Arkansas Department of Environmental Quality
Water Quality Management Plan Update Summary Sheet

Date: July 22, 2020 **Modeling Engineer:** Terry Liu **Reviewed By**: Shane Byrum

☐ New Permit ☒ Renewal Permit ☐ Amended Permit

Type of Discharge: minor treated sanitary and cafeteria wastewater

Facility Name: Arkansas Department of Corrections - North Central Unit

Permit No.: AR0044016

Design Flow Rate (MGD): 0.09

Receiving Stream: Moccasin Creek, thence to the White River

HUC + Reach Code: 11010004+908 **7Q10:** 0.0 cfs

Planning Segment: 4F **County:** Izard

Proposed Monthly Average Effluent Limits in mg/L ($CBOD_5$/TSS/NH_3-N/DO):

April:	10/15/3.9/5*	*DO is Instantaneous Minimum
May-October:	10/15/3/5.1*	*DO is Instantaneous Minimum
November-March:	10/15/5/5*	*DO is Instantaneous Minimum

Current Monthly Average Effluent Limits in mg/L ($CBOD_5$/TSS/NH_3-N/DO):

April:	10/15/3.9/5*	*DO is Instantaneous Minimum
May-October:	10/15/3/5*	*DO is Instantaneous Minimum
November-March:	10/15/5/5*	*DO is Instantaneous Minimum

TMDL Limits: None

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

Reach No.	Length (miles)	DO WQS_C (mg/L)	DO Sag_C (mg/L)	Distance to DO Sag_C (miles)	DO WQS_P (mg/L)	DO Sag_P (mg/L)	Distance to DO Sag_P (miles)
1	0.5	5.0 [1]	5.0	0.06	6.0	7.1	0.0

Values in above table are from a modeling analysis dated July 22, 2020.

Outfall Location (Lat/Long): 36° 10’ 10.65” N; 92° 09’ 29.15” W

Remarks: This is for the reissuance of the discharge permit for this existing facility. A new model was performed with updated hydraulics. Based on updated model, the DO limit during critical season is required to be revised to meet water quality standard for DO. The 208 Plan is being updated to revise the instantaneous minimum DO limit during May through October from 5.0 mg/L to 5.1 mg/L.

[1] Critical season DO standard for Moccasin Creek at the discharge location is set by a UAA, and is more stringent than the default ecoregion standard for watershed less than 10 square miles. The watershed area at discharge location is 6.34 square miles based on USGS StreamStats.

			Ammonia Calculations			
POTW?	No	(Yes or No)			COLOR KEY	
Facility Name	ADC - North Central Unit					User Inputs
Major or Minor	Minor					Calculated values
Permit Number	AR0044016					
Receiving Stream	Moccasin Creek		Ecoregion or River name	Ozark Highlands		
7Q10, cfs	0	USGS Map	Watershed area (mi^2)	6.34		
0.25/0.67 multiplier	0.67		Regulation No. 2 Chronic Toxicity Critieria (Instream Concentration)			
Qb, cfs	0.00			AML, mg/l	DML, mg/l	
Qe, MGD	0.09	Design flow	April	3.9	3.9	
Qe, cfs	0.14		May - October	3.9	3.9	
Cb, mg/l	0	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	Daily Max, mg/l
Qb	% of Low Flow of Receiving Stream	April	3.90	3.90
Cb	Background Concentration	May - October	3.90	3.90
IWC	Instream Waste Concentration Chronic Toxicity Criteria	November - March	10.30	10.30

Chronic Toxicity Criteria vs. D.O. Model Limits

	Monthly Average, mg/l		**Permit Limits**	Daily Maximum, mg/l		**Permit Limits**
Month	Toxicity limit	D.O. limit		Toxicity limit	D.O. limit	
April	3.90	5	3.90	3.90	7.5	3.90
May - October	3.90	3	3.00	3.90	4.5	3.90
November - March	10.30	5	5.00	10.30	7.5	7.50

