

**Arkansas Department of Energy & Environment – Division of Environmental Quality  
Water Quality Management Plan Summary**

**Date:** February 10, 2022 **Modeling Engineer:** Faizan Khan **Reviewed By:** Shane Byrum

New Permit                       Revoke & Reissue Permit                       Modified Permit

**Type of Discharge:** minor treated municipal wastewater

**Facility Name:** City of Flippin – Flippin WWTF

**Permit No.:** AR0021717

**Design Flow:** **0.35 MGD** (previously 0.175 MGD)

**Receiving Stream:** Fallen Ash Creek, thence to the White River

**Assessment Unit (AU):** AR\_11010003\_002                      **7Q10:** 0.006 cfs<sup>1</sup>

**Planning Segment:** 4I    **County:** Marion

**Proposed Effluent Limits in mg/l with New Design Flow of 0.35 MGD:**

	CBOD <sub>5</sub>	TSS	NH <sub>3</sub> -N	DO <sup>2</sup>
<b>May-October:</b>	10	15	2	6.0
<b>November-March:</b>	10	15	9	6.0
<b>April:</b>	10	15	3.9	6.0

**Current Effluent Limits in mg/l with Previous Design Flow of 0.175 MGD:**

	CBOD <sub>5</sub>	TSS	NH <sub>3</sub> -N	DO <sup>2</sup>
<b>May-October:</b>	10	15	2	6.0
<b>November-March:</b>	10	15	9	6.0
<b>April:</b>	10	15	4	6.0

**TMDL Limits:** None

**Justification (Sag = Minimum Modeled Value ≠ Difference in Value):**

Reach No.	Length (miles)	DO WQS <sub>C</sub> (mg/L)	DO Sag <sub>C</sub> (mg/L)	Distance to DO Sag <sub>C</sub> (miles)	DO WQS <sub>P</sub> (mg/L)	DO Sag <sub>P</sub> (mg/L)	Distance to DO Sag <sub>P</sub> (miles)
1a	0.1	2.0	5.6	0.1	6.0	6.6	0.1
1b	0.9	5.0	5.6	0.0	6.0	6.6	0.0

Values in above table are from a modeling analysis dated February 10, 2022.

**Outfall Location (Lat/Long)<sup>3</sup>:** 36° 16' 59.59" N; 92° 35' 08.76" W

<sup>1</sup> USGS StreamStats web-based program

<sup>2</sup> DO limit is an Instantaneous Minimum.

<sup>3</sup> The outfall coordinates were updated based on an [inspection report of the facility dated August 18, 2020](#).

**Remarks:** This is for the revoke and reissue of the discharge permit for this existing facility. A new modeling analysis was performed due to proposed changes to the facility's treatment system, including an increase in design flow from 0.175 MGD to 0.35 MGD per state construction permit [AR0021717C](#).

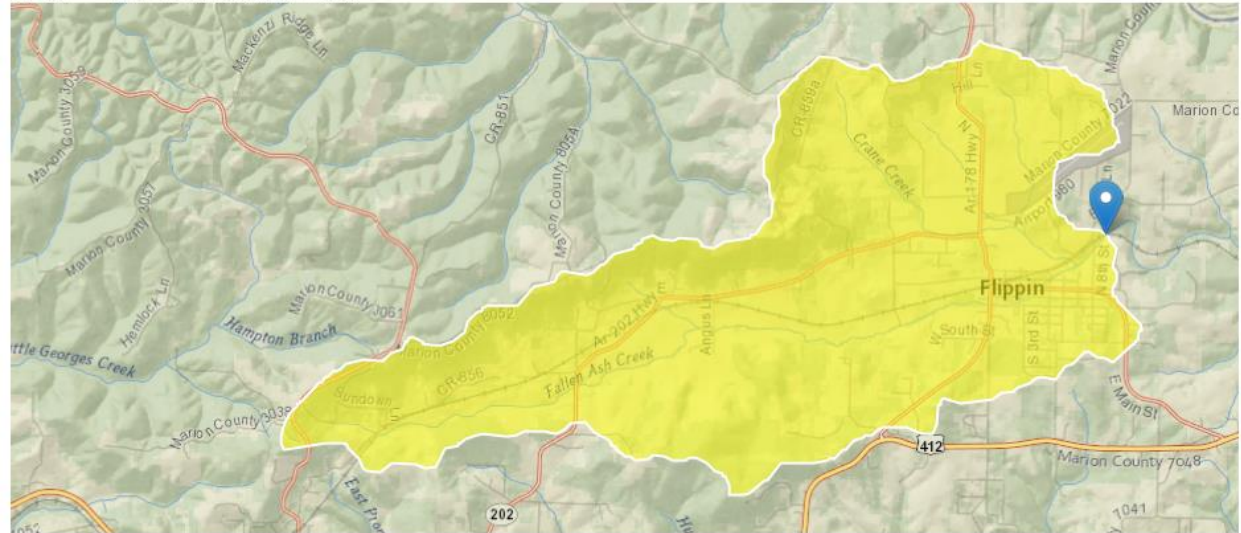
The 208 Plan is being updated to revise the facility design flow from 0.175 MGD to 0.35 MGD, and revise the monthly average NH<sub>3</sub>-N limit during April from 4.0 to 3.9 mg/l based on ammonia toxicity calculations shown on next page.

