vegetated areas of quiescent, sluggish streams (Thorp and Covich, 2001). Two families, Gomphidae and Naurcoridae, were collected in the preliminary sampling but not in the RBP sampling. In all, 31 taxa were collected in the preliminary and RBP sampling combined.

Table 4.7. Summary of RBP macroinvertebrate sampling performed in Reaches 1 and 2 of Unnamed tributary on November 13, 2003.

Order (% of Total Taxa/ % of Total Numbers)	Family	Genus	Total Organisms
Coleoptera (21/11)	Dytiscidae	*Copelatus*	2
	Elmidae	*Dubiraphia*	4
	Haliplidae	*Peltodytes*	7
	Hydrophilidae	*Berosus*	1
	Scirtidae	*Scirtes*	15
	Staphylinidae	*Bledius*	1
Decapoda (3/7)	Cambaridae	*	21
Diptera (14/27)	Chironomidae	*	66
	Culicidae	*	8
	Muscidae	*	1
	Tipulidae	*	1
Ephemeroptera (10/22)	Caenidae	*Caenis*	54
	Ephemeridae	*Hexagenia*	7
	Heptageniidae	*	1
Hemiptera (14/2)	Corixidae	*	1
	Naurcoridae	*	1
	Nepidae	*Ranatra*	2
	Notonectidae	*Notonecta*	4
Lepidoptera (10/3)	Pyralidae	*Acentria*	3
	Pyralidae	*Crambus*	1
	Tortricidae	*Bactra*	3
Megaloptera (7/1)	Corydalidae	*Chauliodes*	1
	Sialidae	*Sialis*	3
Odonata (17/27)	Aeshnidae	*Nasiaeschna*	2
	Anisoptera	**	5
	Coenagionidae	*Ischnura*	29
	Libellulidae	*Erythrodiplax*	2
		Libellula	20
		Pachydiplax	17
Trichoptera (3/<1)	Leptoceridae	*Mystacides*	1
		Total Number of Taxa = 29	284

Note * = Genus level identification not performed
** = not counted as a distinct taxon

4.4.2.2 Fish

A total of 8 fish species were collected during the preliminary and RBP sampling (Table 4.8). The collections included 2 Typical Gulf Coastal ecoregion "Key Species" (*Esox americanus* and *Ictalurus natalis*) and 3 Typical Gulf Coastal ecoregion "Indicator Species" (*Aphredoderus sayanus, Elassoma zonatum* and *Lepomis punctatus*).[1]

Also included in the collections were a number of specimens of *L. marginatus*. In Arkansas, *L. marginatus* is restricted to the Coastal Plain lowlands in scattered localities. Southern Arkansas is at the margin of the geographic distribution of *L. marginatus* making it one of the least common sunfishes in Arkansas (Robison and Buchanan, 1988.)

Table 4.8. Summary of fish species collected during preliminary and RBP sampling.

Family	Species	Common Name	Number of Individuals
Aphredoderidae	*Aphredoderus sayanus***	Pirate perch	4
Centrarchidae	*Lepomis macrochirus*	Bluegill sunfish	1
	L. marginauts	Dollar sunfish	18
	*L. punctatus***	Spotted sunfish	2
	Lepomis spp.	Sunfish spp.	6
Esocidae	*Esox americanus**	Grass pickerel	3
Elassomatidae	*Elassoma zonatum***	Pygmy sunfish	6
Ictaluridae	*Ictalurus natalis**	Yellow bullhead	1
Poecilidae	*Gambusia affinis*	Mosquito fish	5

*Typical Gulf Coastal ecoregion Key species
**Typical Gulf Coastal ecoregion Indicator species

[1] "Key" and "Indicator" species are defined in Regulation No. 2 (APCEC, 2002) as follows: Key Species - Fishes which are normally the dominant species (except for some ubiquitous species) within the important groups such as fish families or trophic feeding levels. All specified key species need not be present to establish a normal or representative fishery. Indicator Species - Species of fish which may not be dominant within a species group and may not be limited to one area of the state, but which, because of their presence, are readily associated with a specific ecoregion. All indicator species need not be present to establish a normal or representative fishery.

4.4.2.3 Habitat Assessment

Observations of the study area indicated a swampy lowland aquatic habitat. The unnamed tributary is sluggish and shallow with dense riparian vegetation. The upper portion of Lake June is swampy with extensive flooded and emergent vegetation. Surface waters in all portions of the study area including the main portion of Lake June were distinctly stained with organic matter.

Table 4.9 summarizes the habitat characterization from the Habitat Assessment Field Data Sheets (Appendix D). The habitat characterization describes a waterbody that, except for the lack of overstory in the sections passing through the powerline right-of-way, is virtually unimpacted in terms of erosion, bank stability and channel alteration. Although portions of the stream that meander through the powerline right-of-way have no overstory, both banks are densely vegetated.

Information summarized in the Physical Characterization/Water Quality Field Data Sheets (Appendix E) indicate that all of the habitat consisted of "pool" with no "run" or "riffle" habitat. Inorganic substrate in both reaches was comprised of 80 – 90% silt and 10 – 20% clay; organic substrate in both reaches was composed predominantly of very fine black organic matter (95%) with some detritis (5%). There was approximately 20% coverage in both reaches by rooted emergent and submergent vegetation and floating and attached algae. Riparian vegetation was comprised of second growth forest dominated by water oak (*Quercus nigra*), willow oak (*Q. phellos)*, sweetgum (*Liquidambar styraciflua*) and loblolly pine (*Pinus taeda*).

Table 4.9. Summary of habitat scores for RBP sampling reaches.

Habitat Parameter	Characterization
Epifaunal Substrate/Available Cover	40 – 70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization.
Embeddedness	Not applicable. No gravel, cobble or boulder particles present.
Velocity/Depth Regime	Only 2 of the 4 habitat regimes (slow-deep, slow-shallow) present.
Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.
Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.
Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.
Frequency of Riffles	Generally all flat water of shallow riffles; poor habitat; distance between riffles divided by the width of stream is a ratio of > 25.
Bank Stability	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.
Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.
Vegetation Zone Width	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clearcuts, lawns or crops) have not impacted zone.

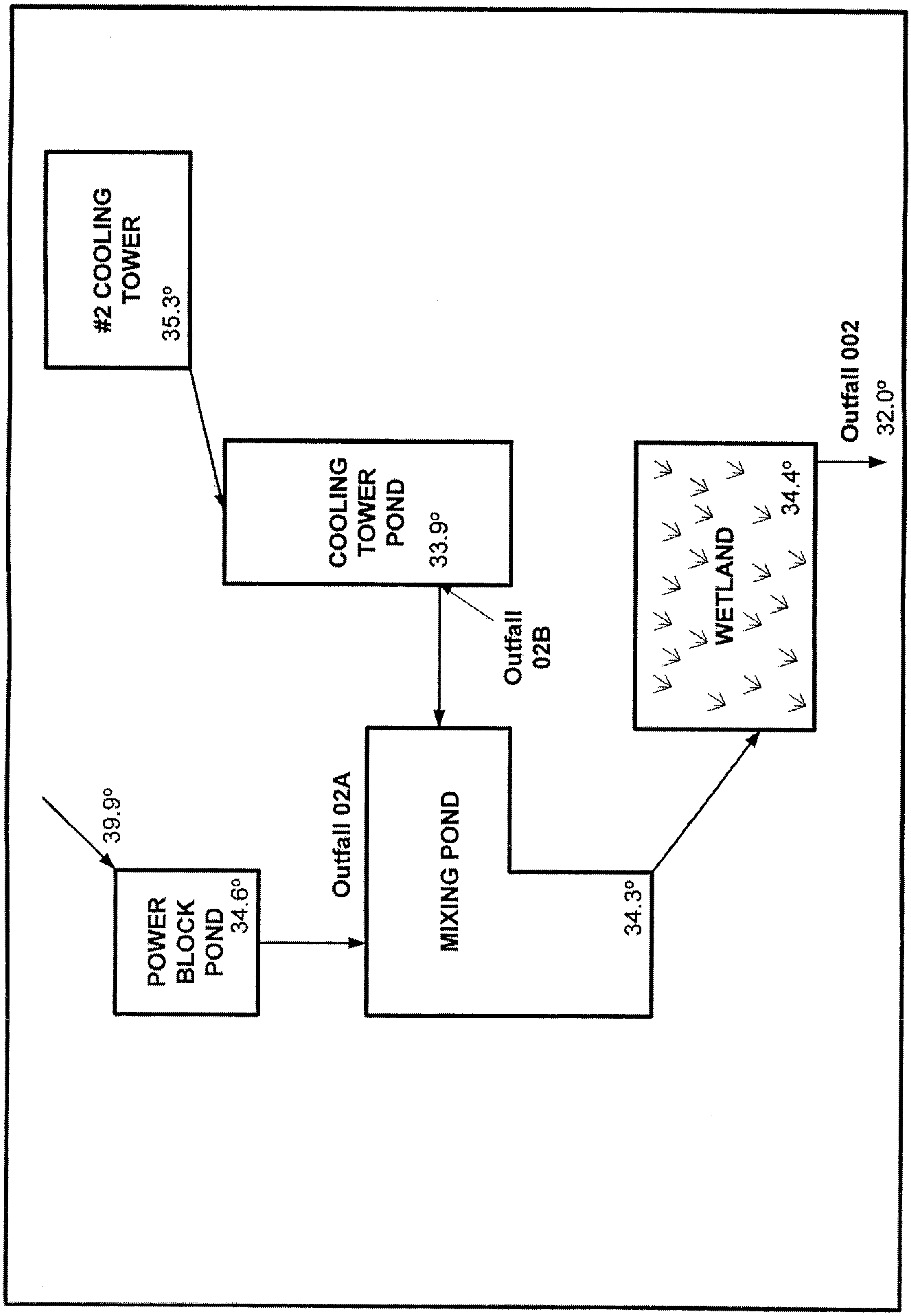

Figure 4.1. Temperature changes in the Couch Plant Treatment pond system on July 23, 2003.

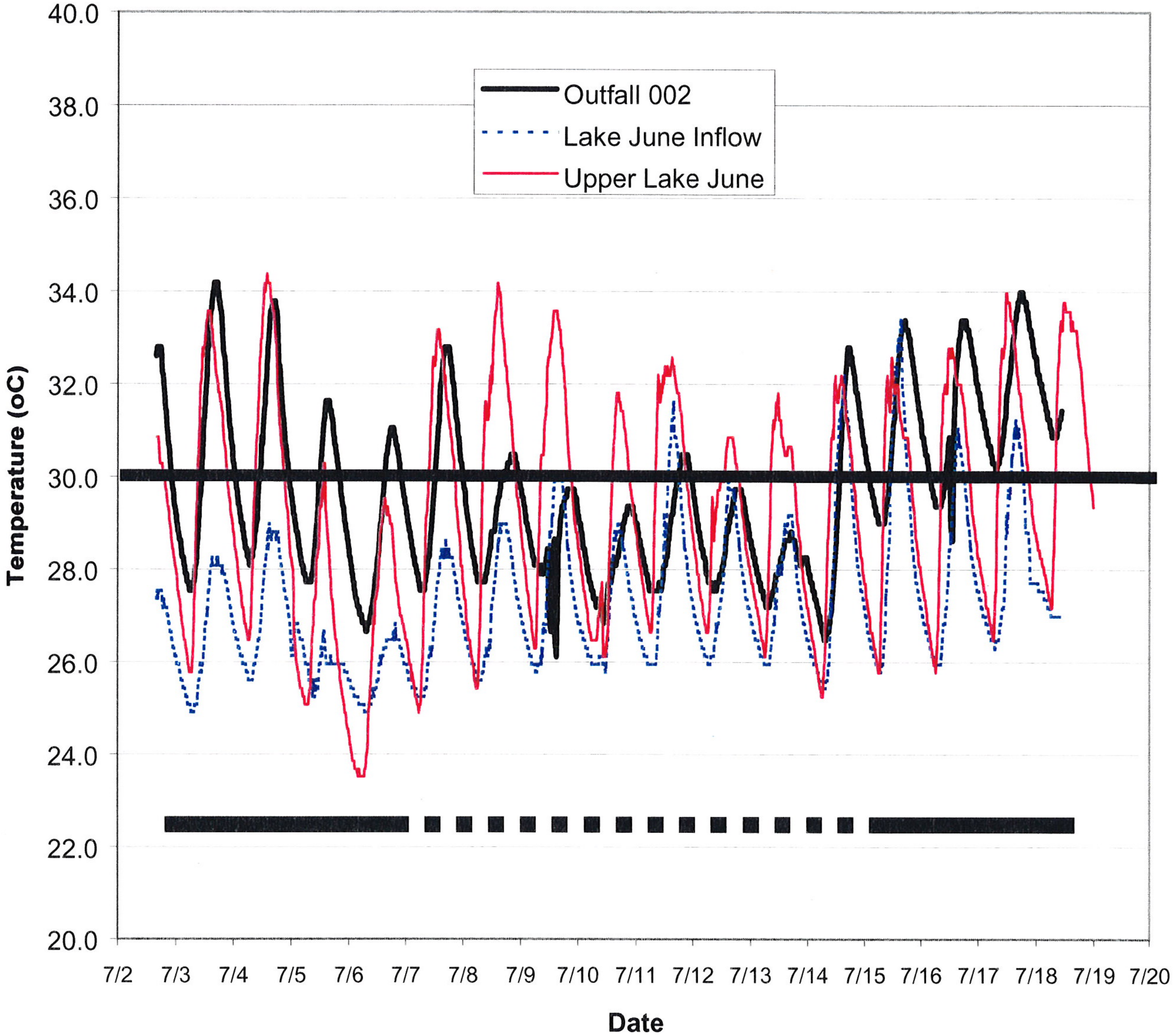

Figure 4.2. Plot of semi-continuous temperature measurements at Outfall 002, the lake inflow and upper Lake June between July 2, 2003 and July 19, 2003. Heavy solid and dashed lines below plots indicate periods of power generation and no power generation, respectively. Heavy solid line through plots indicates existing temperature criterion (30°C).