Minor Permits

Ammonia Toxicity Criteria

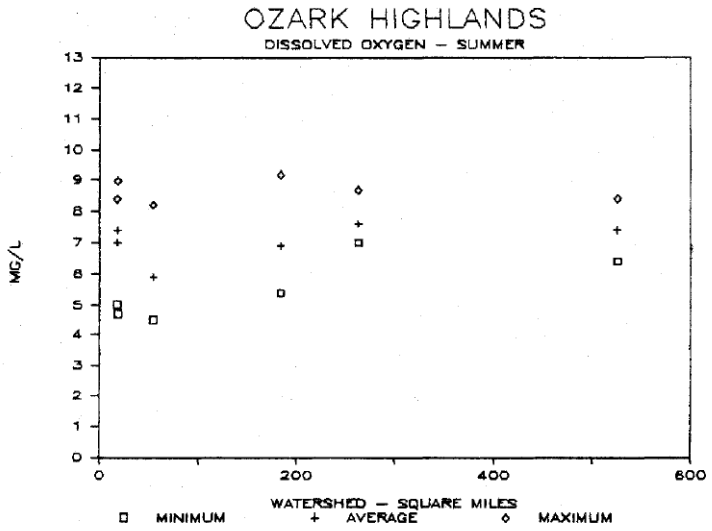
Fish Early Life Stages Absent - Primary Season (November - March), mg/L

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

Figure D-10. Dissolved Oxygen and Saturation Values for Ozark Highlands Ecoregion Reference Streams during Summer Period



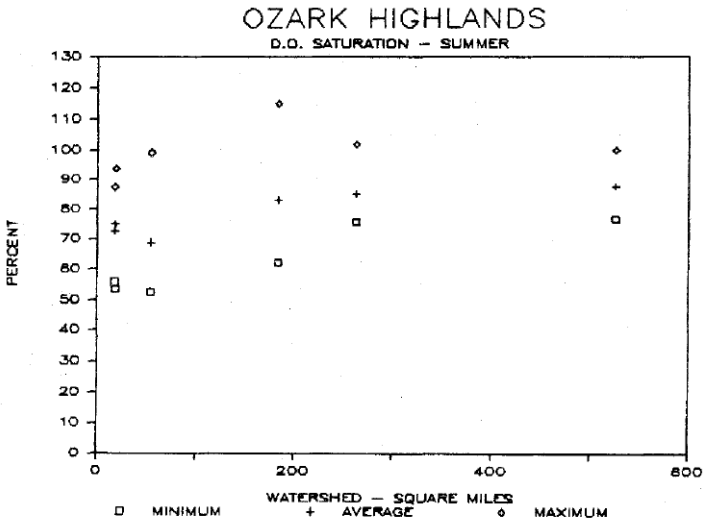
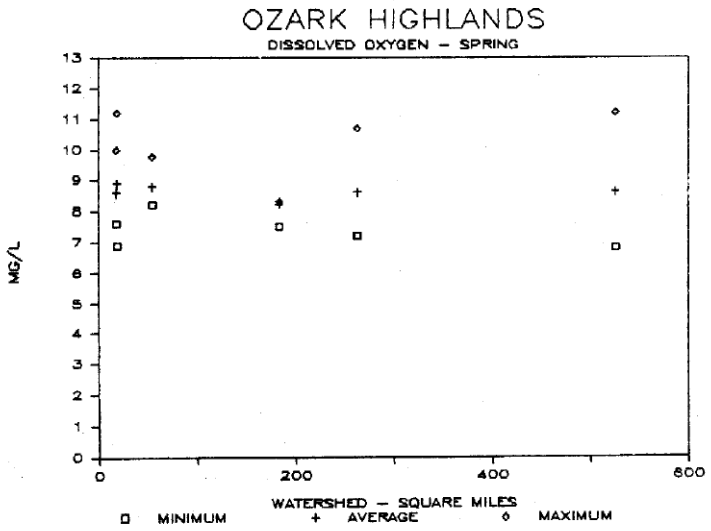
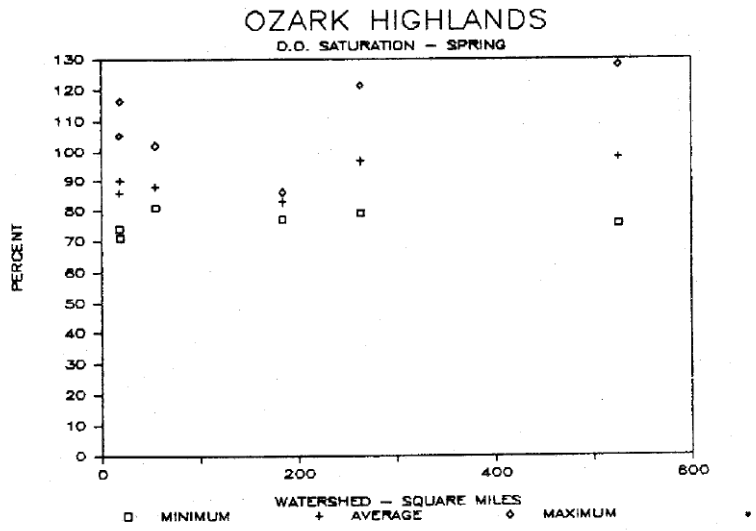