POTW?		Ammonia Calculations		COLOR KEY		
Facility Name	Yes	(Yes or No)			User Inputs	
Major or Minor	City of Flippin				Calculated values	
Permit Number	Minor					
Receiving Stream	AR0021717					
7Q10, cfs	Fallen Ash Creek		Ecoregion or River name	Ozark Highlands		
0.25/0.67 multiplier	0.006	USGS StreamStats	Watershed area (mi <sup>2</sup> )	9.88		
Qb, cfs	0.00		Rule 2 Chronic Toxicity Criteria (Instream Concentration)			
Qe, MGD	0.35	Design flow	April	AML, mg/l	DML, mg/l	
Qe, cfs	0.54		May - October	3.9	3.9	
Cb, mg/l	0.1	Model input upstream	November - March	10.3	10.3	
Allowable Effluent Conc., mg/l						
(Qe * Ce) + (Qb* Cb) = (Qe + Qb) * IWC			Allowable Effluent Conc. (Ce), mg/l			
Qe	Effluent Flow		Ce = (IWC (Qe + Qb) - Cb X Qb) / Qe			
Ce	Allowable Effluent Concentration		Monthly Avg.,mg/l			
Qb	% of Low Flow of Receiving Stream		April	3.9	7-Day Avg, mg/l	
Cb	Background Concentration		May - October	3.9	3.9	
IWC	Instream Waste Concentration Chronic Toxicity Criteria		November - March	10.4	10.4	
<b>Chronic Toxicity Criteria vs. D.O. Model Limits</b>						
	Monthly Average, mg/l		Permit Limits		7-Day Average, mg/l	
Month	Toxicity limit	D.O. limit		Toxicity limit	D.O. limit	Permit Limits
April	3.9	9.0	3.9	3.9	13.5	3.9
May - October	no fishery	2.0	2.0	no fishery	3.0	3.0
November - March	10.4	9.0	9.0	10.4	13.5	10.4

Ammonia Toxicity Criteria					
Minor Permits					
Fish Early Life Stages Absent - Primary Season (November - March), mg/L					
Ecoregion	Temperature	pH	4-day average	30-day average	
Arkansas River	14	7.6	10.3	10.3	
Arkansas River Valley	14	6.7	16.7	16.7	
Boston Mountains	14	6.9	15.8	15.8	
Delta	14	7.1	14.7	14.7	
Gulf Coastal Plains	14	6.6	17	17	
Ouachita Mountains	14	7.1	14.7	14.7	
Ouachita River (L. Mo. to Mouth)	14	6.7	16.7	16.7	
Ozark Highlands	14	7.6	10.3	10.3	
Red River	14	7.5	11.3	11.3	
White River (Dam #10 Mouth)	14	7.7	9.3	9.3	
Fish Early Life Stages Present - Critical Season (April - October), mg/L					
Ecoregion	Temperature	pH	4-day average	30-day average	
Arkansas River	32	7.6	3.2	3.2	
Arkansas River Valley	31	6.7	5.6	5.6	
Boston Mountains	31	6.9	5.3	5.3	
Delta	30	7.1	5.2	5.2	
Gulf Coastal Plains	30	6.6	6.1	6.1	
Ouachita Mountains	30	7.1	5.2	5.2	
Ouachita River (L. Mo. to Mouth)	32	6.7	5.2	5.2	
Ozark Highlands	29	7.6	3.9	3.9	
Red River	32	7.5	3.5	3.5	
White River (Dam #10 Mouth)	32	7.7	2.9	2.9	

# AR0021717 - City of Flippin - StreamStats Report

**Region ID:** AR  
**Workspace ID:** AR20210519135145779000  
**Clicked Point (Latitude, Longitude):** 36.28351, -92.58597  
**Time:** 2021-05-19 08:52:05 -0500



