HICKS CREEK
TMDL FOR NITRATE

US EPA Region 6

With Cooperation from the
Arkansas Department of Environmental Quality

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TABLE OF CONTENTS

List of Tables

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources discharging to the waterbody. A TMDL has been developed for nitrates for Hicks Creek.

Hicks Creek has its origin approximately one mile north of the Mountain Home city limits in the west central part of Baxter County. It flows in a southerly direction through Mountain Home for about four miles prior to receiving the sewage treatment plant (STP) outfall. Hicks Creek then continues south for another 2.9 miles to its confluence with Big Creek. Hicks Creek was listed on the 1998 Arkansas 303(d) list as being impaired for nutrients. To protect the drinking water designated use for this segment the target for TMDL will be established as 10 mg/l nitrates.

This nitrate TMDL includes a single point source discharger, waste load allocation (WLA), load allocation (LA), and margin of safety (MOS). The MOS in this TMDL is implicit and based on a critical zero-upstream flow condition and the Mountain Home STP design flow capacity of 5.0 MGD for dilution calculations. The maximum daily load established by this TMDL for nitrates is 417 mg/L. ??

lbs/ day

1.0 Introduction

The State of Arkansas is required to develop total maximum daily loads (TMDL) for waters not meeting water quality standards in accordance with Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency (EPA) Water Quality Planning and Management Regulations at 40 CFR 130.7. The quality of Arkansas's streams, lakes, and groundwater is monitored by the Arkansas Department of Environmental Quality (ADEQ) and a variety of other partners. This information is used to determine whether water quality standards are being met and whether the designated uses of the waters are being maintained. If waters are found not to be meeting their established criterion and consequently their beneficial uses, the previously cited acts and regulations require that the water body be listed on the State 303(d) list and that a TMDL be developed. Hicks Creek has been so listed on the 1998 Arkansas 303(d) list as being impaired for nutrients. This TMDL seeks to clearly address elements required by EPA regulations to meet the requirements for TMDL development.

2.0 Background

Hicks Creek has its origin approximately one mile north of the Mountain Home city limits in the west central part of Baxter County. It flows in a southerly direction through Mountain Home for about four miles prior to receiving the sewage treatment plant (STP) outfall. Hicks Creek then continues south for another 2.9 miles to its confluence with Big Creek. Big Creek flows 6.3 miles in a south-southeast direction to its confluence with the White River. Hicks Creek drains approximately 15 square miles at its mouth. Big Creek has a watershed of 12 square miles at the Hicks Creek confluence. The stream gradient for Hicks Creek in the vicinity of the municipal treatment facility is on the order of 20-25 feet/mile. As this creek nears the Big Creek confluence, the watershed becomes steeper, with the stream slope increasing to around 40 feet/mile. The upper portion of Big Creek has a slope of 30 feet/mile and also increases to 40 feet /mile near the Hicks Creek confluence. The substrate composition of both streams consists predominantly of rubble and gravel in the upper reaches, with bedrock and boulders being more prevalent near the confluence of the two streams. The pool/riffle ratio in the study area of Hicks Creek was approximately five to one in the upper region, with a long, wide pool present approximately one half mile below the treatment plant outfall which served as a nutrient "sink". Filamentous algae streamers were prevalent in this pool during the study period. Due to the increase in stream slope there is a greater incidence of riffles in both streams in the region of the confluence.

There is an abundance of habitat cover available to both aquatic invertebrates and fish in both streams, however the riffle areas in Big Creek were narrower, dominated by bedrock and boulders, and had a steeper gradient. The substrate composition and gradient resulted in higher velocities in Big Creek during this survey. At the time of the August/ September survey, stream flow in Hicks Creek above the STP was measured at 0.37cfs (cubic feet per second), the Big Creek flow above the Hicks Creek confluence was 1.0 cfs.