Figure D-11. Dissolved Oxygen and Saturation Values for Ozark Highlands Ecoregion Reference Streams during Spring Period





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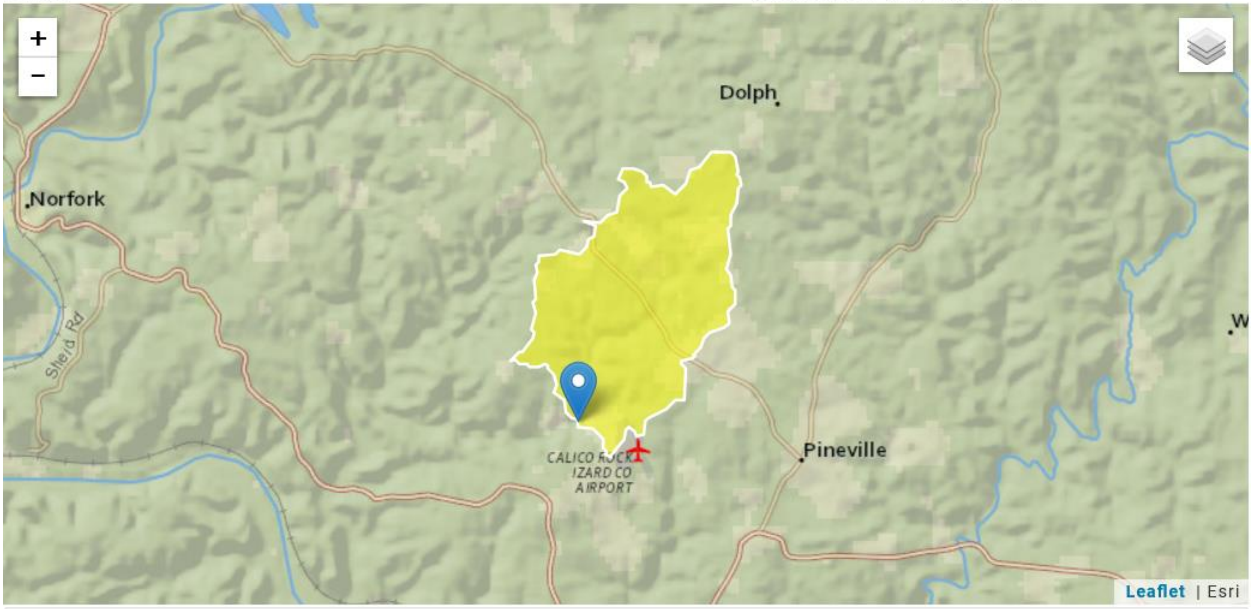
StreamStats Report

Region ID:	AR
Workspace ID:	AR20200629192120432000
Clicked Point (Latitude, Longitude):	36.16986, -92.15819
Time:	2020-06-29 14:21:38 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	6.34	square miles

Sediment Oxygen Demand (SOD) for Various Temperatures and Ecoregion [5]

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

[1] Projected TSS instream after mixing.

[2] 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.