## Basin Characteristics

### Parameter

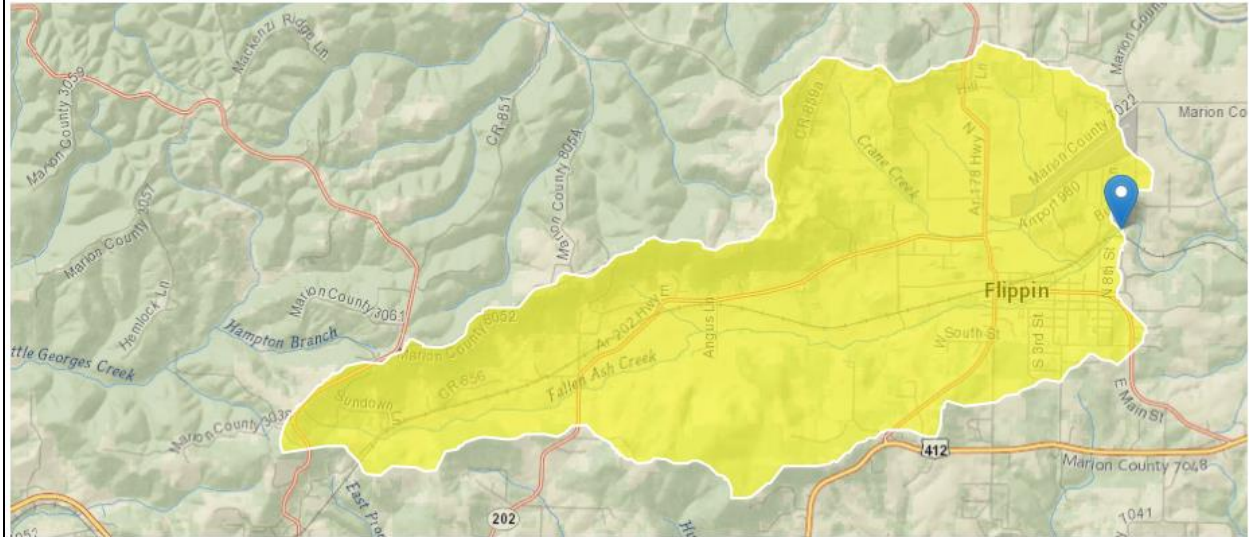
Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	9.88	square miles

7 Day 10 Year Low Flow	0.006	ft <sup>3</sup> /s
------------------------	-------	--------------------

Statistic	Value	Unit
Probability zero flow 7Day	0.00783	dim

# AR0021717 - City of Flippin - StreamStats Report (0.1 miles downstream of outfall)

Region ID: AR  
 Workspace ID: AR20210519140200950000  
 Clicked Point (Latitude, Longitude): 36.28426, -92.58473  
 Time: 2021-05-19 09:02:18 -0500



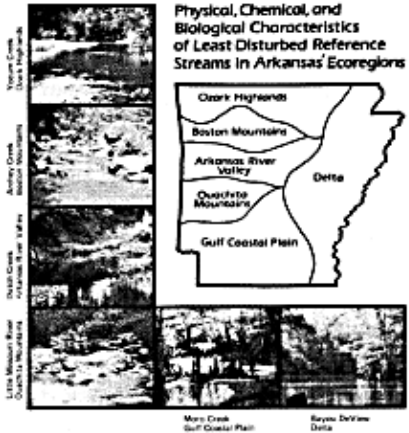
Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	10.2	square miles

This is designated as Reach 1b in the model. This reach, 0.1 miles downstream from the Flippin outfall, signifies the point where the DO water quality standard (Rule 2.505, see below) changes from 2 mg/l to 5 mg/l during the critical season, since the watershed size increases from 9.88 mi<sup>2</sup> (at the outfall) to 10.2 mi<sup>2</sup>.

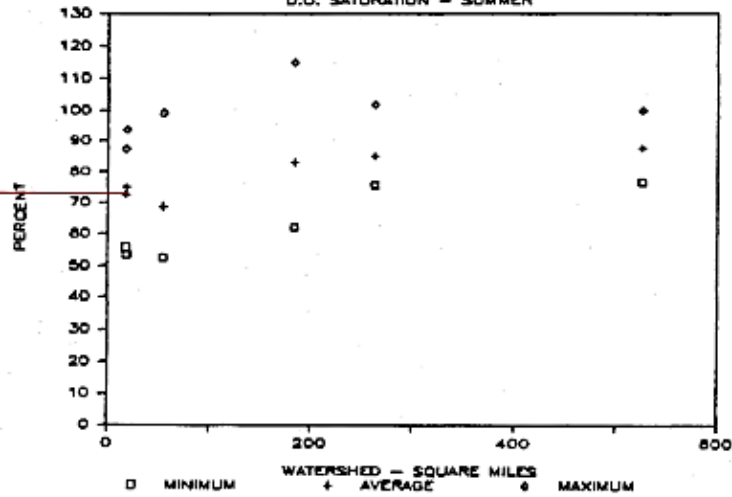
Waterbodies	Criteria (mg/L)	
	Primary	Critical
<b>Streams</b>		
Ozark Highlands		
<10 mi <sup>2</sup> watershed	6	2
10 to 100 mi <sup>2</sup>	6	5
>100 mi <sup>2</sup> watershed	6	6

Source: [Rule 2.505](#)

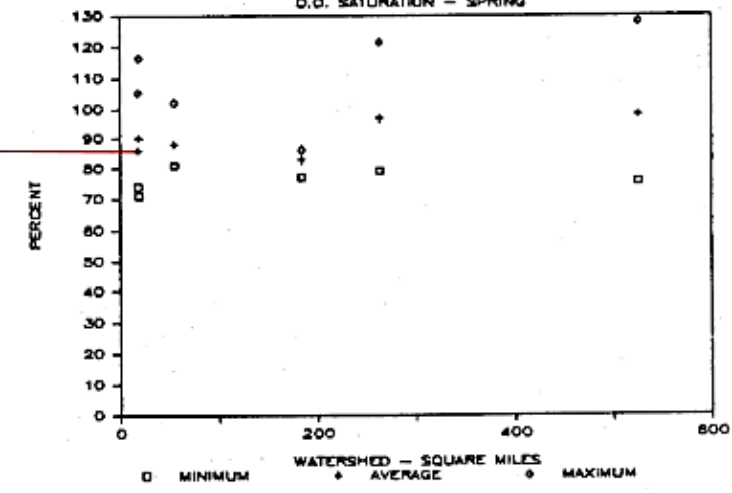


Volume II: Data Analysis  
1987  
State of Arkansas  
Department of Pollution Control and Ecology

