

**Missouri Department of Natural
Resources
Water Pollution Control Program**

Total Maximum Daily Load (TMDL)

for

**East Whetstone Creek
Wright County, Missouri**

Completed: December 17, 2001

Approved:

**Total Maximum Daily Load (TMDL)
For East Whetstone Creek
Pollutant: Biochemical Oxygen Demand (BOD)**

Name: East Whetstone Creek (Identified as Whetstone Creek in the Missouri Water Quality Standards)

Hydrologic Unit Code (HUC): 10290201

Location: Near Mountain Grove in Wright Co., Missouri

Waterbody Identification Number (WBID): 1505

Missouri Stream Class: In the immediate discharge area East Whetstone Creek is unclassified.¹ It becomes a Class C² stream about 1 mile downstream of the Mountain Grove Wastewater Treatment Facility (WWTF).



Map Showing E Whetstone Creek Watershed

A map depicting the classified and unclassified portions of the stream can be found in **Appendix B, Map 2** at the end of the document.

Beneficial Uses: No designated uses in the immediate discharge area; East Whetstone Creek is designated for Wildlife and Livestock Watering and Aquatic Life and Human Health-Fish Consumption (associated with) Human Health, beginning about one mile downstream of the discharges.

Size of Impaired Segment: 2 miles

Location of Impaired Segment: Southern portion of Section 26, Township 29 North, Range 13 West to Southwest portion of Section 31, Township 29 North, Range 12 West.

Pollutants: BOD (Biochemical Oxygen Demand)

Pollutant Source: Two Mountain Grove Wastewater Treatment Facilities (WWTFs)

NPDES Permit Numbers:

Mountain Grove East WWTF—MO-0028711

Mountain Grove West WWTF—MO-0042111

TMDL Priority Ranking: High

¹ That is, it is dry most of the year and does not have permanent pools that will support aquatic life.

² Class C streams may cease flow in dry periods but maintain permanent pools, which support aquatic life. See 10 CSR 20-7.031(1)(F)

1. Background and Water Quality Problems

East Whetstone Creek was incorrectly reported as Whetstone Creek on the 1998 303(d) list of impaired waters and in the Missouri Water Quality Standards. Two miles of the stream are impaired due to high Biochemical Oxygen Demand (which causes low dissolved oxygen) resulting from discharges from the Mountain Grove West Wastewater Treatment Facility and the Mountain Grove East Wastewater Treatment Facility four cell aerated lagoon. The TMDL priority ranking for East Whetstone Creek is high. During dry weather the stream flow is effluent dominated. For this reason this TMDL was calculated at critical low flow conditions (7Q10). The West WWTF is a mechanical plant with a design flow of 0.69 cubic feet per second (cfs). Its present permit limit is 45 mg/L weekly maximum and 30 mg/L monthly average BOD. The East WWTF consists of a four cell aerated lagoon with a facility design flow of 0.34 (cfs). Its present permit limit is 65 milligrams per Liter (mg/L) weekly maximum and 40 mg/L monthly average BOD. Upon expiration of their permit in 2002, the Mountain Grove East WWTF lagoon discharge will be treated at the mechanical plant. The West WWTF mechanical plant will handle the totality of the discharge with an assumed design flow of 1.8 cubic feet per second (cfs).

East Whetstone Creek originates near the town of Mountain Grove, Wright County, Missouri and flows northwesterly to join Whetstone Creek and from there flows into the Gasconade River near the town of Rayborn. Wright County is a part of the Ozark Plateau region and has three physiographic features; the floodplain of the Gasconade River running diagonally southwest to northeast across the county, the deeply dissected areas along drainageways, and the loess-covered ridges in the north and central part of the county. Elevations range from 1,000 feet above sea level on the floodplains to 1,744 feet on the ridges. In the East Whetstone Creek sub-watershed, agricultural land makes up approximately 28.8 percent of the area, forestland comprises 59.1 percent, and urban areas total 11.3 percent. Less than one percent of the area is water or barren land.

Wright County has been characterized as having good cattle growing conditions. It has appropriate soil types for growing pasture grasses and weather conditions that aren't too harsh. The Clarksville-Wilderness-Doniphan soil association is predominant in the East Whetstone Creek watershed. Characteristics of the association include moderately sloping to very steep slopes and somewhat excessively drained to moderately well drained soils on uplands. Most of this association is used for woodlands or pasture. Farming practices are confined to raising beef cattle, dairy farming or logging. Along the lower portion of East Whetstone Creek, the Nolin-Claiborne-Ashton soil association is found. It consists of nearly level to moderately sloping, well-drained soils on flood plains, terraces and foot slopes. Making up only 6 percent of the county, this soil is used for pasture and for growing corn, soybeans and small grains. Farming practices on these soils include raising crops, dairy farming and raising beef cattle. The climate is hot in summer and moderately cool in winter. Annual precipitation is about 42 inches, with 60 percent falling during the growing season. It snows most winters, but normally it only lasts a short time before melting.

The county is in the oak-hickory hardwood forest region. Oaks, such as white oak, northern red oak, black oak and hickory, as well as ash, maple, black cherry, black walnut and dogwood are native to the area. Mark Twain National Forest is located in the northeast corner of the county,

and is used primarily for hunting. Wildlife populations such as whitetail deer and wild turkey are considered to be plentiful.³

In 1812 the Osage Indians were the most numerous Native Americans in the county. The McClurg Fur Company established a trading post just east of the present town of Mountain Grove to trade with the local Osage Indians. By 1832 all Native Americans had left the county and only returned sporadically to hunt. Settlers from Tennessee, Virginia, and Kentucky came to hunt and trap the abundant wildlife in the area. Furs and pelts were shipped to St. Louis by ox team. Principle crops grown were corn and tobacco, and livestock were raised for home consumption. The woods were used in a “free range” situation, with cattle and hogs being allowed to roam to find their own food.