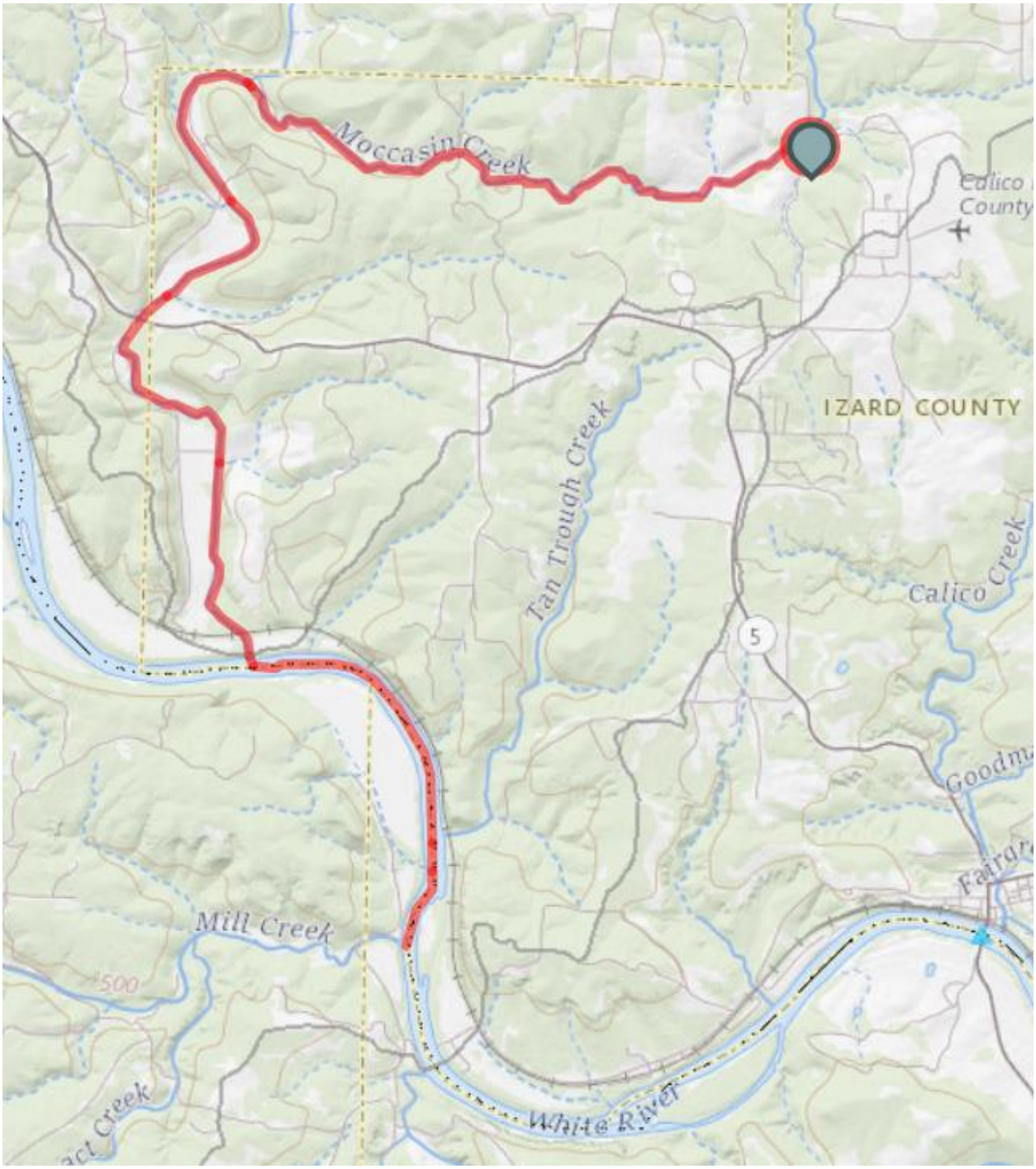
[3] These TSS concentrations are outside of the range given in the MOA, so the corresponding SOD values are estimated.

[4] 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.

[5] 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.

[6] 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.

Flow Diagram:



Model Input Data

W.S. Drainage Area (mi^2) : 6.34

Ecoregion: Ozark Highlands

Q_{DESIGN} : 0.09 MGD

7Q10: 0 cfs (1983 Arkansas Geological Commission Map)

Input Model Coefficients

Reach 1		
Coefficient – at 20° C	Input value	Justification
$BOD_{ult.}/BOD_5$	2.3	EPA Guidance
K_d (1/day)	0.4	MOA, rocky substrate
K_n (1/day)	0.3	MOA, rocky substrate
SOD (g/m^2/day)	0.5	MOA, rocky substrate
K_a (1/day)	7.7 (critical season) 8.1 (primary season)	O'Conner Dobbins equation O'Conner Dobbins equation

Applicable Water Quality Standards		
	Critical Season (May-Oct.)	Primary Season (Nov.-Apr.)
	Reach 1	Reach 1
D.O. Standard (mg/L)	5.0 [2]	6.0
Temp. Standard (°C)	29	22

[2] Critical season DO standard for Moccasin Creek at the discharge location is set by a UAA, and is more stringent than the default ecoregion standard for watershed less than 10 square miles. The watershed area at discharge location is 6.34 square miles based on USGS StreamStats.