### OZARK HIGHLANDS D.O. SATURATION - SUMMER



### OZARK HIGHLANDS D.O. SATURATION - SPRING



Source: [1987 Ecoregion Study](#)

## Sediment Oxygen Demand (SOD) for Various Temperatures and Ecoregion <sup>5</sup>

Rocky Substrate <sup>4</sup>						Applicable Ecoregions <sup>6</sup>
TSS <sup>1</sup>	SOD <sub>20</sub>	SOD <sub>22</sub>	SOD <sub>29</sub>	SOD <sub>30</sub>	SOD <sub>31</sub>	
15 <sup>2</sup>	0.3	0.34	0.51	0.54	0.57	Ozark Highlands Boston Mountains Ouachita Mountains  Critical Season Primary Season
20 <sup>2</sup>	0.5	0.56	0.84	0.90	0.95	
30 <sup>2</sup>	1.0	1.12	1.69	1.79	1.90	
45 <sup>3</sup>	1.4	1.57	2.37	2.51	2.66	
90 <sup>3</sup>	1.8	2.02	3.04	3.22	3.42	
Mixed Substrate						
TSS <sup>1</sup>	SOD <sub>20</sub>	SOD <sub>22</sub>	SOD <sub>29</sub>	SOD <sub>30</sub>	SOD <sub>31</sub>	
15 <sup>2</sup>	0.4	0.45	0.68	0.72	0.76	
20 <sup>2</sup>	0.7	0.79	1.18	1.25	1.33	
30 <sup>2</sup>	1.3	1.46	2.20	2.33	2.47	
45 <sup>3</sup>	1.6	1.80	2.70	2.87	3.04	
90 <sup>3</sup>	1.9	2.13	3.21	3.40	3.61	
Sandy Substrate <sup>4</sup>						Arkansas River Valley Gulf Coastal Plain Delta
TSS <sup>1</sup>	SOD <sub>20</sub>	SOD <sub>22</sub>	SOD <sub>30</sub>	SOD <sub>31</sub>	SOD <sub>32</sub>	
15 <sup>2</sup>	0.5	0.56	0.90	0.95	1.01	
20 <sup>2</sup>	0.8	0.90	1.43	1.52	1.61	
30 <sup>2</sup>	1.5	1.69	2.69	2.85	3.0	
45 <sup>3</sup>	1.8	2.02	3.22	3.42	3.62	
90 <sup>3</sup>	2.0	2.25	3.58	3.80	4.02	

<sup>1</sup> Projected TSS instream after mixing.

<sup>2</sup> TSS values are from MOA with EPA found in the CPP. SOD values for rocky substrate are the lower end of range given in the MOA. SOD values for sandy substrate are the upper end of range given in the MOA.