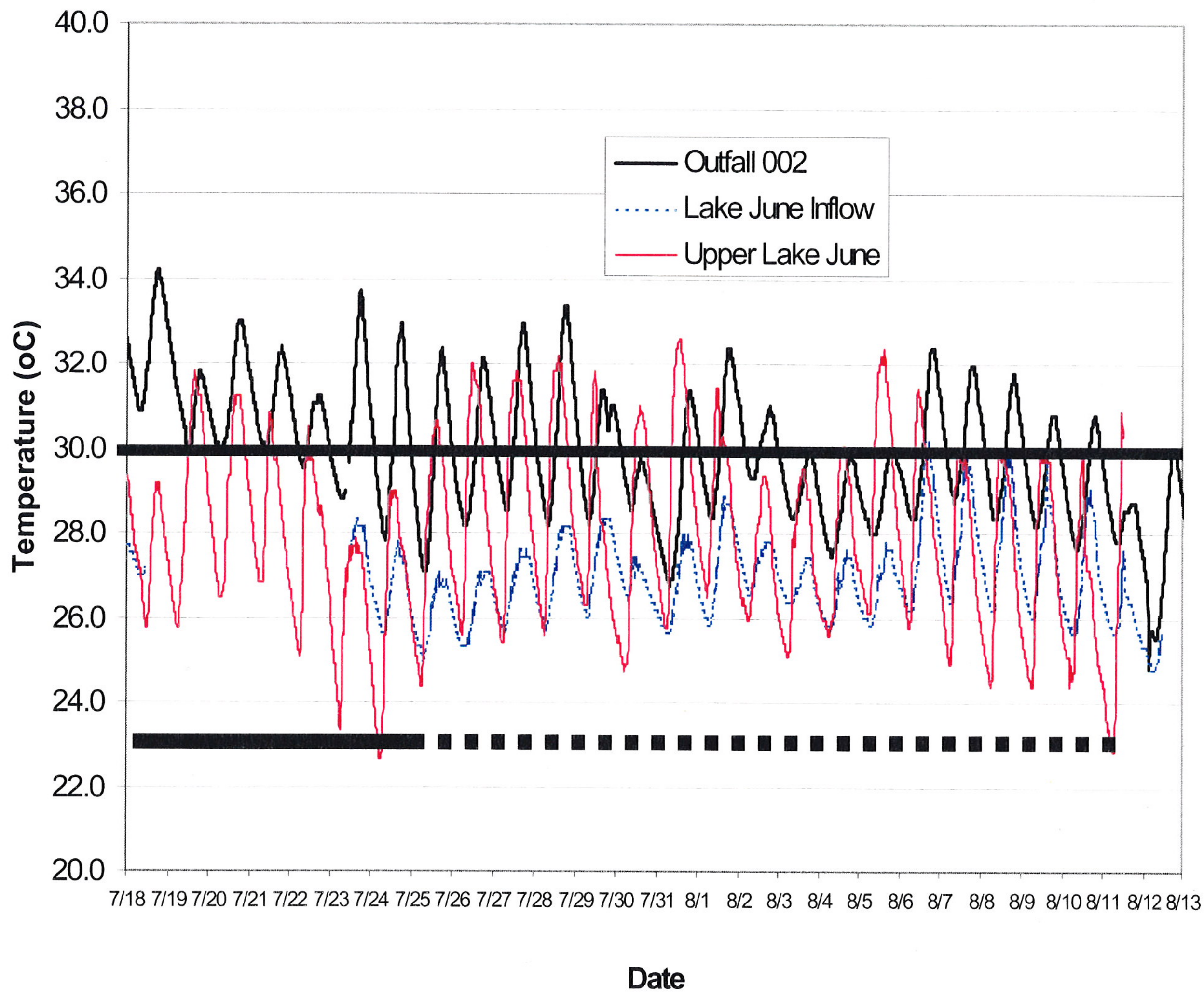

Figure 4.3. Plot of semi-continuous temperature measurements at Outfall 002, the lake inflow and upper Lake June between 7/19/03 and 8/13/03. Heavy solid and dashed lines below plots indicate periods of power generation and no power generation, respectively. Heavy solids line through plots indicates existing temperature criterion (30°C).

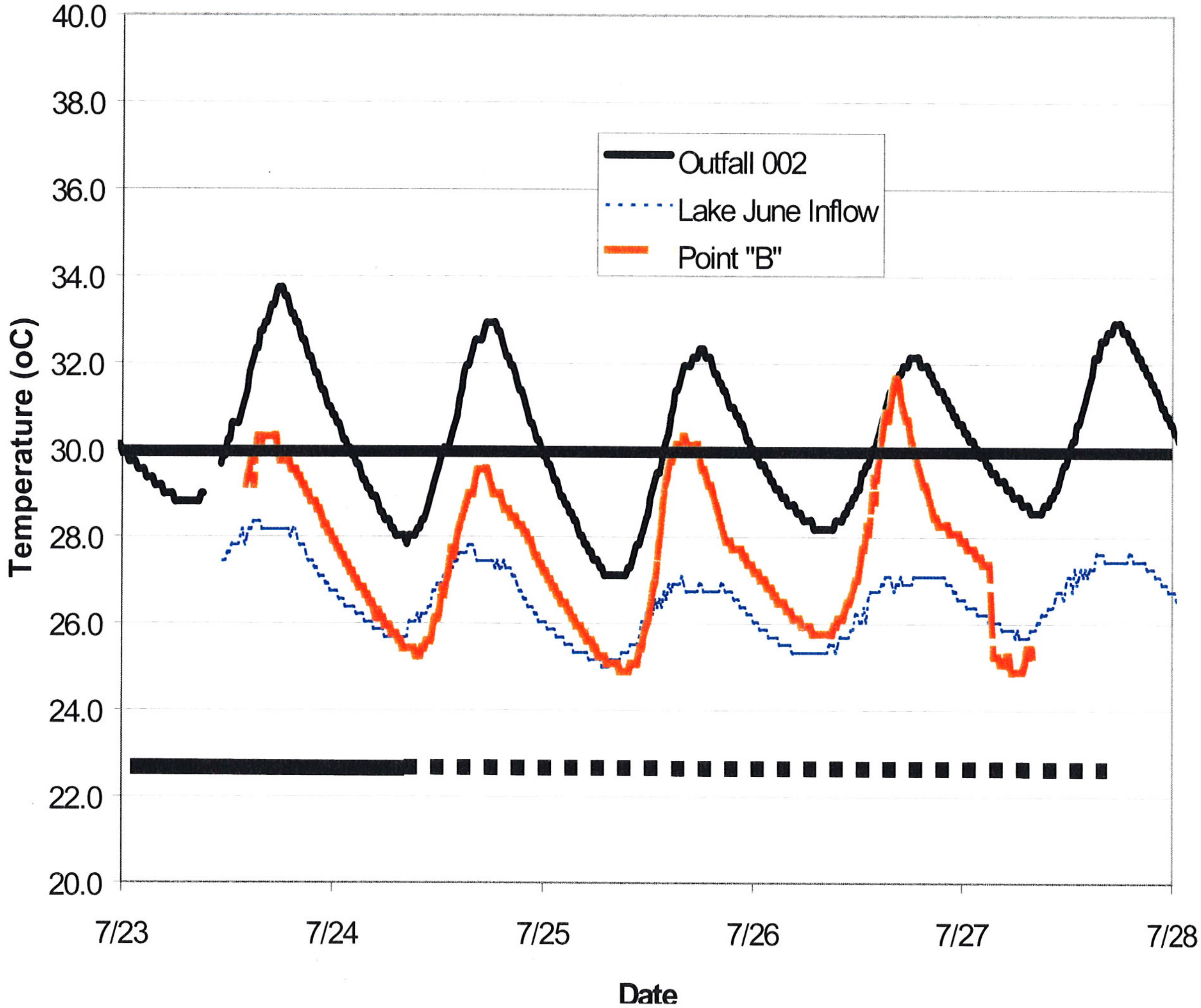

Figure 4.4. Plot of semi-continuous temperature measurements at Outfall 002, Point B and the lake inflow between 7/23/03 and 7/27/03. Heavy solid and dashed lines below plots indicate periods of power generation and no power generation, respectively. Heavy solid lines through plots indicates existing temperature criterion (30°C).

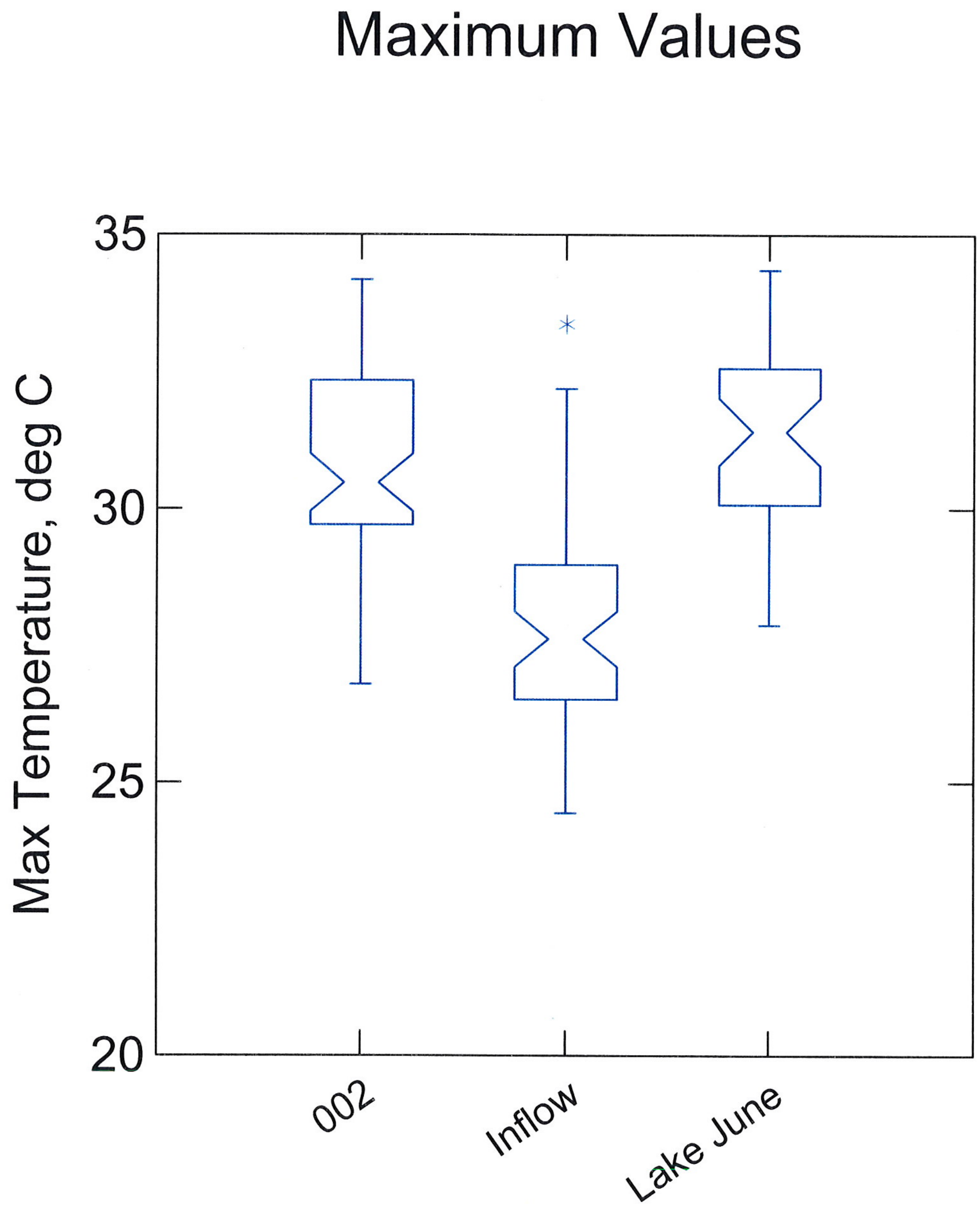

Figure 4.5. Box and whisker plots of daily maximum water temperature at Outfall 002, the lake inflow and upper Lake June, 7/3/03 through 8/13/03.