2.1 Land Use

Based on aerial photographs of the study area, approximately 20 percent of the Hicks Creek watershed has been converted to agricultural uses--predominantly pastureland for cattle grazing. Most of the upper watershed (above the STP) is dominated by urban development, which is continually expanding toward the south. Approximately 50 percent of the lower watershed is still forested, with much of the stream length below the STP being bordered with trees. During the time of the survey Big Creek was relatively unimpacted from urban development, with about a 40% conversion to cleared land and 60% forested. Occasional pastures border Hicks and Big Creeks, creating the potential for cattle access to the streams. During the survey, a dairy farm was noted (with cows in the stream) in the lower portion of the Big Creek drainage, but this has since been converted to a beef cattle operation (personal communication-SCS) (ADEQ, 1995). Currently, there are no records of poultry production houses or confined swine operations within the Hicks Creek watershed.

2.2 Geology

Hicks Creek, Big Creek, and their tributaries lie within the Salem Plateau of the Ozark Highlands ecoregion. The Salem Plateau is characterized by gently sloping to rolling uplands, and steep, stony side slopes with outcrops of dolomite. The elevation ranges from 700 to 1000 feet above sea level. The geology of this drainage is characterized by Cotter and Jefferson City Dolomites, with small areas of Powell Dolomites interspersed in the drainage basin. Soil types in the survey area above the STP are comprised of the Arkana-Moko, Captina-Tonti-Nixa, Doniphan-Nixa, and Doniphan-Ventris Associations. The Arkana-Moko type, located primarily in the upper watershed west of Mountain Home (upper Dodd Creek tributary), is characterized by moderately deep and shallow, gently sloping to steep, well-drained, cherty and stony soils that formed in residuum of dolomite and limestone. The Captina-Tonti-Nixa type, which surrounds the upper Hicks Creek channel, is characterized by deep, nearly level to moderately sloping, moderately well drained, loamy and cherty soils. The soil type in the watershed below the STP (including the Big Creek drainage) is dominated by the Doniphan-Gassv'lle Association, characterized by deep and moderately deep, moderately sloping to steep, well drained, very cherty soils that formed in residuum of cherty dolomite.

3.0 Problem Definition

A water quality investigation was conducted on Hicks Creek, which is the receiving stream of the Mountain Home municipal wastewater treatment facility. Big Creek, the stream receiving the Hicks Creek tributary, was selected as an unimpacted site for data comparison (ADEQ, 1995). This stream survey had a dual purpose: (1) to determine the presence and extent of water quality degradation and its impact on the aquatic life, and (2) to establish the need or value of a TMDL for nutrients on Hicks Creek.

An analysis of the most recent ten years of nutrient data at the WHI 65 station revealed nitrate values that exhibited periodic high concentrations since January 1988. Post-88 nitrate data from this station averaged 6.1 mg/l, with a high value of 18.3mg/l. Although there are exceptions,

generally when ammonia nitrogen concentrations are low, the nitrate values are elevated (ADEQ, 1995). This is evidenced by the database from the WHI 65 (HIC 04) station. During the 1993 survey the nitrate nitrogen was 15.6 mg/l. Stream dilution and utilization by vascular plants, algae and periphyton only reduced the nitrate concentration to 11.2 mg/l at the WHI 65 site. The nitrates remained high to the confluence of Big Creek, which afforded a 50% dilution of the nutrient concentrations.

A review of some of non-permitted wastewater constituents indicates that a change in water quality is occurring due to the wastewater influence (ADEQ 1995). A 76-fold increase in nitrate concentration from the upstream Hicks Creek station to the first station below the STP effluent lends credence to the assumption that significantly elevated levels of these constituents are occurring in this stream due to the STP effluent. Nitrate nitrogen concentrations were still 67 times higher at HIC 05 than at HIC 01. Sufficient concentrations of these nutrients still exist at the lower Hicks Creek stations to produce algae populations capable of causing large dissolved oxygen diurnal fluctuations. Even with the dilution of the upstream Big Creek flow, with its "background" concentrations, nutrients are still present in sufficient concentrations to create nuisance algae. If extended periods of hot, dry weather occurs in this area, the nutrient contributions from the Mountain Home STP effluent could result in substantial algae blooms and subsequent die-off. This cycle will stress the aquatic inhabitants and further impact the macroinvertebrate and fish community currently inhabiting Hicks and Big Creeks.