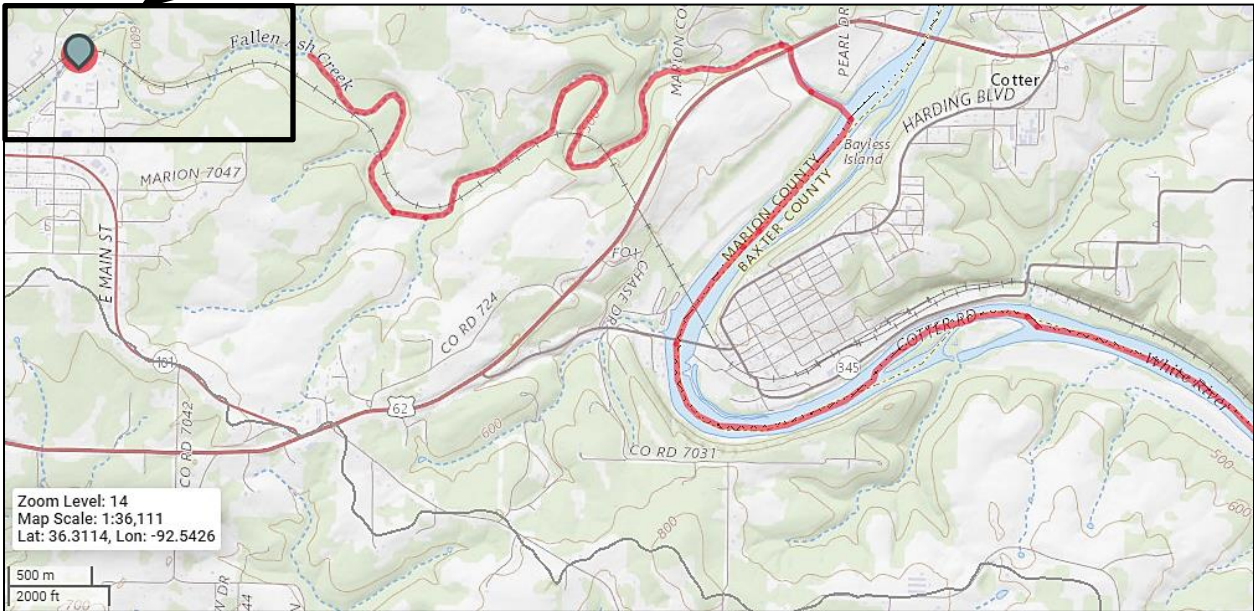
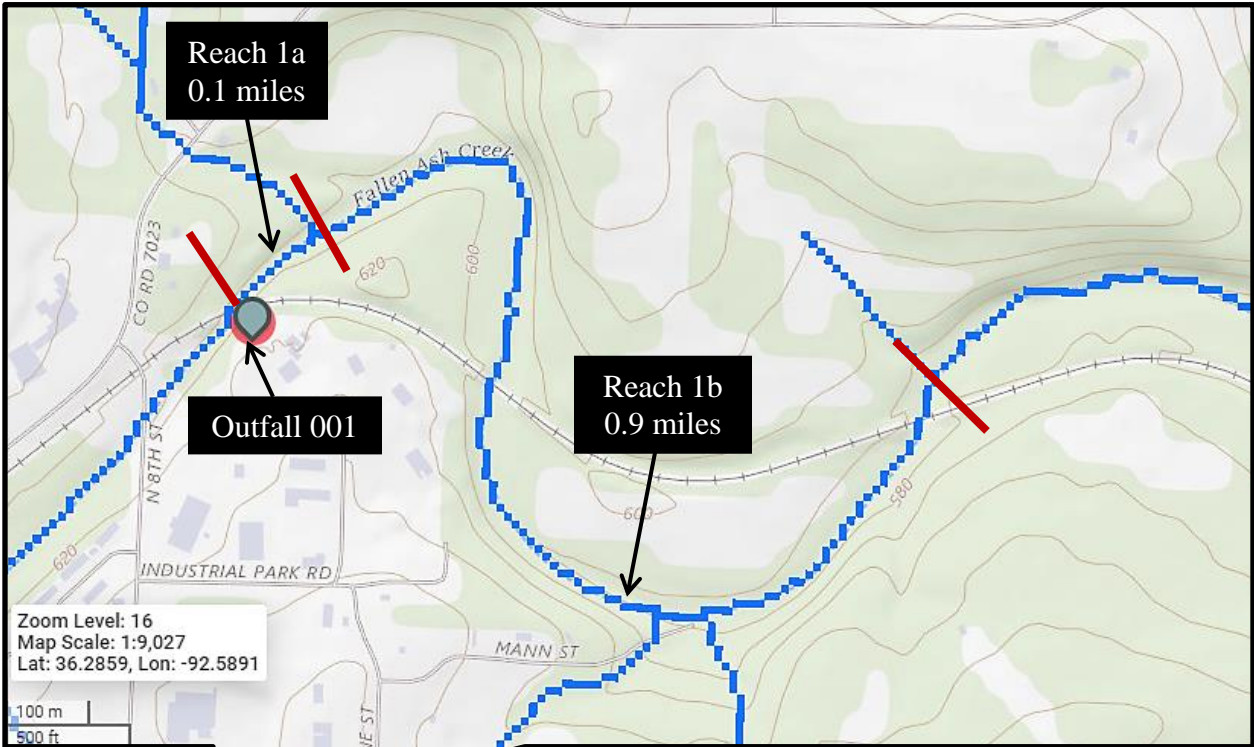
<sup>3</sup> These TSS concentrations are outside of the range given in the MOA, so the corresponding SOD values are estimated.

<sup>4</sup> SOD values given in this table are the lower and upper ends of the recommended range. SOD values between the upper and lower values are acceptable based on nature of substrate.

<sup>5</sup> Deviations from these rates may take place in situations of high instream dilution, which significantly reduces the impact of the benthal (sediment) deposits on oxygen consumption. In these situations, justification on a case by case basis will be provided in the documentation submitted to EPA.

<sup>6</sup> Applicable ecoregions are based on the general characteristics of waterbodies within each ecoregion (Rocky, Gravel, or Mixed). A different substrate type may be used based on site specific observations of the particular stream in question.