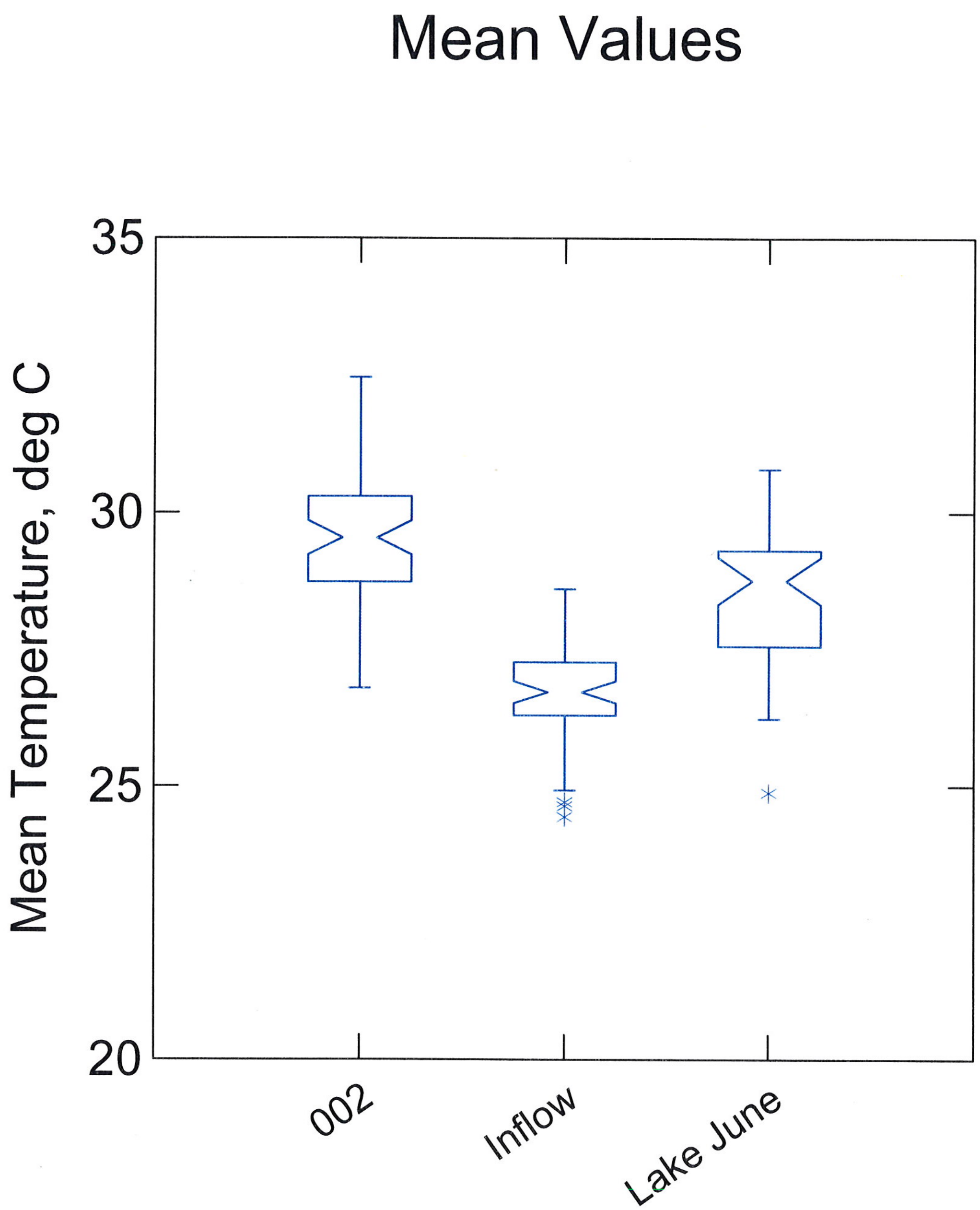

Figure 4.6. Box and whisker plots of daily mean water temperature at Outfall 002, the lake inflow and upper Lake June, 7/3/03 through 8/13/03.

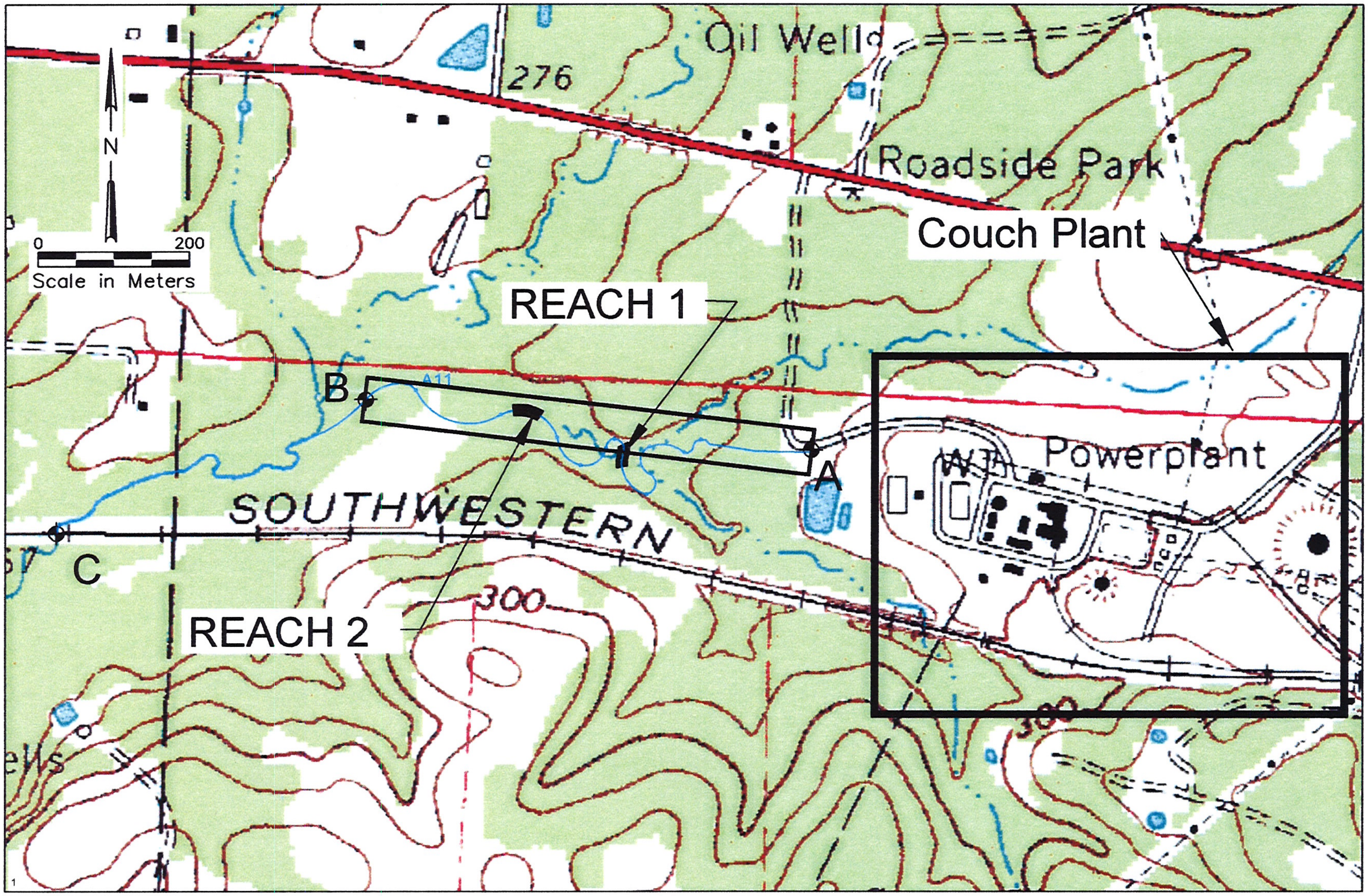

Figure 4.7. Map of study area showing location of reaches 1 and 2 within the unnamed tributary. Box around stream between Point A (Outfall 002) and Point B indicates approximate extent of powerline right-of-way.

5.0 EVALUATION OF TEMPERATURE REGIMES IN RECEIVING WATERBODIES

This section discusses temperature regimes in the receiving waterbodies in relation to the discharge of effluent from the Couch Plant. In evaluating temperature data it is important to remember that the temperature of any water body always responds to changes in atmospheric conditions by being in equilibrium (with a time lag) with those conditions. Therefore, a heated discharge will naturally cool to achieve equilibrium and, similarly, a cooled discharge will warm to equilibrium. Open water bodies such as ponds and lakes have more exposure to the sun and will warm more during the summer than streams flowing through a riparian canopy.

5.1 Couch Plant Discharge

As previously discussed in Section 2.1 and Appendix A, the Couch Plant discharge is heated because it is used as a cooling fluid. In addition, the discharge is stored in open water bodies (i.e. mixing pond and wetland treatment ponds) prior to discharge. Heated water stored in these ponds, given sufficient time, will cool to equilibrium conditions. This cooling is demonstrated in Figure 4.1, which shows relatively rapid initial cooling of the effluent with minimal cooling throughout the remainder of the treatment pond system.

Temperature measurements taken in the treatment pond system suggest that the water temperature in the mixing pond and the wetland may be at or near equilibrium with the ambient conditions present at the time of measurement. The resulting equilibrium temperature in the pond system as indicated by Outfall 002 temperature is similar to lake conditions (i.e. Lake June; Figures 4.2, 4.3, 4.5 and 4.6). The temperature of this discharge water will naturally be warmer than that found on stream systems.

5.2 Cooling in the Treatment Pond System

Because temperature measurements taken in the treatment pond system suggest temperatures near ambient conditions, an analysis was conducted to determine how much Outfall 002 temperatures under the influence of heated water from generation deviate from natural ambient temperatures throughout the year. Following the methods and equations for calculating equilibrium temperature and rates of heat exchange in Edinger et al. (1974), the equilibrium water temperature for each month due to ambient heating and cooling was calculated. Wind and dewpoint values used in the calculations were the minimum and maximum monthly values (as opposed to minimum and maximum daily values) from 9 years of data from NOAA between 1979 and 1992. Solar radiation data used were long term averages for Little Rock obtained from Dr. Joe Nix, Ouachita Baptist University (unpublished data). Water temperatures, with and without heated water from generation, were calculated for 2 scenarios:

1. High ambient temperature scenario using the lowest monthly wind speed and highest monthly dew point for the period of record, and
2. Low ambient temperature scenario using the highest monthly wind speed and the lowest monthly dew point for the period of record.

Under each scenario the expected Outfall 002 temperature was calculated considering residence time in the ponds, the inflow temperature and cooling due to surface heat exchange. The inflow rate for the power block pond was assumed to be 0.02 MGD, which is a conservative (high) estimate of flows from that source. Inflow from the cooling tower pond was estimated based on the 99th percentile flow from Outfall 002 for 2001 through 2003. At this flow rate (0.62 MGD) the treatment pond system has a retention time of 4.0 days. Inflow temperature for the power block pond was set equal to the average of two measurements taken by FTN on August 22 & 24, 2002. The cooling towers were assumed to have the capacity to cool water to 15°F (8.3°C) above the wet bulb temperature and results in water entering the pond system no more than approximately 11°F (6 °C) above ambient. This is a design criterion for cooling towers of the type used at the Couch Plant. Pond dimensions were obtained from Plant records. This analysis provided an estimate of Outfall 002 temperatures which include the influence of ambient heating and cooling as well as the influence of heated water from generation.

A summary of the results of this analysis is presented in Table 5.1. Detailed output of the analysis is presented in Appendix F. The results indicate that the Outfall 002 temperature of the outfall is very near the equilibrium or natural ambient temperature as calculated above. The expected difference between equilibrium temperatures and Outfall 002 temperatures ranged from

0.2 to 3.8°F. These results indicate that the temperature of the Outfall 002 discharge is dominated by ambient atmospheric conditions and solar input.

Table 5.1. Summary results of equilibrium temperature calculations under high and low ambient temperature scenarios.