This report further recommends that future permit limits for the Mountain Home STP facility should consider limitations on nitrate discharges to no more than the 10 mg/l MCL for drinking water supplies, since this stream is designated for drinking water uses. Additionally, most streams in this area of the state enter the groundwater, which also may be used for drinking water supplies.

4.0 Water Quality Standards And Beneficial uses

Hicks Creek, which drains a 10 square mile watershed above the STP effluent discharge, is classified as an Ozark Highlands mid-size watershed perennial fishery. As such, it has an applicable dissolved oxygen standard of 5 mg/l, with a 1 mg/l diurnal fluctuation being allowed for no longer than 8 hours in a 24 hour period when the stream temperature exceeds 22 °C. At stream temperatures of 22 °C or less, a 6 mg/l standard generally applies. The exception to this is during the March through May time frame when the stream temperature is 10 °C or less, and the stream flow exceeds 15cfs. At these conditions, the dissolved oxygen standard is 6.5 mg/l. Big Creek, which has a drainage area of 12 square miles at the Hicks Creek confluence, has the same standards. Designated beneficial uses of these streams, in addition to the previously mentioned fishery use, consists of primary and secondary contact recreation including wading, canoeing, fishing, and swimming-as well as a source of water for domestic, industrial and agricultural uses.

Listed on the 1998 Arkansas 303(d) list with nutrients as the cause, the primary parameter of concern for this water body has been given as nitrates. ADEQ has historically used the Safe Drinking Water Act MCL value for nitrate of 10.0 mg/l as a use limiting criteria for waters with a drinking water designated use. To protect the drinking water designated use for this segment

the target for TMDL will be established as 10 mg/l nitrates.

5.0 TMDL Development

5.1 Model Information

A TMDL for Hicks Creek was developed to address the impact of the Mountain Home STP effluent. The MULTI-SMP: Simplified Method Program (Streeter-Phelps Equations) was used to address dissolved oxygen (DO) and nitrate nitrogen (NO_3-N) standards adopted by the state of Arkansas. The calibrated model was applied to determine the applicable wasteload allocations for the Mountain Home STP effluent which is expected to meet the critical season water quality standards of 5.0 mg/l for DO and 10 mg/l for NO_3-N. Model calibration and TMDL runs are shown in Appendix A.

5.2 Modeling Assumptions

For the purposes of this TMDL, the MULTI-SMP model was calibrated for DO, biological oxygen demand (BOD), and NO_3-N constituents using the water quality data collected by the Arkansas Department of Environmental Quality (ADEQ) between August 30 and September 1, 1993. These data are provided in their report (WQ95-02-1), "Water Quality Survey of the Mountain Home STP Effluent on Hicks Creek" dated February 1995.

5.3 Critical Condition Determination

Data from a single survey conducted on Hicks Creek provided information on both upstream and effluent conditions in Hicks Creek, as well as Big Creek, which was evaluated as a comparable stream with minimal antropogenic impacts. Although this data is limited, it does provide information that upstream contributions of nitrogen are small relative to the STP effluent. For both Hicks Creek upstream of the STP and Big Creek upstream of Hicks Creek, the concentrations of nitrate were low, ranging from 0.16 mg/l for Hicks Creek and 0.51mg/l for Big Creek. According to USGS data, Hicks Creek at Mountain Home has a Q7-10 between 0 and 1cfs. From this data it was concluded that upstream contributions from nonpoint sources could be considered relatively small and under all conditions of flow would only serve to dilute the effluent concentrations. The critical condition for this TMDL is therefore the zero upstream flow scenario.