# Model Schematic



Source: [USGS StreamStats](https://streamstats.crk.usgs.gov/)



## Model Input Data

**W.S. Drainage Area (mi<sup>2</sup>):** 9.88 (Reach 1a, Fallen Ash Creek at outfall)  
 10.2 (Reach 1b, Fallen Ash Creek, 0.1 miles downstream from outfall)

**Ecoregion:** Ozark Highlands

**Q<sub>DESIGN</sub>:** 0.35 MGD

**Receiving Stream:** Fallen Ash Creek, thence to the White River

**7Q10:** 0.006 cfs (Annual, USGS StreamStats)

### Critical Season Stream Hydraulics

Quick Calculator		Critical Season Stream Hydraulics							
0.006	Headwater in CFS		0.072323	0.5	0.567722	0.4	24.35498	0.1	Accum
				FPS		Feet		Feet	MGD
0.35	Discharger 1 in MGD		Reach 1 Velocity	0.054	Depth	0.446	Width	22.931	0.354

### Primary Season Stream Hydraulics

Quick Calculator		Primary Season Stream Hydraulics							
0.458	Headwater in CFS		0.072323	0.5	0.567722	0.4	24.35498	0.1	Accum
				FPS		Feet		Feet	MGD
0.35	Discharger 1 in MGD		Reach 1 Velocity	0.072	Depth	0.568	Width	24.354	0.646

Primary Season headwater (seasonal fishery flow, Rule 2) calculation:

$$1 \text{ cfs} - (\text{design flow in cfs})$$

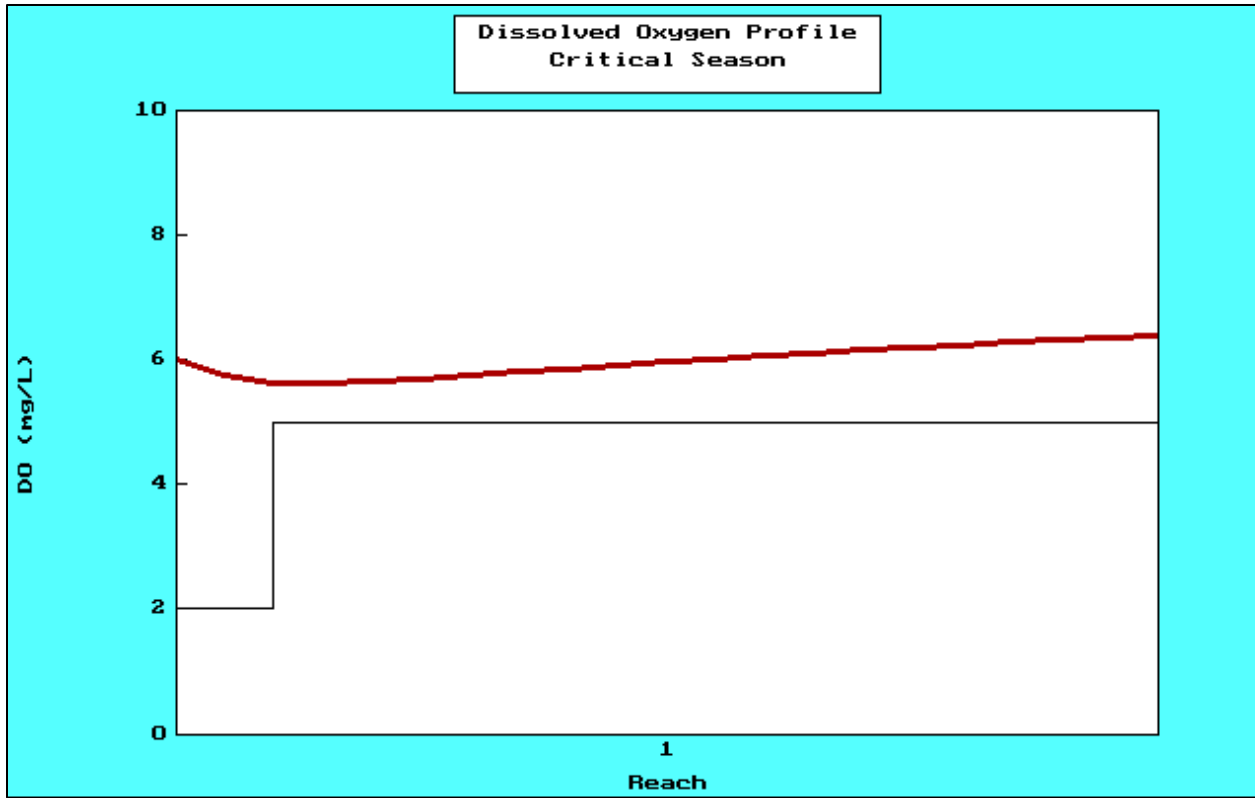
$$1 \text{ cfs} - (0.35 \text{ MGD in cfs})$$

$$1 \text{ cfs} - (0.542 \text{ cfs}) = \mathbf{0.458 \text{ cfs}}$$

## Input Model Coefficients

Reach 1a/1b				
Coefficient – at 20° C	Input Value		Justification	
BOD <sub>ult.</sub> /BOD <sub>5</sub>	2.3		EPA Guidance	
K <sub>d</sub> (1/day)	0.5		MOA, rocky substrate	
K <sub>n</sub> (1/day)	0.3		MOA, rocky substrate	
SOD (g/m <sup>2</sup> /day)	0.3 (0.51 @ 29°C)		MOA, rocky substrate, TSS = 15	
K <sub>a</sub> (1/day)	10.1 (Critical Season) 8.1 (Primary Season)		O'Connor-Dobbins equation	
	Critical Season (May-Oct)		Primary Season (Nov-Apr)	
	Reach 1a	Reach 1b	Reach 1a	Reach 1b
DO Standard	2 mg/l	5 mg/l	6 mg/l	
Temperature Standard	29°C		22°C	
Stream Velocity	0.054 ft/s		0.072 ft/s	
Stream Depth	0.446 ft		0.568 ft	