Lowest monthly wind speed and highest monthy dew point						
	Equilibrium Temperature		Outfall 002 Temperature		Outfall 002 Minus Equilibrium	
Month	°C	°F	°C	°F	°C	°F
JAN	9.3	48.8	11.1	52.0	1.8	3.2
FEB	11.7	53.1	12.9	55.2	1.2	2.1
MAR	15.3	59.5	16.0	60.9	0.7	1.3
APR	22.0	71.6	22.4	72.3	0.4	0.6
MAY	28.0	82.3	28.2	82.7	0.2	0.4
JUN	30.9	87.6	31.0	87.8	0.1	0.2
JUL	31.3	88.3	31.5	88.6	0.2	0.3
AUG	31.3	88.4	31.6	88.9	0.3	0.5
SEP	27.8	82.0	28.2	82.8	0.4	0.8
OCT	20.3	68.6	21.0	69.8	0.7	1.2
NOV	13.1	55.5	14.5	58.1	1.4	2.5
DEC	10.1	50.1	11.9	53.5	1.9	3.4
Highest monthly wind speed and lowest monthy dew point						
	Equilibrium Temperature		Outfall 002 Temperature		Outfall 002 Minus Equilibrium	
Month	°C	°F	°C	°F	°C	°F
JAN	-1.1	30.0	0.8	33.5	1.9	3.5
FEB	3.5	38.4	4.8	40.6	1.3	2.3
MAR	9.9	49.9	10.9	51.6	1.0	1.7
APR	15.3	59.5	15.8	60.5	0.6	1.0
MAY	21.1	70.0	21.5	70.6	0.3	0.6
JUN	24.6	76.3	24.8	76.7	0.2	0.4
JUL	27.9	82.3	28.2	82.8	0.3	0.5
AUG	26.5	79.7	26.9	80.3	0.3	0.6
SEP	22.9	73.2	23.5	74.2	0.5	1.0
OCT	14.1	57.3	15.0	59.0	0.9	1.7
NOV	8.4	47.2	10.0	50.1	1.6	2.9
DEC	-1.2	29.9	0.9	33.6	2.1	3.8

5.3 Unnamed Tributary Temperature Regime

67% of temperature measurements taken at Outfall 002 during power generation exceeded 30°C while 27% of temperatures recorded during periods of non-generation exceeded 30°C. This result indicates that although Outfall 002 temperatures are clearly affected by generation activities, heating of the treatment pond system due to ambient atmospheric conditions and solar input also causes discharge temperatures to exceed 30°C in the absence of generation. In general, air temperatures are warmer on days when generation occurs as compared to days when no generation occurs.

Figures 4.5 and 4.6 indicate little overlap between Outfall 002 and inflow data with respect to either mean or maximum temperatures. These results indicate, as expected, that the water discharged from Outfall 002 cools substantially by the time it reaches the lake inflow such that exceedances of 30°C at the lake inflow are infrequent.

Conclusion

Both power generation and ambient heating/cooling of the treatment pond system influence the temperature regime in Outfall 002. The resulting Outfall 002 temperatures are comparable to surface water temperatures in upper Lake June and are strongly influenced by ambient atmospheric conditions and solar input. This is supported by calculations showing that Outfall 002 temperature are similar to calculated equilibrium temperatures. The temperature regime in the unnamed tributary reflects cooling of the discharge as it approaches a new equilibrium determined by ambient meteorological conditions as the discharge passes through shaded portions of the receiving stream. The smaller volume of water in the unnamed tributary also responds more rapidly to changes in atmospheric conditions than the larger volumes in Lake June or the treatment ponds.

5.4 Lake June Temperature Regime

Surface temperatures measured in upper Lake June during July and August (Figures 4.2 and 4.3) illustrate diel temperature fluctuations expected in surface waters of lakes during summer months. Box and whisker plots shown in Figures 4.5 and 4.6 show that mean and maximum temperatures in upper Lake June temperatures are higher than temperatures measured at the lake inflow.

Conclusion

Maximum surface temperatures in Lake June are primarily influenced by solar radiation and ambient atmospheric conditions (temperature, humidity, wind) rather than by the temperature regimes of the lake inflow or Outfall 002.

5.5 Temperature Regime in Receiving Waterbody: Summary and Conclusions

Ambient heating/cooling of the treatment pond system results in temperatures at Outfall 002 that are comparable to surface water temperatures in Lake June. The temperature regime of the lake inflow is probably not affected by the temperature regime of Outfall 002 as evidenced by substantial cooling of the effluent stream between Outfall 002 and the lake. Similarly, the temperature regime of Lake June is relatively unaffected by the temperature regime at the lake inflow as indicated by higher temperatures in Lake June as compared to the inflow. The information compiled for this study indicates a system with a thermal regime that is largely controlled by ambient atmospheric conditions and solar input rather than by heating due to power generation.

6.0 EVALUATION OF EXISTING AND ATTAINABLE USES

The following sections discuss attainment of uses with respect to the existing temperature regimes and habitat in the unnamed tributary. As discussed in Section 2.3.2 all designated uses are attained in Lake June and are not discussed further.

As discussed in Section 2.3.1 the designated uses for the unnamed tributary are:

1. Seasonal Gulf Coastal fishery;
2. Secondary contact recreation;
3. Domestic water supply;
4. Industrial water supply; and
5. Agricultural water supply.

6.1 Seasonal Gulf Coastal Fishery and Other Forms of Aquatic Life

Seasonal Fishery: The "fisheries" designated use in streams provides "...for the protection and propagation of fish and other forms of aquatic life adapted to flowing water systems whether or not the flow is perennial" (APCEC 2002.) A Typical Gulf Coastal fishery is defined in APCEC (2002) as a fish community "...characterized by a limited portion of sensitive species; sunfishes are distinctly dominant followed by darters and minnows". A seasonal fishery is defined in APCEC (2002) as "The designated fishery use that occurs in some waterbodies only during the period when stream flows increase substantially and water temperatures are cooler. This is normally during the months of December through May". Table 6.1 lists the Key and Indicator Species that generally characterize the Typical Gulf Coastal ecoregion fishery.

As discussed in Section 3.0, a reference stream comparison approach was not used in this evaluation due to the difficulty in identifying appropriate reference locations. Therefore, interpretation of the fish community data is based on ecoregion data. Sampling of the fish community indicated the presence of 8 species of fish including 2 Key and 3 Indicator Species (Table 4.8). The fish assemblage present in the unnamed tributary was clearly dominated by sunfish. Although no darters and few cyprinids were collected, piscivorous predators (*E. americanus*) were present, indicating the presence of prey species.

Table 6.1. Key and Indicator Species of the Typical Gulf Coastal ecoregion fishery defined in APCEC (2002). Asterisks indicated species present in samples collected in the unnamed tributary.

Key Species		Indicator Species	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Redfin shiner	*Lythrurus umbratilis*	Pirate perch	*Aphredoderus sayanus**
Spotted sucker	*Minytrema melnops*	Warmouth	*Lepomis gulosus*
Yellow bullhead	*Ictalurus natalis**	Spotted sunfish	*Lepomis punctatus**
Flier	*Centrarchus macropterus*	Dusky darter	*Percina sciera*
Slough darter	*Etheostoma gracile*	Creek chubsucker	*Semotilius artomaculatus*
Grass pickerel	*Esox americanus**	Banded pygmy sunfish	*Elassoma zonatum**

The habitat evaluation of both reaches in the unnamed tributary indicated essentially unimpaired, natural habitat. However, only slow shallow and slow deep depth/velocity regimes were present. In addition, substrate in both reaches was comprised entirely of silt, clay, fine organic matter and detritis. Physical habitat structure was comprised primarily of emergent and submerged vegetation. These findings indicate that, while existing habitat is of good quality, the diversity of habitat types is limited. The habitat is essentially comprised of very slow velocity water over soft substrate with emergent and submerged vegetation. Because the number of fish species present is a reflection of the diversity of habitat, a seasonal Gulf Coastal fishery appears to be adequately represented given the limited diversity of habitat types present in the sampling reaches.

Macroinvertebrates: Regulation No. 2 does not explicitly address benthic macroinvertebrate assemblages. However, macroinvertebrate assemblages represent "other forms of aquatic life" and are important in assessing the attainment of the fisheries use. As with the fish community, interpretation of the benthic macroinvertebrate data, in this case, is based on comparisons with ecoregion data.

A total of 31 invertebrate taxa (not including gastropods and oligocheates) were collected on the 3 sampling dates from the unnamed tributary. Coleoptera, Diptera, Hemiptera and Odonata dominated the samples, making up 2/3 of the total taxa and numbers of invertebrates identified. The families representing these orders are known to inhabit primarily heavily vegetated lentic habitats and/or vegetated areas of quiescent, sluggish streams (Thorp and Covich, 2001).

The total number of taxa collected in the unnamed tributary was compared with data from summer collections in least disturbed streams in the Gulf Coastal ecoregion reported in ADPCE (1987). Although the streams sampled in ADPCE (1987) were larger (drainage areas ranged from 23 to 451 mi^2) and sampling was more intensive than in this study (e.g. all organisms in each sample were counted and identified instead of a subsample), the ADPCE data provide a rough point of comparison for the data collected in this study. Only the 4 smallest least disturbed streams from ADPCE (1987) are included for comparison herein. The watershed areas of excluded streams ranged from 148 to 451 mi^2 and are probably not comparable to the Couch receiving stream. To make the ADPCE invertebrate collection data comparable with the data from this study, the ADPCE data were adjusted as follows:

- Genus level identifications in the ADPCE data set for dipterans and decapods were transformed into family level identifications,
- Gastropod and oligocheate taxa were eliminated from the ADPCE data set.

After these adjustments the number of taxa in the 4 least disturbed streams ranged from 12 to 54 (Table 6.2.) compared to 31 taxa from the unnamed tributary of this study (Table 6.2). It may be noteworthy that the two least disturbed streams having fewer taxa than the unnamed tributary are East Fork Tulip Creek and Cypress Creek which receive most of their critical season flow from groundwater systems (ADPCE 1987).

In summary, the taxonomic composition of the benthic invertebrate community is consistent with the type of habitat present and shows a level of richness (number of taxa) that overlaps that found in least disturbed streams in the Gulf Coastal ecoregion.

Conclusion

The designated seasonal Gulf Coastal fishery use is an existing use given the limited diversity of habitat types present in the sampling reaches. Benthic macroinvertebrate taxonomic richness is comparable to least disturbed streams. These findings indicate that the unnamed tributary of the receiving waterbody is suitable for the propagation of fish and other forms of aquatic life and is attaining its designated aquatic life use in the presence of temperature exceedances at Outfall 002.

Table 6.2. Summary of adjusted number of taxa from summer invertebrate collections in least disturbed Gulf Coastal ecoregion streams from ADPCE (1987) and from the unnamed tributary in this study. See text for description of adjustment of ADPCE data. NA=Not Applicable

Water Body (Watershed area in mi^2)	Total Taxa (unadjusted)	Total Taxa (adjusted)
White Water Creek (23)	60	54
Big Creek (59)	43	36
East Fork Tulip Creek (46)	15	12
Cypress Creek (73)	26	22
Ecoregion Stream Average	46.7	42.9
Unnamed tributary (this study)	31	NA

6.2 Secondary Contact Recreation

The secondary contact use designates waters where "…secondary activities like boating, fishing or wading are involved." (APCEC, 2002). No change in this use will be proposed as part of this evaluation and it is unlikely that this use would be affected by an increase in the temperature criterion. Use of the unnamed tributary for secondary contact activities is limited due to difficult access. Access to the uppermost portion of the unnamed tributary must be gained through locked Entergy property. Access to other portions is made extremely difficult by dense vegetation and lack of roads or trails. Although conversations with local residents did not indicate that the unnamed tributary was used for secondary contact and no evidence of use (litter, discarded fishing supplies) was observed by field sampling personnel, the designated secondary contact recreational use is attainable.

Conclusion

It is unlikely that existing temperature exceedances at Outfall 002 impair the attainment of the designated secondary contact use in the unnamed tributary. No change in this use is proposed as part of this evaluation.

6.3 Domestic, Industrial and Agricultural Water Supply

The domestic water supply use designates waters that "...will be protected for use in public and private water supplies" (APCEC, 2002). The industrial water supply use designates water that "...will be protected for use as process or cooling water" (APCEC 2002). No water intake structures or pump inlets were noted by sampling personnel during visits to the site.

The agricultural water supply use designates water that "...will be protected for irrigation of crops and/or consumption by livestock" (APCEC 2002). The unnamed tributary may be unsuitable for cattle watering due to steep banks and very soft substrate. Although livestock access to the lower unnamed tributary is prevented by a fence, cattle undoubtedly access the waterbody periodically.

Conclusion

No change in these designated uses are proposed as part of this evaluation. It is unlikely that these uses are impaired or will be impaired by the existing temperature regime at Outfall 002.