Critical Season Stream Hydraulics

Q mgd	V	D	W	Ka (O'Conner Dobbins)
0.005	0.005	0.175	9.635	11.980
0.01	0.007	0.215	10.327	10.797
0.015	0.009	0.243	10.754	10.160
0.02	0.011	0.265	11.068	9.730
0.025	0.012	0.283	11.318	9.410
0.03	0.013	0.299	11.526	9.156
0.035	0.015	0.313	11.705	8.947
0.04	0.016	0.326	11.862	8.770
0.045	0.017	0.338	12.003	8.616
0.05	0.018	0.349	12.130	8.481
0.055	0.019	0.359	12.246	8.361
0.06	0.020	0.368	12.353	8.252
0.065	0.021	0.377	12.452	8.154
0.07	0.022	0.386	12.545	8.064
0.075	0.023	0.394	12.632	7.981
0.08	0.024	0.401	12.714	7.904
0.085	0.025	0.409	12.791	7.832
0.09	0.026	0.416	12.864	7.765
0.095	0.027	0.423	12.934	7.702
0.1	0.028	0.429	13.001	7.643

Velocity Coefficient	Depth Coefficient	Width Coefficient	Product of Coefficients (should equal 1)
0.085	0.751	15.665	1.000

Velocity Exponent	Depth Exponent	Width Exponent	Sum of Exponents (should equal 1)
0.6	0.3	0.1	1.0

This worksheet is the hydraulics for stream flows up to 0.2 MGD.

The Velocity, Depth, and Width values in chart to left are from the following emperical equations which were developed based on the emperical relationships presented on page 2-33 of EPA September 1983 Technical Guidance Manual for Performing Waste Load Allocations, Book II (Streams and Rivers).

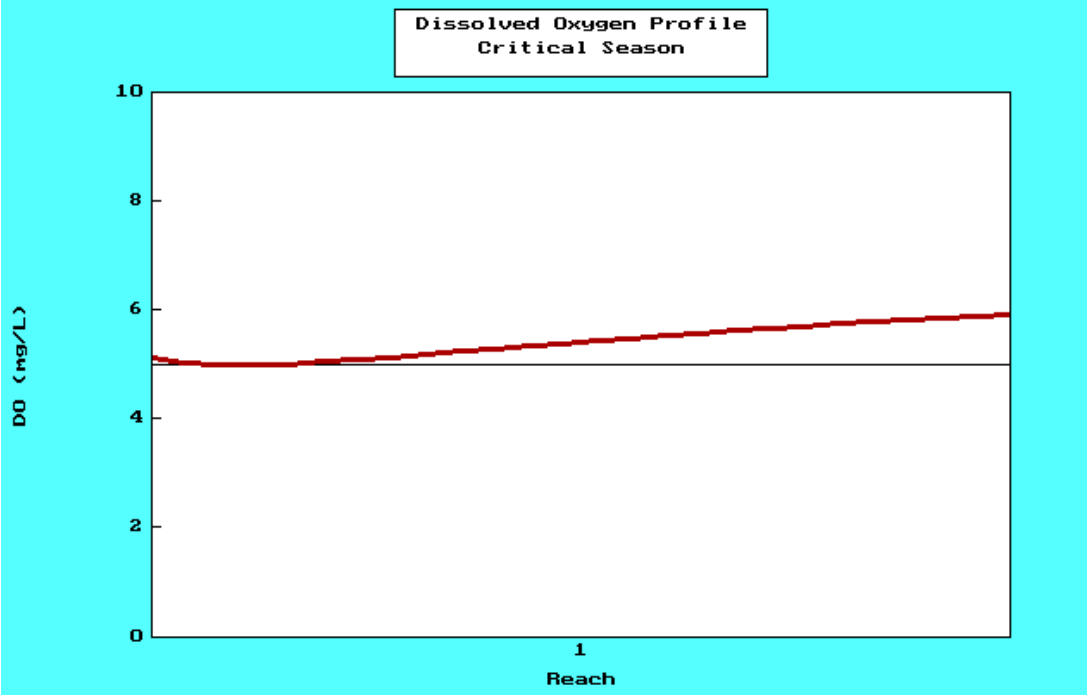
Velocity = $0.085\ Q^{0.6}$

Depth = $0.751\ Q^{0.3}$

Width = $15.665\ Q^{0.1}$

Primary Season Stream Hydraulics

0.86	Headwater in CFS		0.072323	0.5	0.567722	0.4	24.35498	0.1	Accum
				FPS		Feet		Feet	MGD
0.09	Discharger 1 in MGD	Reach 1 Velocity		0.072	Depth	0.568	Width	24.353	0.646