**Critical Season Model (21717\_C.smp)**  
**10/15/2/6 simulation (CBOD<sub>5</sub>/TSS/NH<sub>3</sub>/DO)**



Critical Season		TABULAR MODEL OUTPUT		
	River Mile	DO (mg/L)	BOD (mg/L)	NH3 (mg/L)
1	1.00	6.00	22.77	1.98
2	0.95	5.73	21.82	1.91
3	0.90	5.63	20.91	1.85
4	0.85	5.62	20.03	1.79
5	0.80	5.64	19.19	1.73
6	0.75	5.69	18.39	1.67
7	0.70	5.74	17.62	1.61
8	0.65	5.80	16.88	1.56
9	0.60	5.85	16.17	1.51
10	0.55	5.90	15.50	1.46
11	0.50	5.96	14.85	1.41
12	0.45	6.01	14.23	1.36
13	0.40	6.06	13.63	1.32
14	0.35	6.10	13.06	1.27
15	0.30	6.15	12.51	1.23
16	0.25	6.19	11.99	1.19
17	0.20	6.23	11.49	1.15
18	0.15	6.27	11.01	1.11
19	0.10	6.31	10.54	1.07
20	0.05	6.35	10.10	1.04
21	-0.00	6.38	9.68	1.00

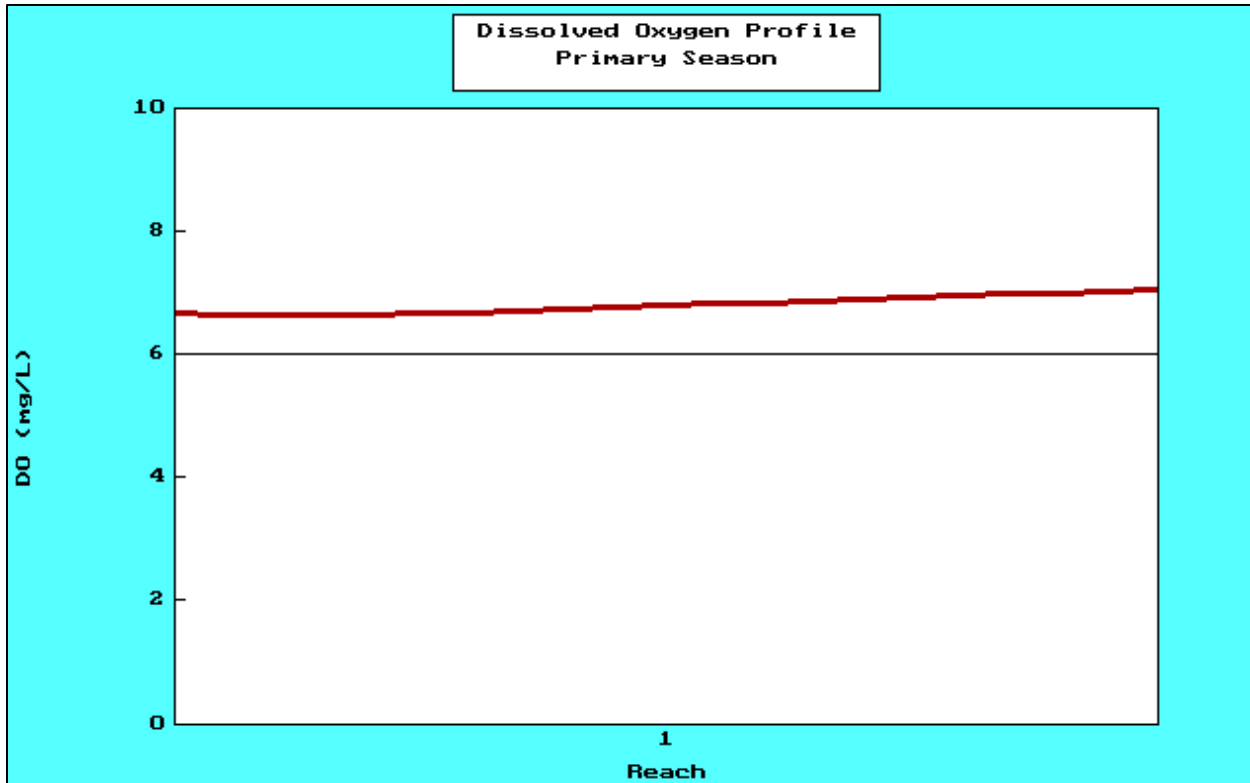
Critical Season		Run information screen	
Name of receiving stream		Fallen Ash Creek	
Number of discharges	(max = 10)		1
Number of reaches	(max = 10)		1
Reaeration type	(O, T, M)	O'Connor-Dobbins	
Run title for screen display		Critical Season	
Graphics printer type	(HP, FX, LQ, None)		None
Printed graph resolution	(Low, Med, High)		None