7.0 PROPOSED SITE-SPECIFIC TEMPERATURE CRITERION

No removal or modification of any designated use is being proposed as part of this evaluation. Designated uses that are most likely to be affected by a thermal discharge (i.e. aquatic life uses) are being attained in both the unnamed tributary and Lake June under the current temperature regime (including temperature exceedances) at Outfall 002. Biological and chemical data from the unnamed tributary indicate that a seasonal Gulf Coastal fishery use is attained and benthic macroinvertebrate taxonomic richness is comparable to least disturbed streams. The existing temperature regime is unlikely to impair other designated uses in the unnamed tributary (e.g. secondary contact recreation, domestic water supply, industrial water supply and agricultural water supply).

These findings indicate that the receiving waterbody is suitable for the propagation of fish and other forms of aquatic life and is attaining its designated aquatic life use under the existing temperature regime, including exceedances, at Outfall 002. **Therefore, the proposed year-round site-specific temperature criterion for the unnamed tributary is recommended to be a maximum of 35.0°C (95.0°F) with no delta 5°F.** This value is based on plant records and *in situ* monitoring during 2003 and is equal to the maximum temperature attained during 2001 through 2003 rounded up to the nearest whole Celsius degree. This criterion is justified by the following findings of the study:

1. The temperature regime in the treatment pond system is at or near equilibrium with ambient conditions and acts as a natural pond system. The resulting temperature regime at Outfall 002 is similar to the surface temperature regime in Lake June.
2. A diverse aquatic life community is present in the unnamed tributary and all designated uses are attained at the proposed temperature criterion.
3. The temperature regime of Lake June is unaffected by the temperature regime of Outfall 002, thereby protecting downstream uses.
4. Plant records and temperature monitoring data indicate that this criterion can be met by the Plant even during periods of power generation during warm weather.
5. The Outfall 002 temperatures should not exceed natural temperature by more than 5°F.

8.0 ALTERNATIVE EVALUATION: NO ACTION

The present strategy for meeting NPDES permit limits for temperature is to cool the final effluent by blending the discharge with groundwater. Groundwater is currently derived primarily from one of six groundwater wells on site. During 2001 and 2002 plant records show that the plant used 60.5 and 90.2 million gallons, respectively, of groundwater. Of this usage, approximately 50% (30 and 45 million gallons in 2001 and 2002, respectively) was used to cool the final effluent. The "no action" option would involve continuing this approach to achieve permit compliance.

The "no action" option is undesirable for 3 reasons:

1. Recent studies indicate that present rates of water removal from the groundwater aquifer are not sustainable (SGCD 2002) and that the Sparta Aquifer is targeted for conservation efforts.
2. Groundwater quality may be deteriorating.
3. Use of groundwater results in increased operating cost for the plant

Figure 8.1 shows time series results of monitoring of chlorides, total iron and specific conductance in the HCSES production wells. The figure indicates deteriorating water quality in Well Number 2. As a result, Entergy has discontinued use of Well Number 2. USGS well records indicate that the production wells used by Entergy tap the Sparta Aquifer. Recent studies have shown the Sparta Aquifer to be experiencing unsustainable rates of water withdrawal (McKee et al 2004; SGCD 2002; UCWCD 2004).

Recent increases to ground water pumping capacity will allow Entergy to control further temperature exceedances at Outfall 002. However, as indicated by Figure 8.1, further deterioration of groundwater quality is possible if the "no action" option is selected and present rates of water usage are maintained. In addition, the "no action" option would involve continued water removals from the already over exploited Sparta Aquifer.

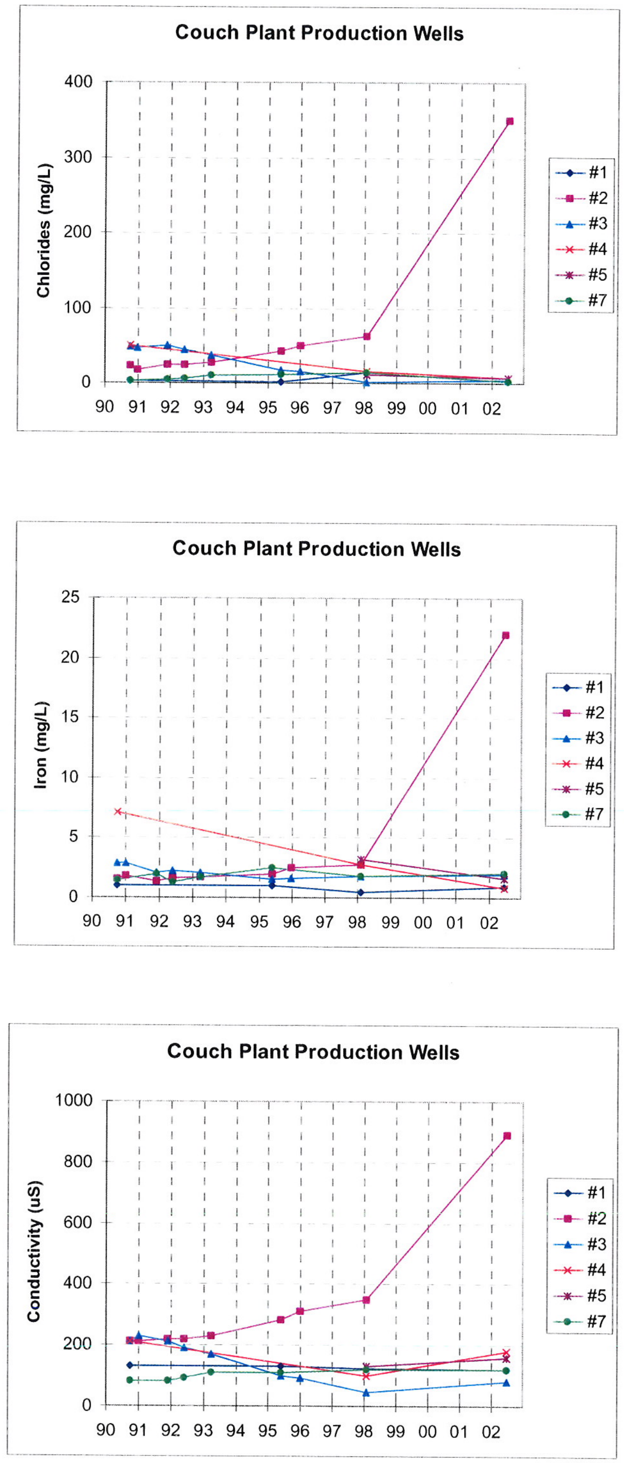

Figure 8.1. Time series plots for conductivity, chlorides and iron from Couch wells 2, 3, 4, 5, and 7.

9.0 BENEFITS OF SITE-SPECIFIC CRITERION

The primary benefit to a site-specific temperature criterion will be the elimination of groundwater pumping from the Sparta Aquifer for purposes of cooling the discharge. It is not possible from existing records to calculate the amount of groundwater that is used for the purpose of cooling the Outfall 002 discharge. However, plant personnel estimate that approximately 50% of the groundwater pumped during warm weather power production (30 to 45 million gallons per year) is used for this purpose. A site-specific temperature criterion would result in a significant decrease in the Couch Plant's use of water from the over exploited Sparta Aquifer. The facility would still use groundwater for production purposes.

10.0 CONCLUSIONS

Exceedances of the 30°C limit in the NPDES permit for the Couch Plant (NPDES Permit No. AR0000493) have occurred at Outfall 002 during July, August and September. Provisions in NPDES Permit No. AR0000493 allow Entergy to cool the discharge by blending with groundwater.

The study provided documentation and support for the following conclusions and recommendations:

1. The thermal regime of the receiving waterbody is primarily controlled by ambient atmospheric conditions and solar input rather than by heating due to power generation.
2. The receiving waterbody is suitable for the propagation of fish and other forms of aquatic life and is attaining its designated aquatic life use in the presence of temperature exceedances at Outfall 002.
3. No designated uses are impaired due to the current level of temperature exceedances at Outfall 002.
4. A site-specific temperature criterion of 35.0°C is proposed for the unnamed tributary between Outfall 002 and the lake inflow. This criterion is near the maximum temperature attained at Outfall 002 during 2001 through 2003.
5. A site-specific temperature criterion of 35°C will allow Entergy to substantially reduce groundwater pumping from the Sparta Aquifer for the purposes of cooling its discharge while maintaining designated uses in the unnamed tributary and Lake June.
6. The "no action" option will result in continued pumping of Sparta aquifer groundwater for purposes of cooling the discharge.
7. Information obtained during the summer of 2003 indicates that the Plant will be able to consistently meet the proposed criterion.

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APPENDIX A

Description of Couch Plant Treatment Process

A1. WASTEWATER PROCESS

The Couch Plant uses water from the Sparta aquifer for plant operations. A water flow diagram is provided in Figure A.1. The two sources of water discharged from the plant under NPDES permit No. AR0000493 are low volume waste water and cooling tower blowdown. The sources and treatment of this discharge water is discussed in the following two sections.

A1.1 Internal Outfall 02A - Low Volume Waste

All source water used at the Couch Plant is drawn from one of six active wells. The well water is first aerated to precipitate iron. The precipitate is collected in settling basins that also act as storage basins for reserve water capacity. Cooling water makeup and miscellaneous service water is supplied directly from the settling basin. A zeolite softener/evaporator system is utilized on both units to further purify the settled water for boiler makeup. Each unit has its own evaporator that supplies high purity boiler makeup when the unit is in operation. To maintain proper dissolved solids levels within the evaporators, a continuous evaporator blowdown is employed. The estimated average continuous evaporator blowdown is 477 gpd and 21,800 gpd for Units I and II, respectively. The blowdown is directed to the floor drain system. In addition to continuous blowdown the evaporators are occasionally thermally shocked to remove scale buildup.

The floor and yard drainage exits the plant via 3 main gravity drainage lines. General floor and equipment drains for Unit I are collected in a building sump which periodically transfers the floor drainage to the central yard drainage system. The central yard system picks up general yard drainage and runoff from the north and west sides of Unit I.

The east drainage system collects yard runoff from the switchyard and battery house area. The turbine oil area for Unit II also drains into this system. Central and east yard drainage systems join together in a common line, which enters the Power Block Pond.

The west drainage system collects general runoff from the plant's west yard, including the stations settling basin area. Nearly the entire Unit II floor and equipment drains via this drainage system. Flow associated with the west yard drains into Power Block Pond.

Chemicals used to remove metals include Nalco's Nalmet 8702 and Ultion 8185. Nalmet is a heavy metal remover used to remove copper from the effluent, Ultrion 8185 is an inorganic/organic blend of cationic polymers use to help form a small floc that more readily settles copper in the wastewater pond.

The discharge from the Power Block Pond makes up internal Outfall 02A. Flow measurements are made at this point using a weir. The average discharge based on DMR data is 0.10 MGD.

A1.2 Internal Outfall 02B – Cooling Tower Blowdown

The recirculating cooling water system at the Couch Plant is designed to dissipate the waste heat associated with power production. A cooling tower serves each unit. The Unit I tower is a forced fan type designed to cool approximately 33,000 gpm of recirculation water from the main condensers. The Unit II tower is a six-cell induced draft tower with a rate capacity of 750×10^6 BTU/hr at 83,000 gpm recirculation water. During the cooling process a portion of the recirculating water is evaporated causing an increase in the dissolved solids of the remaining water. To control this concentration and maintain system chemistry, water is discharged from the cooling system as blowdown and replaced with higher quality makeup water provided by the plant's water wells. Blowdown from both units is discharged from the cool side of the tower. Discharge from the Cooling Tower Pond makes up internal Outfall 02B. Flow is monitored at this point using a weir. Chemicals used to control system chemistry and prevent scaling include Calgon TowerBrom 960, Calgon H-130 Microbiocide, Calgon H-460 Microbiocide and Cuprostat. The average flow through internal Outfall 02B based on DMR data is 0.21 MGD.

A1.3 Outfall 002 – Low Volume Waste and Cooling Tower Blowdown

Effluent from internal outfalls 02A and 02B are combined in the mixing pond. The combined effluent then flows into a constructed wetlands treatment system which, in turn, discharges through Outfall 002 under NPDES permit No. AR0000493 (Figure A.1). Measurements and samples required by the NPDES permit are taken at a wier constructed at Outfall 002. Following the weir, groundwater is metered as needed into the flow to maintain temperature of the discharge below the permitted level.