5.4 Seasonal Variation

Section 303(d)(1) requires that all TMDLs be "established at a level necessary to implement the applicable water quality standard with seasonal variations. Stream flow conditions in this stream are determined to have a low flow Q7-10 conditions of 0-1cfs. The most critical period for meeting the established target for DO and nitrate in this stream is at the low flow condition.

5.5 Margin of Safety

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). This requirement for a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on the loading reductions and receiving water quality. A MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative analytical assumptions used in establishing the TMDL. The MOS is not intended to compensate for failure to consider known sources. The MOS in this TMDL is implicit and based on the conservative assumptions given below:

- The model was run for critical zero-upstream flow conditions,
- STP design flow capacity (5.0 MGD) was used for dilution calculations

5.6 TMDL Allocations

A critical element of developing a TMDL is establishing the assimilative capacity of the stream. This requires establishing the instream concentration allowable under the standards and the appropriate flow condition. For this TMDL the target instream DO is 5. mg/l and the target instream nitrate value is 10 mg/l. The appropriate flow value would be the upstream flow for Hicks Creek plus the STP effluent contribution. The critical condition for this TMDL is 0cfs flow upstream of the effluent discharge; therefore the flow is simply the rate of discharge from the treatment facility. Since the upstream flow at the critical condition is zero, the LA is zero. Using this flow and the allowable concentration, the critical condition allowable loads provided in Table 1 below may be present in the stream.

The TMDL is expressed as:

TMDL = WLA (wasteload allocation) + LA (load allocation) + MOS

Where WLA and MOS are both zero.

Table 1. Calculated Load Allocation

Parameter	Concentration (mg/l)	Load (lbs/day)
$CBOD_5$	10.00	417.00
NH_3-N	2.00	83.40
NO_3-N	10.00	417.00
DO	5.0	----

References

Arkansas Department of Environmental Quality (ADEQ). 1995. Water Quality Survey of the Mountain Home STP Effluent on Hicks Creek. WQ95-02-1

_____. 1999. NPDES Permit #AR0021211 for City of Mountain Home, Baxter County, Mountain Home, Arkansas.

APPENDIX A

Model Calibration and TMDL Runs

BVC

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    **********************************************************************
    *                        SIMPLIFIED METHOD PROGRAM                   *
    *                          COMPLETE INPUT LISTING                    *
    **********************************************************************

File Name: ARHICK3.OUT
Projection Run: Effluent CBOD5 = 10 mg/l; NH3-N= 2 mg/l; NO3-N= 10 mg/l;
and DO= 7 mg/l
RESULTS: Will maintain instream NO3-N standards of 10 mg/l and DO standards
of 5.0 mg/l



 *-*-*-*-*-*  Run Information *-*-*-*-*-*

Name of receiving stream ------------------------------  Hicks Creek
Number of discharges ----------------------------------  1
Number of reaches -------------------------------------  2
Reaeration type ---------------------------------------  O'Connor-Dobbins
Run title ---------------------------------------------  Mountain Home
STP

 *-*-*-*-*-* Upstream Parameters *-*-*-*-*-*
                Parameter                        Value      Comment
  Flow                              (cfs)       0.000
  Temperature                        (øC)      25.000
  Dissolved Oxygen                  (mg/l)      6.700
  5-Day BOD                         (mg/l)      3.000
  Ult. CBOD / 5-Day BOD                         2.300
  pH                                 (su)      -0.000
  Ammonia  (NH3-N and NO3-N)        (mg/l)      0.050
  Alkalinity                        (mg/l)     -0.000

 *-*-*-*-*-* Effluent Parameters *-*-*-*-*-*

 Number of Discharges =          1


For Discharge Number    1 (Mountain Home)
                Parameter                        Value      Comment
    Flow                            (MGD)       5.000
  Temperature                        (øC)      25.000
  Dissolved Oxygen                  (mg/l)      7.000
  5-Day BOD                         (mg/l)     10.000
  Ult. CBOD / 5-Day BOD                         2.300
  pH                                 (su)      -0.000
  Ammonia                           (mg/l)     12.000