Critical Season		Upstream River Parameters		Comments
Flow	(cfs)	0.01		7Q10 = 0.006cfs
Temperature	(°C)	29.00		WQS Ozark High
Dissolved Oxygen	(mg/l)	5.75		75%sat ER Study
5-Day BOD	(mg/l)	1.00		assumed
Ult. CBOD / 5-Day BOD		2.30		default
pH	(su)	7.00		assumed
Ammonia	(mg/l)	0.10		assumed
Alkalinity	(mg/l)	-0.00		
Upstream river mile		1.00		model length

Critical Season	Parameters for Discharge 1		Comments
Flow	(MGD)	0.35	design flow
Temperature	(°C)	29.00	WQS Ozark High
Dissolved Oxygen	(mg/l)	6.00	permit
5-Day BOD	(mg/l)	10.00	permit
Ult. CBOD / 5-Day BOD		2.30	default
pH	(su)	7.00	default
Ammonia	(mg/l)	2.00	permit
Alkalinity	(mg/l)	-0.00	
Beginning of Reach Number		1	
Name of Discharger		Flippin	

Critical Season	Parameters for Reach 1		Comments
Length	(mile)	1.00	model length
Velocity	(fps)	0.05	spreadsheet
Slope	(ft/mile)	-0.00	
Average Depth	(ft)	0.45	spreadsheet
Temperature	(°C)	29.00	Calculated
BOD Removal Rate	(1/day)	0.50	MOA, rocky sub
NH3 Decay Rate	(1/day)	0.30	MOA, rocky sub
Sediment Oxygen Demand	(g/m <sup>2</sup> /day)	0.51	k20=0.3(TSS=15)
Photosynthesis/respiration	(mg/L/day)	-0.00	

**Primary Season Model (21717\_P.smp)  
10/15/9/6 simulation (CBOD<sub>5</sub>/TSS/NH<sub>3</sub>/DO)**



Primary Season		TABULAR MODEL OUTPUT		
	River Mile	DO (mg/L)	BOD (mg/L)	NH3 (mg/L)
1	1.00	6.65	13.50	4.92
2	0.95	6.62	13.19	4.84
3	0.90	6.61	12.89	4.77
4	0.85	6.62	12.59	4.70
5	0.80	6.63	12.30	4.63
6	0.75	6.65	12.02	4.56
7	0.70	6.67	11.74	4.50
8	0.65	6.70	11.47	4.43
9	0.60	6.72	11.21	4.36
10	0.55	6.75	10.95	4.30
11	0.50	6.78	10.70	4.24
12	0.45	6.80	10.45	4.17
13	0.40	6.83	10.21	4.11
14	0.35	6.86	9.98	4.05
15	0.30	6.89	9.75	3.99
16	0.25	6.91	9.52	3.93
17	0.20	6.94	9.30	3.88
18	0.15	6.97	9.09	3.82
19	0.10	6.99	8.88	3.76
20	0.05	7.02	8.68	3.71
21	-0.00	7.04	8.48	3.65

Primary Season		Run information screen	
Name of receiving stream		Fallen Ash Creek	
Number of discharges	(max = 10)	1	
Number of reaches	(max = 10)	1	
Reaeration type	(0, T, M)	O'Connor-Dobbins	
Run title for screen display		Primary Season	
Graphics printer type	(HP, FX, LQ, None)	None	
Printed graph resolution	(Low, Med, High)	None	

Primary Season		Upstream River Parameters		Comments
Flow	(cfs)	0.46	seasonal fishery	
Temperature	(°C)	22.00	WQS Ozark High	
Dissolved Oxygen	(mg/l)	7.41	85%sat ER Study	
5-Day BOD	(mg/l)	1.00	assumed	
Ult. CBOD / 5-Day BOD		2.30	default	
pH	(su)	7.00	assumed	
Ammonia	(mg/l)	0.10	assumed	
Alkalinity	(mg/l)	-0.00		
Upstream river mile		1.00	model length	

Primary Season	Parameters for Discharge 1		Comments
Flow	(MGD)	0.35	design flow
Temperature	(°C)	22.00	WQS Ozark High
Dissolved Oxygen	(mg/l)	6.00	permit
5-Day BOD	(mg/l)	10.00	permit
Ult. CBOD / 5-Day BOD		2.30	default
pH	(su)	7.00	default
Ammonia	(mg/l)	9.00	permit
Alkalinity	(mg/l)	-0.00	
Beginning of Reach Number		1	
Name of Discharger		Flippin	

Primary Season	Parameters for Reach 1		Comments
Length	(mile)	1.00	model length
Velocity	(fps)	0.07	spreadsheet
Slope	(ft/mile)	-0.00	
Average Depth	(ft)	0.57	spreadsheet
Temperature	(°C)	22.00	Calculated
BOD Removal Rate	(1/day)	0.50	MOA, rocky sub
NH3 Decay Rate	(1/day)	0.30	MOA, rocky sub
Sediment Oxygen Demand	(g/m <sup>2</sup> /day)	0.34	k20=0.3(TSS=15)
Photosynthesis/respiration	(mg/L/day)	-0.00	