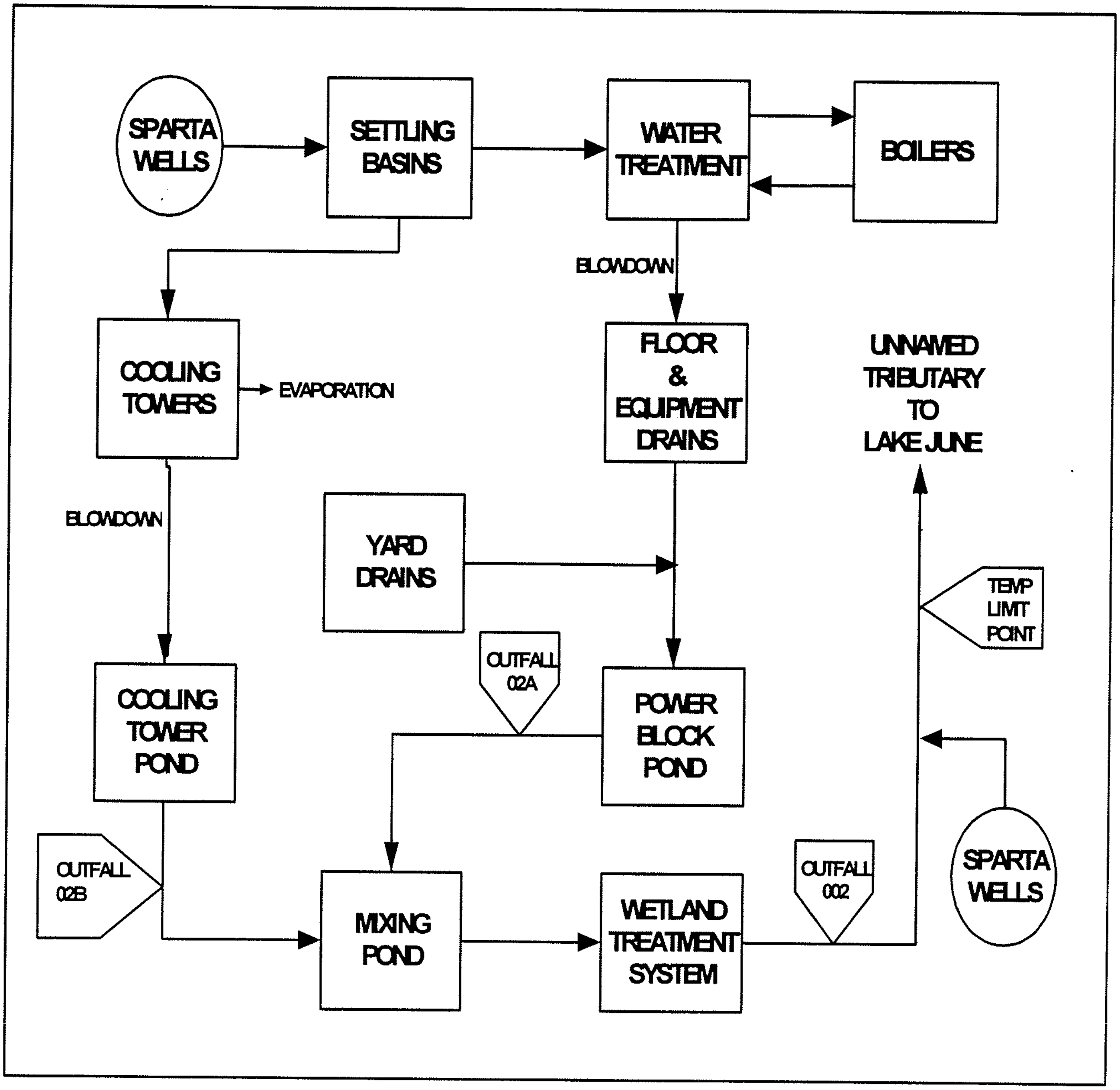


Figure A.1. Flow diagram of Couch Plant.

APPENDIX B

Evaluation of Dissolved Oxygen and Copper Concentration in the Receiving Waterbody

B.1 COPPER

As noted in Section 2.6, Outfall 002 exceeds the NPDES permit limit for total recoverable copper (Table 2.1). The potential for aquatic life impairment due to copper exceedances at Outfall 002 was examined by evaluating copper bioavailability in the HCSES receiving stream. Bioavailability of metals can be evaluated using the water effect ratio (WER). The water effect ratio is typically determined empirically using toxicity tests performed in metal-spiked site water samples and laboratory water prepared to match the hardness and ionic strength of the site water. Bioavailability can also be evaluated using the biotic ligand model (BLM, DiToro, et al. 2001) to estimate the WER. The BLM forms the basis for the most recent update of EPA's copper criteria document (USEPA, 2003). The BLM quantitatively predicts the LC50 of metals (e.g. copper) in a sample of water using analytical measurements of chemical ligands (e.g. organic carbon, carbonate, sulfate, cationic metals) that directly or indirectly bind with free copper or compete for biochemical binding sites (i.e. biotic ligands). The WER of a sample can be estimated by dividing the BLM predicted LC50 for the site sample by the BLM predicted LC50 for laboratory water having hardness and pH similar to the site water.

A BLM analysis was performed using analytical results obtained from site water samples collected from the unnamed tributary on 7/23/03. The required water quality measurements (e.g. total calcium, total magnesium, total alkalinity, dissolved organic carbon, pH) for evaluating copper toxicity are given in Di Toro et al. (2000) and were determined by direct analysis of site water samples. BLM calculations were performed using BLM Version 1.0.0 (http://www.hydroqual.com). Input values for the BLM parameters for the site and lab water are summarized in Table B.1. Results of the BLM output are presented in Table B.2.

Table B.1. Summary of input values for BLM analysis. Input values for SO_4 and Cl are ½ the ecoregion values as reported in APCEC (2002) page 5-11. Reference water values for Ca, Mg and total alkalinity were the averages of the site values.

Input Parameter	Matrix			
	Point A	Point B	Point C	Reference Water
Temp	25	25	25	25
pH	7.0	7.0	7.0	7.0
Total Cu (ug/L)	13	27	5.7	0.1
DOC (mg C/L)	2.9	5.8	6.6	0.5
HA (%)	10	10	10	10
Ca (mg/L)	8.8	7.8	6.6	7.8
Mg (mg/L)	1.9	1.7	1.6	1.73
Na (mg/L)	24	21	14	19.7
K (mg/L)	1	1	1	1
SO_4 (mg/L)	16	16	16	16
Cl (mg/L)	7	7	7	7
Total Alkalinity (mg $CaSO_4$/L)	57	45	25	42.3
S^{-2} (mg/L)	0.01	0.01	0.01	0.01

Table B.2. Summary of predicted LC50 values and WERs from the BLM analysis of the unnamed tributary.

C. dubia			
Matrix	LC50 (mmoles/L)	LC50 (ug/L)	WER
Outfall 002 (Point A)	3.36E-07	21	5.7
Point B	6.71E-07	43	11.4
Inflow (Point C)	7.27E-07	43	12.3
Lab	5.89E-08	3.7	NA
D. pulex			
Matrix	LC50 (mmoles/L)	LC50 (ug/L)	WER
Outfall 002 (Point A)	2.90E-07	18	5.7
Point B	5.81E-07	37	11.5
Inflow (Point C)	6.30E-07	40	12.4
Lab	5.06E-08	3.2	NA
P. promelas			
Matrix	LC50 (mmoles/L)	LC50 (ug/L)	WER
Outfall 002 (Point A)	3.66E-06	232	3.3
Point B	6.12E-06	389	5.5
Inflow (Point C)	6.37E-06	405	5.7
Lab	1.12E-06	71	NA

B.2 DISSOLVED OXYGEN

As noted in Section 4.3, DO measurements taken at Point B and/or the lake inflow on July 23, 2003 and September 3, 2003 were below the "critical" season ecoregion criterion of 2 mg/L for streams with watersheds <10 mi^2 (Tables 4.3 and 4.4). DO measurements taken in Reaches 1 and 2 (between Outfall 002 and Point B) on November 13, 2003 (Table 4.5) were less than the "primary" season ecoregion criterion of 5 mg/L. *In situ* measurements of temperature, dissolved oxygen (DO) and pH in the receiving waterbody indicate a dystrophic waterbody with high temperatures, low DO and low pH. Low pH and low DO measurements (Tables 4.3, 4.4, and 4.5) are consistent with the low current velocity and fine, organic detritus-rich sediment in the unnamed tributary. Low DO and low pH in Lake June (Table 4.2) are also consistent with the distinct organic staining noted in Lake June. DO measurements below ecoregion criteria appear to be a natural feature of the Lake June system and are consistent with the warm temperatures and organic staining observed. The results of fisheries surveys and aquatic life evaluation (Section 6.1) indicate that the DO regime in the Lake June system does not impair aquatic life.

B.2.1. BLM Evaluation of Copper Toxicity to Fish

Predicted WER values *P. promelas* were 3.3 to 5.7 indicating the presence of factors that significantly affect copper bioavailability to fish. Predicted LC50 values for *P. promelas* ranged from 232 to 405 ug/L dissolved copper (Table B.2). These predicted LC50 values are far greater than total copper concentrations reported in routine monitoring of Outfall 002 (Tables B.2 and 2.1). These results indicate that effluent concentrations bioavailable copper are far below concentrations expected to impair fish communities.

B.2.2. BLM Evaluation of Copper Toxicity to Invertebrates

Predicted WER values for invertebrates (*C. dubia* and *Daphnia pulex*) ranged from 5.7 at Outfall 002 to 12.4 at Point C. The predicted LC50 and WER values for dissolved copper for invertebrates (*C. dubia* and *D. pulex*) showed a rapid increase from Outfall 002 to Point B (WER = 11.4) with only a slight change from Point B to Point C. This result suggests that a WER value near 10 may accurately describe most of the unnamed tributary. The increase in the WER from Outfall 002 to Point B reflects the increase in dissolved organic carbon (DOC) between these two locations. This increase is consistent with field observations of the appearance of the receiving stream in the unnamed tributary. These results suggest that only approximately 20% of the dissolved copper at Outfall 002 is bioavailable (WER values near 5), while only about 10% of the dissolved copper is bioavailable (WER values 11 to 12) below Point B. The results of this analysis indicate that, although Outfall 002 exceeds permit limits for total copper, a large portion of the dissolved copper (and an even larger portion of the total copper) is biologically unavailable in the unnamed tributary. Given the observed increase in the degree of organic staining of the surface water of Lake June, bioavailability of water column copper in Lake June is likely to be even lower.

For the purpose of discussion, Table B.3 compares results of copper analyses from DMR monitoring of Outfall 002 and samples collected as part of this study in the unnamed tributary (from Tables 4.3 and 4.5) with the site water LC50 predicted by the BLM (i.e. average of LC50 values for Points A, B and C for *D. pulex* and *C. dubia*). A comparison of the maximum total copper value from DMR monitoring (51 ug/L, Table 2.1) and the total copper concentration measured Reach 2 on 11/12/03 (90 mg/L, Table 4.5) indicates that total copper concentrations may approach or exceed the dissolved copper LC50 in site water as predicted by the BLM. Site water samples collected on 7/23/03 indicate that approximately 50% of the total copper present in the receiving stream is present as dissolved copper (Table 4.3). If these results reflect the typical relative proportions of total and dissolved copper in the receiving stream, then dissolved copper in the unnamed tributary is typically less than the average predicted dissolved copper LC50 (34 mg/L) in site water (Table B.3). An exception to this is the measured concentration of 90 ug/L (45 ug/L estimated dissolved) in Reach 2 on 11/12/03 (Table 4.5). This concentration is somewhat higher than any concentration measured at Outfall 002 and is significantly higher than the concentration also measured on 11/12/03 in nearby Reach 1. Accordingly, the measured value at Reach 2 may reflect unusual analytical variability.

The results of the BLM analysis indicate that the total copper present in the receiving stream is largely biologically unavailable and rarely reaches toxic levels. This conclusion is supported by the lack of toxicity to *C. dubia* (Section 2.7). The results of the biological assessment (Section 6.1) further indicate that copper exceedances have not impaired aquatic life in the unnamed tributary and Lake June.

Table B.3. Comparison of estimated dissolved copper concentrations with site water LC50 for copper predicted by the BLM analysis. Dissolved concentrations were estimated assuming that dissolved concentrations are ½ of total concentrations (based on measured dissolved concentration on sample collected 7/23/03).