   NOTE:  NH3-N = 2 mg/l and NO3-N = 10 mg/l)

  Alkalinity                        (mg/l)     -0.000
    Beginning of Reach Number                   1.000

 *-*-*-*-*-* Reach Information *-*-*-*-*-*

 Number of Reaches =          2
  Reaeration Type is O'Connor-Dobbins
```

For Reach Number 1

Parameter		Value	Comment
Length	(mile)	1.000	
Velocity	(fps)	0.200	
Slope	(ft/mile)	20.000	
Average Depth	(ft)	0.700	
Temperature	(øC)	25.000	Calculated
BOD Removal Rate	(1/day)	0.200	
NH3+NO3 loss Rate	(1/day)	0.300	
Sediment Oxygen Demand	(g/mý/day)	1.160	
Photosynthesis/respiration	(mg/L/day)	-0.000	

Temperature-corrected BOD removal rate	(1/day)	0.252
Temperature-corrected NH3+NO3 loss rate	(1/day)	0.441
Calculated reaeration rate at 20ø C	(1/day)	9.850
Temperature-corrected reaeration rate	(1/day)	11.096
Calculated reach-averaged width	(ft)	55.214

For Reach Number 2

Parameter		Value	Comment
Length	(mile)	2.000	
Velocity	(fps)	0.200	
Slope	(ft/mile)	25.000	
Average Depth	(ft)	0.700	
Temperature	(øC)	24.100	
BOD Removal Rate	(1/day)	0.200	
NH3+NO3 loss Rate	(1/day)	0.300	
Sediment Oxygen Demand	(g/mý/day)	1.160	
Photosynthesis/respiration	(mg/L/day)	0.000	

Temperature-corrected BOD removal rate	(1/day)	0.241
Temperature-corrected NH3+NO3 loss rate	(1/day)	0.411
Calculated reaeration rate at 20ø C	(1/day)	9.850
Temperature-corrected reaeration rate	(1/day)	10.861
Calculated reach-averaged width	(ft)	55.214

original model (1992) used

$\bar{U} = .1$ fps

depth = 3 ft.

$K_a = 3$ to 4

$K_n = .87$

$K_d = .2$

--*-*-*-* Results for Hicks Creek *-*-*-*-*-*

Discharge is to -- Hicks Creek
Run Title is -- Mountain Home STP

River Mile	DO Predicted	DO Observed	BOD Predicted	BOD Observed	NH3+NO3 Predicted	NH3+NO3 Observed
3.000	7.000		23.000		12.000	
3.000	7.000		23.000		12.000	
2.950	6.676		22.912		11.919	
2.900	6.405		22.824		11.839	
2.850	6.179		22.736		11.760	
2.800	5.991		22.649		11.681	
2.750	5.834		22.562		11.603	
2.700	5.705		22.476		11.525	
2.650	5.598		22.389		11.447	
2.600	5.510		22.303		11.371	
2.550	5.439		22.218		11.294	
2.500	5.381		22.133		11.218	
2.450	5.335		22.048		11.143	
2.400	5.298		21.963		11.068	
2.350	5.269		21.879		10.994	

2.300	5.247	21.795	10.920
2.250	5.231	21.711	10.847
2.200	5.220	21.628	10.774
2.150	5.213	21.545	10.702
2.100	5.210	21.462	10.630
2.050	5.209	21.380	10.559
2.000	5.211	21.298	10.488
2.000	5.211	21.298	10.488
1.900	5.282	21.141	10.357
1.800	5.341	20.986	10.228
1.700	5.391	20.832	10.100
1.600	5.434	20.679	9.974
1.500	5.471	20.527	9.849
1.400	5.505	20.376	9.726
1.300	5.537	20.226	9.605
1.200	5.566	20.077	9.485
1.100	5.594	19.930	9.366
1.000	5.621	19.783	9.249
0.900	5.646	19.638	9.134
0.800	5.671	19.493	9.020
0.700	5.696	19.350	8.907
0.600	5.719	19.208	8.796
0.500	5.743	19.067	8.686
0.400	5.766	18.927	8.577
0.300	5.788	18.788	8.470
0.200	5.811	18.649	8.365
0.100	5.833	18.512	8.260
0.000	5.855	18.376	8.157

BVC

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**********************************************************************
*                        SIMPLIFIED METHOD PROGRAM                   *
*                          COMPLETE INPUT LISTING                    *
**********************************************************************

File Name: ARHICK4.OUT
Projection Run: Effluent CBOD5 = 10 mg/l; NH3-N= 2 mg/l; and DO= 7 mg/l
RESULTS: Will maintain instream DO standards of 5.0 mg/l



 *-*-*-*-*-*  Run Information *-*-*-*-*-*

Name of receiving stream ------------------------------  Hicks Creek
Number of discharges ----------------------------------  1
Number of reaches -------------------------------------  2
Reaeration type ---------------------------------------  O'Connor-Dobbins
Run title ---------------------------------------------  Mountain Home
STP

 *-*-*-*-*-* Upstream Parameters *-*-*-*-*-*
                Parameter                      Value      Comment
  Flow                              (cfs)      0.000
  Temperature                        (øC)     25.000
  Dissolved Oxygen                  (mg/l)      6.700
  5-Day BOD                         (mg/l)      3.000
  Ult. CBOD / 5-Day BOD                         2.300
  pH                                 (su)     -0.000
  Ammonia                           (mg/l)      0.050
  Alkalinity                        (mg/l)     -0.000

 *-*-*-*-*-* Effluent Parameters *-*-*-*-*-*

 Number of Discharges =          1


For Discharge Number    1 (Mountain Home)
                Parameter                      Value      Comment
    Flow                            (MGD)      5.000
  Temperature                        (øC)     25.000
  Dissolved Oxygen                  (mg/l)      7.000
  5-Day BOD                         (mg/l)     10.000
  Ult. CBOD / 5-Day BOD                         2.300
  pH                                 (su)     -0.000
  Ammonia                           (mg/l)      2.000
  Alkalinity                        (mg/l)     -0.000
    Beginning of Reach Number                   1.000

 *-*-*-*-*-* Reach Information *-*-*-*-*-*

 Number of Reaches =          2
  Reaeration Type is O'Connor-Dobbins

For Reach Number    1
                Parameter                      Value      Comment
  Length                            (mile)     1.000
  Velocity                           (fps)     0.200
```