Critical Season	TABULAR MODEL OUTPUT		
	River Mile	DO (mg/L)	BOD (mg/L)	NH3 (mg/L)
1	0.50	5.10	23.00	3.00
2	0.48	5.01	22.36	2.92
3	0.46	4.98	21.73	2.84
4	0.44	4.98	21.12	2.76
5	0.42	5.00	20.53	2.68
6	0.40	5.03	19.95	2.61
7	0.38	5.08	19.39	2.53
8	0.36	5.13	18.85	2.46
9	0.34	5.17	18.32	2.39
10	0.32	5.23	17.81	2.33
11	0.30	5.28	17.31	2.26
12	0.28	5.33	16.82	2.20
13	0.26	5.37	16.35	2.14
14	0.24	5.42	15.89	2.08
15	0.22	5.47	15.45	2.02
16	0.20	5.52	15.02	1.97
17	0.18	5.56	14.59	1.91
18	0.16	5.60	14.19	1.86
19	0.14	5.65	13.79	1.81
20	0.12	5.69	13.40	1.76
21	0.10	5.73	13.03	1.71
22	0.08	5.77	12.66	1.66
23	0.06	5.80	12.31	1.61
24	0.04	5.84	11.96	1.57
25	0.02	5.88	11.63	1.53
26	-0.00	5.91	11.30	1.48

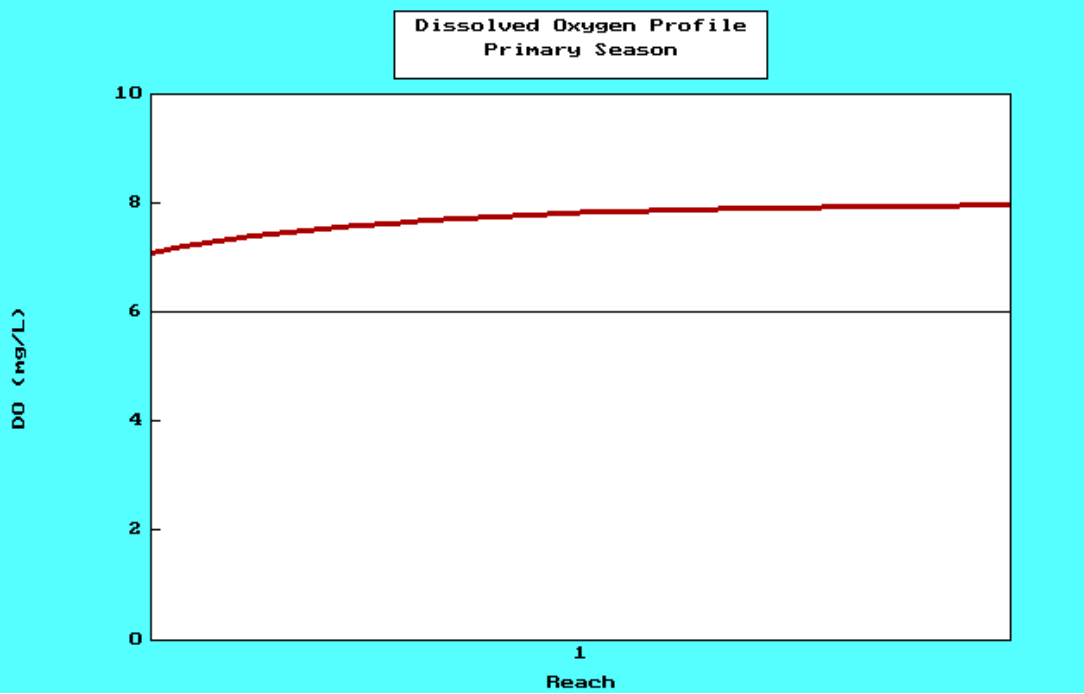
Critical Season	Run information screen	
Name of receiving stream		Moccasin Creek
Number of discharges	(max = 10)	1
Number of reaches	(max = 10)	1
Reaeration type	(O, T, M)	O'Connor-Dobbins
Run title for screen display		Critical Season
Graphics printer type	(HP, FX, LQ, None)	None
Printed graph resolution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