Date	Location	Total Copper (ug/L)	Dissolved Copper (ug/L)
5/31/02	Outfall 002	18	9
10/31/02	Outfall 002	10	5
12/31/02	Outfall 002	42	21
1/31/03	Outfall 002	23	12
2/28/03	Outfall 002	51	26
3/31/03	Outfall 002	25	13
7/31/03	Outfall 002	12	6
8/31/03	Outfall 002	10	5
7/23/03	Outfall 002	13	7.7 *
7/23/03	Point B	27	13 *
7/23/03	Point C	5.7	< 5 *
11/12/03	Reach 1	26	13
11/12/03	Reach 2	90	45
Average LC50 predicted by BLM = 34 ug/L (See text)			

*Measured dissolved concentrations

APPENDIX C

Habitat Evaluation Forms Used in Rapid Bioassessment

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION
STATION #________ RIVERMILE________	STREAM CLASS
LAT ___________ LONG ___________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE _______ TIME _______ AM PM — REASON FOR SURVEY

WEATHER CONDITIONS	**Now** / **Past 24 hours** ❑ storm (heavy rain) ❑ ❑ rain (steady rain) ❑ ❑ showers (intermittent) ❑ ____%❑ %cloud cover ❑____% ❑ clear/sunny ❑ **Has there been a heavy rain in the last 7 days?** ❑ Yes ❑ No **Air Temperature**_____ °C **Other**___________________
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)**
STREAM CHARACTERIZATION	**Stream Subsystem** ❑ Perennial ❑ Intermittent ❑ Tidal **Stream Origin** ❑ Glacial ❑ Spring-fed ❑ Non-glacial montane ❑ Mixture of origins ❑ Swamp and bog ❑ Other_________ **Stream Type** ❑ Coldwater ❑ Warmwater **Catchment Area**_________km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Other ______ ❑ Residential **Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources **Local Watershed Erosion** ❑ None ❑ Moderate ❑ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ❑ Trees ❑ Shrubs ❑ Grasses ❑ Herbaceous **dominant species present** ______
INSTREAM FEATURES	**Estimated Reach Length** ______m **Estimated Stream Width** ______m **Sampling Reach Area** ______m² **Area in km² (m²x1000)** ______km² **Estimated Stream Depth** ______m **Surface Velocity (at thalweg)** ______m/sec **Canopy Cover** ❑ Partly open ❑ Partly shaded ❑ Shaded **High Water Mark** ______m **Proportion of Reach Represented by Stream Morphology Types** ❑ Riffle______% ❑ Run______% ❑ Pool______% **Channelized** ❑ Yes ❑ No **Dam Present** ❑ Yes ❑ No
LARGE WOODY DEBRIS	**LWD** ______m² **Density of LWD** ______m²/km² **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ❑ Rooted emergent ❑ Rooted submergent ❑ Rooted floating ❑ Free floating ❑ Floating Algae ❑ Attached Algae **dominant species present** ______ **Portion of the reach with aquatic vegetation** ____%
WATER QUALITY	**Temperature** ______ °C **Specific Conductance** ______ **Dissolved Oxygen** ______ **pH** ______ **Turbidity** ______ **WQ Instrument Used** ______ **Water Odors** ❑ Normal/None ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Fishy ❑ Other______ **Water Surface Oils** ❑ Slick ❑ Sheen ❑ Globs ❑ Flecks ❑ None ❑ Other______ **Turbidity (if not measured)** ❑ Clear ❑ Slightly turbid ❑ Turbid ❑ Opaque ❑ Stained ❑ Other______
SEDIMENT/ SUBSTRATE	**Odors** ❑ Normal ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Anaerobic ❑ None ❑ Other______ **Oils** ❑ Absent ❑ Slight ❑ Moderate ❑ Profuse **Deposits** ❑ Sludge ❑ Sawdust ❑ Paper fiber ❑ Sand ❑ Relict shells ❑ Other______ **Looking at stones which are not deeply embedded, are the undersides black in color?** ❑ Yes ❑ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION # ________ RIVERMILE ________	STREAM CLASS	
LAT ________ LONG ________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE ______ TIME ______ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

APPENDIX D

Completed Habitat Assessment Field Sheets

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Couch outfall	LOCATION Couch ~~at~~ Plant
STATION # Reach 2 RIVERMILE	STREAM CLASS —
LAT Sufield Rock LONG	RIVER BASIN —
STORET #	AGENCY FTN
INVESTIGATORS DMR, JLJ	
FORM COMPLETED BY DMR	DATE 11/13/03 TIME 1415 AM (PM) — REASON FOR SURVEY Site assessment

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 13	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness NA	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
4. Sediment Deposition 18	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE ~~5~~	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	~~(5)~~ 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Note: per conv. field team— "storm was soft silty," but not "deposited" sediment. PSD 12/19/03

Couch Outfall Reach 2 11/13/03

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Reach 1

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME outfall	LOCATION Coach 4At plant
STATION # R1 RIVERMILE	STREAM CLASS
LAT See field book LONG	RIVER BASIN
STORET #	AGENCY FW
INVESTIGATORS DMR, JLJ	
FORM COMPLETED BY DMR	DATE 11/13/03 TIME 1100 AM PM — REASON FOR SURVEY 5th assessment

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 14	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness N/A	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition 18	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 14	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

to 5 per conv. 1 field team — bottom was soft & silty but not "pointed" sediment. RDD 12/19/03

Couch Outfall Reach, 11/13/03

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 17	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 8 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 10 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 9 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

APPENDIX E

Completed Physical Characterization/Water Quality Field Data Sheets

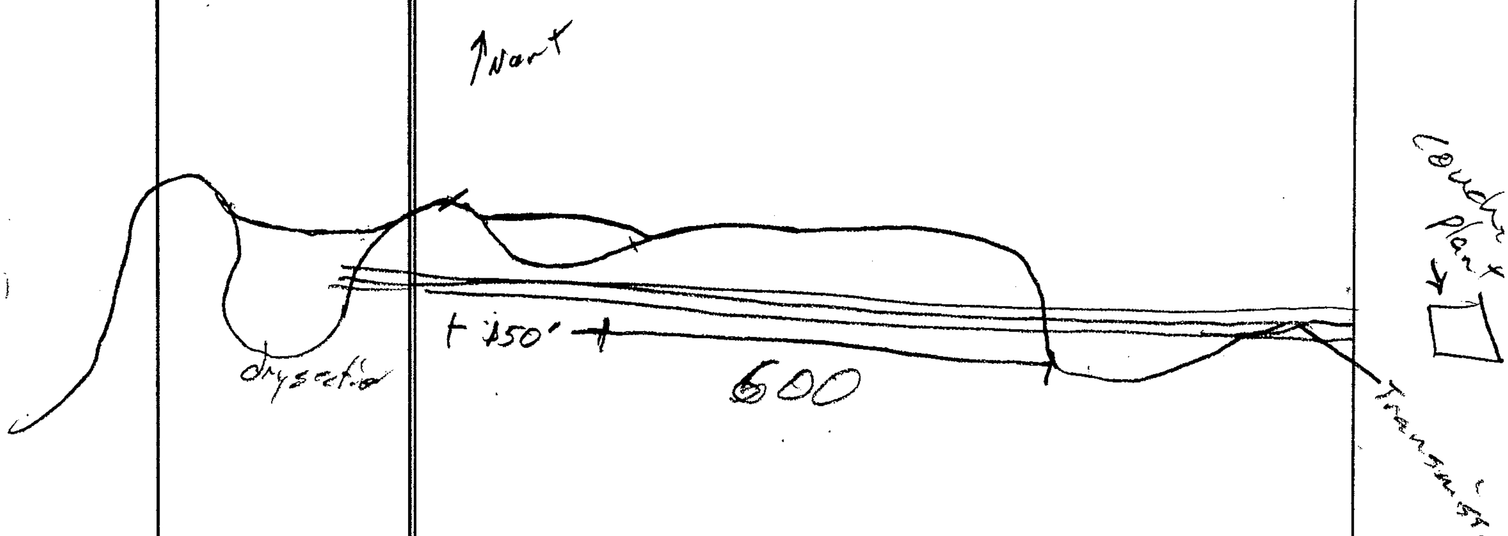
PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

Reach 2

STREAM NAME Outfal	LOCATION Couchu Plant
STATION # R2 RIVERMILE ____	STREAM CLASS ⁄
LAT See field book LONG ⁄	RIVER BASIN ⁄
STORET # ⁄	AGENCY FTN
INVESTIGATORS JLJ DMR	
FORM COMPLETED BY JLJ	DATE 13 NOV 03 TIME 1400 AM (PM) — REASON FOR SURVEY Fish sampling

WEATHER CONDITIONS	Now		Past 24 hours	
Overcast Cool/windy	☐	storm (heavy rain)	☐	Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No
	☐	rain (steady rain)	☐	Air Temperature 70 °C
	☐	showers (intermittent)	☐	
	80 % ☐	%cloud cover	☐ ___ %	Other ____
	☒	clear/sunny	☒	

SITE LOCATION/MAP — Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem: ☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type: ☐ Coldwater ☒ Warmwater

Stream Origin: ☐ Glacial ☒ Non-glacial montane ☐ Swamp and bog ☐ Spring-fed ☐ Mixture of origins ☒ Other Plant Outfall 002

Catchment Area ________ km²

Couch Outfall Reach 2 11/13/03

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☒ Forest ☐ Field/Pasture ☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial ☐ Other ____ **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☒ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	Indicate the dominant type and record the dominant species present ☒ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous; dominant species present Pinus Taeda, Q phellos, Q Nigra
INSTREAM FEATURES	Estimated Reach Length 150 m; Estimated Stream Width 1-2 m; Sampling Reach Area 150 m²; Area in km² (m²x1000) ____ km²; Estimated Stream Depth 1 m; Surface Velocity ~0 m/sec (at thalweg); Canopy Cover ☐ Partly open ☒ Partly shaded ☐ Shaded; High Water Mark ____ m; Proportion of Reach Represented by Stream Morphology Types ☐ Riffle ____% ☐ Run ____% ☐ Pool 100 %; Channelized ☐ Yes ☐ No; Dam Present ☐ Yes ☐ No
LARGE WOODY DEBRIS	LWD ____ m²; Density of LWD ____ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	Indicate the dominant type and record the dominant species present ☒ Rooted emergent ☒ Rooted submergent ☐ Rooted floating ☐ Free floating ☒ Floating Algae ☒ Attached Algae; dominant species present ____; Portion of the reach with aquatic vegetation 20 %
WATER QUALITY	Temperature 15.56° C; Specific Conductance 178.6; Dissolved Oxygen 4.34; pH 6.73; Turbidity ____; WQ Instrument Used Hydrolab; Water Odors ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other None; Water Surface Oils ☐ Slick ☒ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other ____; Turbidity (if not measured) ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☒ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE	Odors ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☒ Other sulfuric/methane; Oils ☐ Absent ☒ Slight ☐ Moderate ☐ Profuse; Deposits ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other silt; Looking at stones which are not deeply embedded, are the undersides black in color? ☐ Yes ☐ No N/A

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	5 %
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	95 %
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm	80 %			
Clay	< 0.004 mm (slick)	20 %			

Reach 1

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME outfall	LOCATION Couchu Ent. Plant.
STATION # R4 RIVERMILE	STREAM CLASS
LAT See field Books LONG	RIVER BASIN
STORET #	AGENCY FTN
INVESTIGATORS SLJ, DMP	
FORM COMPLETED BY SLJ	DATE 12NOV03 TIME 1100 AM PM — REASON FOR SURVEY Fish sampling

WEATHER CONDITIONS

overcast cool - Windy

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
80% ☐	%cloud cover	☐ ___ %
☐	clear/sunny	☐

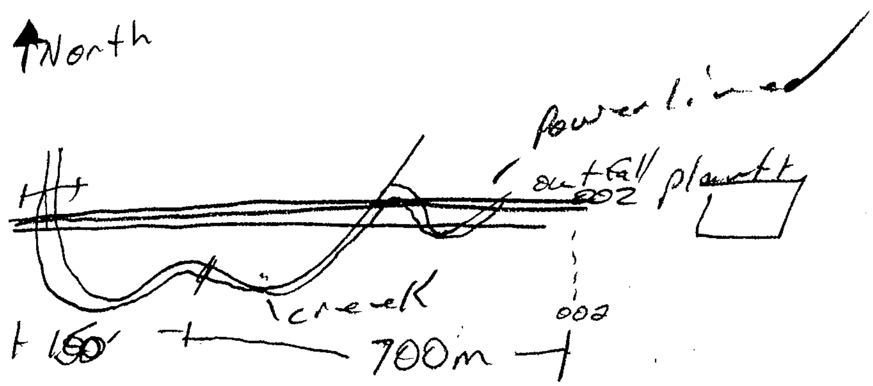
Has there been a heavy rain in the last 7 days?
☐ Yes ☒ No

Air Temperature 70° C

Other ____________

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial
☒ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☐ Mixture of origins
☒ Other Plant Outfall

Catchment Area ________ km^2

Couch Outfall Reach 1 11/13/03

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☒ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ____ ☐ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☒ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **dominant species present** Q. nigra, phellos, Liquidambar Stariflua, Pinus Taeda
INSTREAM FEATURES	**Estimated Reach Length** 40 m **Estimated Stream Width** ~2 m **Sampling Reach Area** 40 m² **Area in km² (m²x1000)** 4 km² **Estimated Stream Depth** 1 m **Surface Velocity (at thalweg)** ~0 m/sec **Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** 0 m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle ____% ☐ Run ____% ☐ Pool 100 % **Channelized** ☒ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** ____ m² **Density of LWD** ____ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☒ Rooted emergent ☒ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **dominant species present** ____ **Portion of the reach with aquatic vegetation** 20 %
WATER QUALITY	**Temperature** 15.06 °C **Specific Conductance** 189.4 **Dissolved Oxygen** 4.55 **pH** 6.9 **Turbidity** ____ **WQ Instrument Used** Hydrolab **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ~~☒ Other sulfur~~ SL **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ____ **Turbidity (if not measured)** ☐ Clear ☒ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE	**Odors** ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☒ Other Sulfuric **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other ____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No NA