Slope	(ft/mile)	20.000	
Average Depth	(ft)	0.700	
Temperature	(øC)	25.000	Calculated
BOD Removal Rate	(1/day)	0.200	
NH3 Decay Rate	(1/day)	0.300	
Sediment Oxygen Demand	(g/mý/day)	1.160	
Photosynthesis/respiration	(mg/L/day)	-0.000	

Temperature-corrected BOD removal rate	(1/day)	0.252
Temperature-corrected NH3 decay rate	(1/day)	0.441
Calculated reaeration rate at 20ø C	(1/day)	9.850
Temperature-corrected reaeration rate	(1/day)	11.096
Calculated reach-averaged width	(ft)	55.214

For Reach Number 2

Parameter		Value	Comment
Length	(mile)	2.000	
Velocity	(fps)	0.200	
Slope	(ft/mile)	25.000	
Average Depth	(ft)	0.700	
Temperature	(øC)	24.100	
BOD Removal Rate	(1/day)	0.200	
NH3 Decay Rate	(1/day)	0.300	
Sediment Oxygen Demand	(g/mý/day)	1.160	
Photosynthesis/respiration	(mg/L/day)	0.000	

Temperature-corrected BOD removal rate	(1/day)	0.241
Temperature-corrected NH3 decay rate	(1/day)	0.411
Calculated reaeration rate at 20ø C	(1/day)	9.850
Temperature-corrected reaeration rate	(1/day)	10.861
Calculated reach-averaged width	(ft)	55.214