Critical Season	Upstream River Parameters		Comments
Flow	(cfs)	0.00	
Temperature	(°C)	29.00	
Dissolved Oxygen	(mg/l)	5.37	70%sat ER study
5-Day BOD	(mg/l)	1.00	
Ult. CBOD / 5-Day BOD		2.30	
pH	(su)	7.00	
Ammonia	(mg/l)	0.10	
Alkalinity	(mg/l)	-0.00	
Upstream river mile		0.50	

Critical Season	Parameters for Discharge 1		Comments
Flow	(MGD)	0.09	
Temperature	(°C)	29.00	
Dissolved Oxygen	(mg/l)	5.10	
5-Day BOD	(mg/l)	10.00	
Ult. CBOD / 5-Day BOD		2.30	
pH	(su)	7.00	
Ammonia	(mg/l)	3.00	
Alkalinity	(mg/l)	-0.00	
Beginning of Reach Number		1	
Name of Discharger		ADC-NorthCentra	

Critical Season	Parameters for Reach 1		Comments
Length	(mile)	0.50	
Velocity	(fps)	0.03	
Slope	(ft/mile)	-0.00	
Average Depth	(ft)	0.42	
Temperature	(°C)	29.00	Calculated
BOD Removal Rate	(1/day)	0.40	
NH3 Decay Rate	(1/day)	0.30	
Sediment Oxygen Demand	(g/m^2/day)	0.51	k20=0.3(tss=15)
Photosynthesis/respiration	(mg/L/day)	-0.00	

Primary Season Model (44016_P.smp)
10/15/5/5 simulation (CBOD5/TSS/NH3/DO)



Primary Season	TABULAR MODEL OUTPUT		
River Mile	DO (mg/L)	BOD (mg/L)	NH3 (mg/L)
1 0.50	7.07	5.18	0.78
2 0.48	7.19	5.14	0.78
3 0.46	7.29	5.11	0.77
4 0.44	7.38	5.07	0.77
5 0.42	7.45	5.03	0.76
6 0.40	7.52	4.99	0.76
7 0.38	7.57	4.96	0.75
8 0.36	7.62	4.92	0.75
9 0.34	7.67	4.88	0.75
10 0.32	7.71	4.85	0.74
11 0.30	7.74	4.81	0.74
12 0.28	7.77	4.78	0.73
13 0.26	7.79	4.74	0.73
14 0.24	7.82	4.70	0.72
15 0.22	7.84	4.67	0.72
16 0.20	7.85	4.64	0.72
17 0.18	7.87	4.60	0.71
18 0.16	7.88	4.57	0.71
19 0.14	7.90	4.53	0.70
20 0.12	7.91	4.50	0.70
21 0.10	7.92	4.47	0.69
22 0.08	7.93	4.43	0.69
23 0.06	7.93	4.40	0.69
24 0.04	7.94	4.37	0.68
25 0.02	7.95	4.33	0.68
26 -0.00	7.95	4.30	0.67

Primary Season	Run information screen	
Name of receiving stream		Moccasin 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		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)	0.86	seasonalfishery
Temperature	(°C)	22.00	
Dissolved Oxygen	(mg/l)	7.41	85%sat ER study
5-Day BOD	(mg/l)	1.00	
Ult. CBOD / 5-Day BOD		2.30	
pH	(su)	7.00	
Ammonia	(mg/l)	0.10	
Alkalinity	(mg/l)	-0.00	
Upstream river mile		0.50	

Primary Season	Parameters for Discharge 1		Comments
Flow	(MGD)	0.09	
Temperature	(°C)	22.00	
Dissolved Oxygen	(mg/l)	5.00	
5-Day BOD	(mg/l)	10.00	
Ult. CBOD / 5-Day BOD		2.30	
pH	(su)	7.00	
Ammonia	(mg/l)	5.00	
Alkalinity	(mg/l)	-0.00	
Beginning of Reach Number		1	
Name of Discharger		ADC-NorthCentra	

Primary Season	Parameters for Reach 1		Comments
Length	(mile)	0.50	
Velocity	(fps)	0.07	
Slope	(ft/mile)	-0.00	
Average Depth	(ft)	0.57	
Temperature	(°C)	22.00	Calculated
BOD Removal Rate	(1/day)	0.40	
NH3 Decay Rate	(1/day)	0.30	
Sediment Oxygen Demand	(g/m^2/day)	0.34	k20=0.3(tss=15)
Photosynthesis/respiration	(mg/L/day)	-0.00	