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	5%
Boulder	> 256 mm (10")		Muck-Mud	black, very fine organic (FPOM)	95%
Cobble	64-256 mm (2.5"-10")		Marl	grey, shell fragments	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)				
Silt	0.004-0.06 mm	90 ~~100~~ %			
Clay	< 0.004 mm (slick)	10			

NA

APPENDIX F

Detail Results of Equilibrium Temperature Calculations

HEAT BUDGET FOR ENTERGY COUCH PONDS
HIGHEST MONTHLY WIND SPEED FOR EACH MONTH; LOWEST MONTHLY DEW POINT FOR EACH MONTH
PHM 4/06/05

MONTH	MAX. MONTHLY WIND, W (mph)	AVG SOLAR RADIAT, Hs (Langley)	MIN. MONTHLY DEW POINT, Td (F)	WATER TEMP, Ts (C)	Tm (C)	HEAT EXCHANGE COEFF, K (W/m2/C)	EQUIL TEMP, Te (C)	WET BULB TEMP (F)
JAN	9.1	198	21.0	9.3	1.6	19.2	-1.1	27
FEB	9.4	272	27.0	11.7	4.5	20.9	3.5	32
MAR	9.7	356	37.0	15.3	9.0	24.1	9.9	43
APR	8.6	437	45.0	22.0	14.6	26.3	15.3	50
MAY	7.9	523	54.9	28.0	20.3	30.1	21.1	59
JUN	7.1	571	60.4	30.9	23.3	31.3	24.6	64
JUL	7.6	551	68.6	31.3	25.8	35.2	27.9	72
AUG	7.2	505	66.6	31.3	25.3	33.5	26.5	70
SEP	7.2	412	61.3	27.8	22.0	30.1	22.9	65
OCT	7.5	333	45.0	20.3	13.8	23.5	14.1	50
NOV	8.0	230	37.4	13.1	8.0	20.5	8.4	43
DEC	8.2	183	21.1	10.1	2.0	18.1	-1.2	27

Power block pond
Area of surface = 21400 ft2
Area of bottom = 7607 ft2
Depth in middle = 8.5 ft
Volume of pond = 118335 ft3
Average depth = 5.5 ft = 1.7 m

Cooling tower pond
Area of surface = 17580 ft2
Area of bottom = 5235 ft2
Depth in middle = 8.5 ft
Volume of pond = 91826 ft3
Average depth = 5.2 ft = 1.6 m

MONTH	Power block: Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)	Cooling tower: Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)
JAN	0.02	1062	39.0	-1.1	0.64	26	5.6	4.0
FEB	0.02	1062	39.0	3.5	0.64	26	8.3	7.1
MAR	0.02	1062	39.0	9.9	0.64	26	14.4	13.2
APR	0.02	1062	39.0	15.3	0.64	26	18.3	17.4
MAY	0.02	1062	39.0	21.1	0.64	26	23.3	22.6
JUN	0.02	1062	39.0	24.6	0.64	26	26.1	25.6
JUL	0.02	1062	39.0	27.9	0.64	26	30.6	29.5
AUG	0.02	1062	39.0	26.5	0.64	26	29.4	28.4
SEP	0.02	1062	39.0	22.9	0.64	26	26.7	25.4
OCT	0.02	1062	39.0	14.1	0.64	26	18.3	17.1
NOV	0.02	1062	39.0	8.4	0.64	26	14.4	13.0
DEC	0.02	1062	39.0	-1.2	0.64	26	5.6	4.1

Mixing pond
Area of surface = 39200 ft2
Area of bottom = 13626 ft2
Depth in middle = 8.5 ft
Volume of pond = 215156 ft3
Average depth = 5.5 ft = 1.7 m

Wetland basin pond
Area of surface = 24586 ft2
Area of bottom = 13183 ft2
Depth in middle = 2 ft
Volume of pond = 37181 ft3
Average depth = 1.5 ft = 0.5 m

MONTH	Mixing: Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)	Wetland basin: Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)	Difference between 002 (outlet of wetland basin pond) and equil. temp. (C)
JAN	0.66	59	3.8	1.7	0.66	10	1.7	0.8	1.9
FEB	0.66	59	7.0	5.4	0.66	10	5.4	4.8	1.3
MAR	0.66	59	13.1	11.5	0.66	10	11.5	10.9	1.0
APR	0.66	59	17.3	16.2	0.66	10	16.2	15.8	0.6
MAY	0.66	59	22.5	21.7	0.66	10	21.7	21.5	0.3
JUN	0.66	59	25.6	25.0	0.66	10	25.0	24.8	0.2
JUL	0.66	59	29.5	28.5	0.66	10	28.5	28.2	0.3
AUG	0.66	59	28.3	27.2	0.66	10	27.2	26.9	0.3
SEP	0.66	59	25.3	23.9	0.66	10	23.9	23.5	0.5
OCT	0.66	59	17.1	15.5	0.66	10	15.5	15.0	0.9
NOV	0.66	59	12.8	10.8	0.66	10	10.8	10.0	1.6
DEC	0.66	59	3.9	1.8	0.66	10	1.8	0.9	2.1

NOTES :
1. CALCULATIONS FOR EQUILIBRIUM TEMPERATURE AND RATE OF HEAT EXCHANGE FOLLOW THE METHODS AND EQUATIONS IN "HEAT EXCHANGE IN THE ENVIRONMENT" (EDINGER, BRADY, AND GEYER; 1974).
2. WIND AND DEWPOINT WERE THE MAXIMUM AND MINIMUM MONTHLY VALUES (AS OPPOSED TO MAXIMUM AND MINIMUM DAILY VALUES) FROM 9 YEARS OF DATA FROM NOAA BETWEEN 1979 AND 1992.
3. SOLAR RADIATION WERE LONG TERM AVERAGES FOR LITTLE ROCK OBTAINED FROM JOE NIX, OUACHITA BAPTIST UNIVERSITY (UNPUBLISHED DATA).
4. INFLOW RATES FOR POWER BLOCK POND AND COOLING TOWER POND WERE ESTIMATED FROM STATISTICAL ANALYSIS OF DAILY DATA FROM OUTFALL 002 FOR 2001-2003, AND A FAX OF DAILY DATA FOR JULY 2002.
5. INFLOW TEMPERATURE FOR POWER BLOCK POND WAS SET EQUAL TO AVERAGE OF TWO MEASUREMENTS BY FTN ON AUGUST 22 & 24, 2002
6. INFLOW TEMPERATURE FOR COOLING TOWER POND WAS ASSUMED TO BE WET BULB TEMPERATURE PLUS 15 F.

HEAT BUDGET FOR ENTERGY COUCH PONDS
LOWEST MONTHLY WIND SPEED FOR EACH MONTH; HIGHEST MONTHLY DEW POINT FOR EACH MONTH
PHM 4/06/05

MONTH	MIN. MONTHLY WIND, W (mph)	AVG SOLAR RADIAT, Hs (Langley)	MAX. MONTHLY DEW POINT, Td (F)	WATER TEMP, Ts (C)	Tm (C)	HEAT EXCHANGE COEFF, K (W/m2/C)	EQUIL TEMP, Te (C)	WET BULB TEMP (F)
JAN	4.8	198	37.9	9.3	6.3	15.9	9.3	43
FEB	6.0	272	39.8	11.7	8.0	17.8	11.7	45
MAR	7.3	356	45.0	15.3	11.3	21.4	15.3	50
APR	6.7	437	56.5	22.0	17.8	25.2	22.0	60
MAY	6.1	523	66.7	28.0	23.6	29.2	28.0	70
JUN	5.5	571	71.3	30.9	26.4	30.6	30.9	74
JUL	5.6	551	73.0	31.3	27.0	31.5	31.3	76
AUG	5.0	505	74.0	31.3	27.3	30.5	31.3	77
SEP	5.1	412	69.0	27.8	24.2	27.7	27.8	72
OCT	5.7	333	55.8	20.3	16.8	22.7	20.3	59
NOV	6.7	230	45.4	13.1	10.3	19.8	13.1	50
DEC	6.0	183	41.0	10.1	7.5	17.5	10.1	46

Power block pond

Area of surface = 21400 ft2
Area of bottom = 7607 ft2
Depth in middle = 8.5 ft
Volume of pond = 118335 ft3
Average depth = 5.5 ft = 1.7 m

MONTH	Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)
JAN	0.02	1062	39.0	9.3
FEB	0.02	1062	39.0	11.7
MAR	0.02	1062	39.0	15.3
APR	0.02	1062	39.0	22.0
MAY	0.02	1062	39.0	28.0
JUN	0.02	1062	39.0	30.9
JUL	0.02	1062	39.0	31.3
AUG	0.02	1062	39.0	31.3
SEP	0.02	1062	39.0	27.8
OCT	0.02	1062	39.0	20.3
NOV	0.02	1062	39.0	13.1
DEC	0.02	1062	39.0	10.1

Cooling tower pond

Area of surface = 17580 ft2
Area of bottom = 5235 ft2
Depth in middle = 8.5 ft
Volume of pond = 91826 ft3
Average depth = 5.2 ft = 1.6 m

Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)
0.62	27	14.4	13.4
0.62	27	15.6	14.7
0.62	27	18.3	17.5
0.62	27	23.9	23.3
0.62	27	29.4	28.9
0.62	27	31.7	31.4
0.62	27	32.8	32.2
0.62	27	33.3	32.6
0.62	27	30.6	29.6
0.62	27	23.3	22.5
0.62	27	18.3	17.0
0.62	27	16.1	14.8

Mixing pond

Area of surface = 39200 ft2
Area of bottom = 13626 ft2
Depth in middle = 8.5 ft
Volume of pond = 215156 ft3
Average depth = 5.5 ft = 1.7 m

MONTH	Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)
JAN	0.64	60	13.3	11.7
FEB	0.64	60	14.6	13.4
MAR	0.64	60	17.5	16.4
APR	0.64	60	23.3	22.6
MAY	0.64	60	28.9	28.3
JUN	0.64	60	31.4	31.1
JUL	0.64	60	32.2	31.6
AUG	0.64	60	32.6	31.8
SEP	0.64	60	29.6	28.5
OCT	0.64	60	22.4	21.4
NOV	0.64	60	16.9	15.1
DEC	0.64	60	14.6	12.7

Wetland basin pond

Area of surface = 24586 ft2
Area of bottom = 13183 ft2
Depth in middle = 2 ft
Volume of pond = 37181 ft3
Average depth = 1.5 ft = 0.5 m

Flow (MGD)	Residence time (hrs)	Inflow temp. (C)	Outflow temp. (C)	Difference between 002 (outlet of wetland basin pond) and equil. temp. (C)
0.64	10	11.7	11.1	1.8
0.64	10	13.4	12.9	1.2
0.64	10	16.4	16.0	0.7
0.64	10	22.6	22.4	0.4
0.64	10	28.3	28.2	0.2
0.64	10	31.1	31.0	0.1
0.64	10	31.6	31.5	0.2
0.64	10	31.8	31.6	0.3
0.64	10	28.5	28.2	0.4
0.64	10	21.4	21.0	0.7
0.64	10	15.1	14.5	1.4
0.64	10	12.7	11.9	1.9

NOTES :

1. CALCULATIONS FOR EQUILIBRIUM TEMPERATURE AND RATE OF HEAT EXCHANGE FOLLOW THE METHODS AND EQUATIONS IN "HEAT EXCHANGE IN THE ENVIRONMENT" (EDINGER, BRADY, AND GEYER; 1974).
2. WIND AND DEWPOINT WERE THE MINIMUM AND MAXIMUM MONTHLY VALUES (AS OPPOSED TO MINIMUM AND MAXIMUM DAILY VALUES) FROM 9 YEARS OF DATA FROM NOAA BETWEEN 1979 AND 1992.
3. SOLAR RADIATION WERE LONG TERM AVERAGES FOR LITTLE ROCK OBTAINED FROM JOE NIX, OUACHITA BAPTIST UNIVERSITY (UNPUBLISHED DATA).
4. INFLOW RATES FOR POWER BLOCK POND AND COOLING TOWER POND WERE ESTIMATED FROM STATISTICAL ANALYSIS OF DAILY DATA FROM OUTFALL 002 FOR 2001-2003, AND A FAX OF DAILY DATA FOR JULY 2002.
5. INFLOW TEMPERATURE FOR POWER BLOCK POND WAS SET EQUAL TO AVERAGE OF TWO MEASUREMENTS BY FTN ON AUGUST 22 & 24, 2002
6. INFLOW TEMPERATURE FOR COOLING TOWER POND WAS ASSUMED TO BE WET BULB TEMPERATURE PLUS 15 F.