--*-*-*-* Results for Hicks Creek *-*-*-*-*-*

Discharge is to -- Hicks Creek
Run Title is -- Mountain Home STP

River Mile	DO Predicted	DO Observed	BOD Predicted	BOD Observed	NH3 Predicted	NH3 Observed
3.000	7.000		23.000		2.000	
3.000	7.000		23.000		2.000	
2.950	6.958		22.912		1.987	
2.900	6.923		22.824		1.973	
2.850	6.895		22.736		1.960	
2.800	6.871		22.649		1.947	
2.750	6.852		22.562		1.934	
2.700	6.837		22.476		1.921	
2.650	6.825		22.389		1.908	
2.600	6.815		22.303		1.895	
2.550	6.807		22.218		1.882	
2.500	6.801		22.133		1.870	
2.450	6.797		22.048		1.857	
2.400	6.794		21.963		1.845	
2.350	6.793		21.879		1.832	
2.300	6.792		21.795		1.820	
2.250	6.792		21.711		1.808	
2.200	6.792		21.628		1.796	
2.150	6.793		21.545		1.784	
2.100	6.795		21.462		1.772	

2.050	6.797	21.380	1.760
2.000	6.799	21.298	1.748
2.000	6.799	21.298	1.748
1.900	6.847	21.141	1.726
1.800	6.883	20.986	1.705
1.700	6.911	20.832	1.683
1.600	6.933	20.679	1.662
1.500	6.951	20.527	1.642
1.400	6.966	20.376	1.621
1.300	6.978	20.226	1.601
1.200	6.989	20.077	1.581
1.100	6.999	19.930	1.561
1.000	7.008	19.783	1.542
0.900	7.016	19.638	1.522
0.800	7.024	19.493	1.503
0.700	7.031	19.350	1.485
0.600	7.038	19.208	1.466
0.500	7.045	19.067	1.448
0.400	7.052	18.927	1.430
0.300	7.058	18.788	1.412
0.200	7.065	18.649	1.394
0.100	7.071	18.512	1.377
0.000	7.077	18.376	1.359

```
BVC
    ************************************************************************
    *                        SIMPLIFIED METHOD PROGRAM                     *
    *                          COMPLETE INPUT LISTING                      *
    ************************************************************************


File Name:  ARHICK1.OUT
Calibration Run: Input for CBOD5, NH3-N, NO3-N, and DO are from survey
data.



 *-*-*-*-*-*  Run Information *-*-*-*-*-*

Name of receiving stream ------------------------------  Hicks Creek
Number of discharges ----------------------------------  1
Number of reaches -------------------------------------  2
Reaeration type ---------------------------------------  O'Connor-Dobbins
Run title ---------------------------------------------  Mountain Home
STP

 *-*-*-*-*-* Upstream Parameters *-*-*-*-*-*
                Parameter                      Value      Comment
  Flow                              (cfs)      0.370
  Temperature                       (øC)      23.800
  Dissolved Oxygen                  (mg/l)     7.800
  5-Day BOD                         (mg/l)     0.400
  Ult. CBOD / 5-Day BOD                        2.300
  pH                                 (su)     -0.000
  Ammonia (NH3+NO3)                 (mg/l)     0.240
  Alkalinity                        (mg/l)    -0.000

 *-*-*-*-*-* Effluent Parameters *-*-*-*-*-*

 Number of Discharges =          1


For Discharge Number    1 (Mountain Home)
                Parameter                      Value      Comment
    Flow                            (MGD)      1.122
  Temperature                       (øC)      26.700
  Dissolved Oxygen                  (mg/l)     8.600
  5-Day BOD                         (mg/l)     2.400
  Ult. CBOD / 5-Day BOD                        2.300
  pH                                 (su)     -0.000
  Ammonia (NH3+No3)                 (mg/l)    15.680
  Alkalinity                        (mg/l)    -0.000
    Beginning of Reach Number                  1.000

 *-*-*-*-*-* Reach Information *-*-*-*-*-*

 Number of Reaches =          2
  Reaeration Type is O'Connor-Dobbins

For Reach Number    1
                Parameter                      Value      Comment
  Length                            (mile)     1.000
  Velocity                           (fps)     0.200
```

Slope	(ft/mile)	20.000	
Average Depth	(ft)	0.700	
Temperature	(øC)	26.190	Calculated
BOD Removal Rate	(1/day)	0.200	
NH3+NO3 loss Rate	(1/day)	0.300	
Sediment Oxygen Demand	(g/mý/day)	1.160	
Photosynthesis/respiration	(mg/L/day)	-0.000	

Temperature-corrected BOD removal rate	(1/day)	0.266
Temperature-corrected NH3+No3 loss rate	(1/day)	0.483
Calculated reaeration rate at 20ø C	(1/day)	9.850
Temperature-corrected reaeration rate	(1/day)	11.415
Calculated reach-averaged width	(ft)	15.033

For Reach Number 2

Parameter		Value	Comment
Length	(mile)	2.000	
Velocity	(fps)	0.200	
Slope	(ft/mile)	25.000	
Average Depth	(ft)	0.700	
Temperature	(øC)	24.100	
BOD Removal Rate	(1/day)	0.200	
NH3+No3 loss Rate	(1/day)	0.300	
Sediment Oxygen Demand	(g/mý/day)	1.160	
Photosynthesis/respiration	(mg/L/day)	0.000	

Temperature-corrected BOD removal rate	(1/day)	0.241
Temperature-corrected NH3+NO3 loss rate	(1/day)	0.411
Calculated reaeration rate at 20ø C	(1/day)	9.850
Temperature-corrected reaeration rate	(1/day)	10.861
Calculated reach-averaged width	(ft)	15.033

--*-*-*-* Results for Hicks Creek *-*-*-*-*-*

Discharge is to -- Hicks Creek
Run Title is -- Mountain Home STP

River Mile	DO Predicted	DO Observed	BOD Predicted	BOD Observed	NH3+NO3 Predicted	NH3+NO3 Observed
3.000	8.459	8.600	4.711	5.500	12.966	12.200
3.000	8.459		4.711		12.966	
2.950	7.881		4.692		12.870	
2.900	7.398		4.673		12.776	
2.850	6.996		4.654		12.682	
2.800	6.660		4.635		12.588	
2.750	6.382		4.617		12.496	
2.700	6.151		4.598		12.404	
2.650	5.960		4.579		12.313	
2.600	5.802		4.561		12.222	
2.550	5.672		4.542		12.132	
2.500	5.566		4.524		12.043	
2.450	5.480		4.506		11.955	
2.400	5.410		4.487		11.867	
2.350	5.355		4.469		11.779	
2.300	5.311		4.451		11.693	
2.250	5.276		4.433		11.607	
2.200	5.250		4.415		11.521	
2.150	5.231		4.397		11.437	
2.100	5.218		4.379		11.353	

2.050	5.209		4.362		11.269	
2.000	5.204	6.200	4.344	2.530	11.186	11.270
2.000	5.204		4.344		11.186	
1.900	5.350		4.312		11.047	
1.800	5.462		4.280		10.909	
1.700	5.549		4.249		10.772	
1.600	5.618		4.218		10.638	
1.500	5.674		4.187		10.505	
1.400	5.721		4.156		10.374	
1.300	5.762		4.125		10.244	
1.200	5.797		4.095		10.116	
1.100	5.829		4.065		9.990	
1.000	5.858		4.035		9.865	
0.900	5.885		4.005		9.742	
0.800	5.911		3.976		9.620	
0.700	5.936		3.947		9.500	
0.600	5.959		3.918		9.382	
0.500	5.982		3.889		9.264	
0.400	6.004		3.860		9.149	
0.300	6.026		3.832		9.034	
0.200	6.047		3.804		8.922	
0.100	6.068		3.776		8.810	
0.000	6.089		3.748		8.700	