Originally established as the Phillips Academy, Seminary Grove or Mountain Grove Academy was established in 1857. It was the only institution of higher learning in the area. It was funded by tuition, and attracted students from as far away as West Plains. During the Civil War, Seminary Grove Academy was closed and was taken over by bushwhackers. These bandits’ main activity was stealing cattle, driving them to Rolla, and selling them to the Union Army. Federal army officers got suspicious about the origin of the cattle and conducted an investigation. After trailing the bushwhackers back to their headquarters, the army surrounded the seminary and killed all the bushwhackers but two, who were released due to their youth. After that, the Webster County Militia occupied the building and kept order in the town until the end of the War. The Seminary reopened after the War, but was later made into an orphanage and a hospital and finally closed.⁴ Wright County did not settle rapidly until after the Civil War, and its greatest advance has been since the building of the railroad through a portion of the county.

The year 1899 saw the establishment of the Missouri State Fruit Experiment Station on 190 acres of land just north of Mountain Grove. The first director of the State Fruit Experiment Station, J.T. Stinson, introduced the saying “an apple a day keeps the doctor away.” Several commercially important fruit cultivars were released from the station, including Ozark Gold apple, Loring and Topaz peach, and Ozark Premier and Bluefre plum. The traditional breeding program was discontinued in 1985. Now, the Fruit Experiment Station does research on apple and peach trees and small fruits such as strawberries, blueberries and bramble fruits. The station is the home of the Midwest Viticulture and Enology Center. The center provides quality grape and wine research and advisory programs for the Midwest region. Extensive research has been done on grafting grapes and in French grape hybrids. The station operated as a state agency under a board of trustees appointed by the Governor until 1974. At that time, authority for the station was put under the Board of Regents of Southwest Missouri State University.⁵

Also established in 1899, the Poultry Experiment Station was located adjacent to the Fruit Experiment Station. The Poultry Experiment Station researched poultry housing design, incubator and brooder design, varieties of poultry best adapted to Missouri. They also researched poultry diseases and treatments. The duties of the experiment station were transferred

³ “Gasconade River Watershed Inventory and Assessment”, Missouri Department of Conservation, Missouri Rivers and Its Watershed web site www.conservation.state.mo.us/fish/watershed/gascon/contents/130cotxt.htm

⁴ History and Families of Wright County, Missouri Volume 1, Turner Publishing Company, Paducah, KY, 1993.

⁵ “History of the State Fruit Experiment Station”, Southwest Missouri State University—Mountain Grove, mtngrv.smsu.edu/SFEShistory.htm

to the University of Missouri-Columbia in the same reorganization that gave authority for the fruit experiment station to Southwest Missouri State University. The Poultry Experiment Station was closed in 1974.⁶

More recently, the Wright County Soil Conservation District has implemented innovative programs to improve cattle raising and to promote pasture management. Best management practices introduced include spring developments, streambank stabilization, pasture renovation methodology and portable shade structures to keep cattle out of creeks.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

Beneficial Uses:

No beneficial uses exist in the immediate discharge area; East Whetstone Creek is designated for Wildlife and Livestock Watering and Aquatic Life and Human Health (associated with) Fish Consumption, beginning about one mile downstream of the discharges. The stream classifications and designated uses are located in 10 CSR 20-7.031(1) C and table H in the Missouri Water Quality Standards (WQS).

Anti-degradation Policy:

Missouri's Water Quality Standards include the U. S. Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, and can be found at 10 CSR 20-7.031(2).

Tier I defines baseline conditions for all waters and it requires that existing beneficial uses be protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen and ammonia) are met to protect uses.

Tier II requires that no degradation of high-quality waters occur unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal Tier I criteria.

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; Tier III requires that no degradation under any conditions occurs. Management may prohibit discharge or certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

This TMDL will result in the protection of existing beneficial uses, which conforms to Missouri's Tier I anti-degradation policy.

3. Specific Criteria and Numeric Water Quality Target:

Biochemical Oxygen Demand (BOD)

⁶ Missouri Revised Statutes, Section 262.200, "Promotion of Agriculture and Horticulture" and Section 173.005, "Department of Higher Education".

Biochemical Oxygen Demand (BOD) is the parameter used to determine the impact wastewater will cause on Dissolved Oxygen (DO) levels in a receiving stream. There is no numeric criterion in the Water Quality Standards for BOD. Since DO cannot be allocated, DO is linked to BOD for allocation purposes. BOD is a pollutant that is measurable and can be allocated in a TMDL.

BOD is composed of carbonaceous oxygen demand (CBOD) and nitrogenous oxygen demand (NBOD). NBOD can be estimated directly from total Kjeldahl nitrogen (TKN) according to the relation $NBOD = 4.57 \text{ TKN}$ (Chapra, S 1997). The numeric link between dissolved oxygen and BOD is generated by the water quality model QUAL2E, and is supported by U.S. Environmental Protection Agency (EPA). The QUAL2E model calculates BOD by using CBOD and nitrogen data from actual sample analyses. State Water Quality Standards for all Missouri streams, except cold water fisheries, call for the maintenance of 5 mg/L dissolved oxygen⁷ or the normal background level of dissolved oxygen, whichever is lower.⁸ In East Whetstone Creek the normal background level is 5.0 mg/L, which matches the standard for warm water fisheries, and that is the criterion used for the purposes of the TMDL.

Summary of Numeric Instream Criteria:

Table 1 summarizes the instream numeric chronic criteria for limited Warm-Water Fishery extracted from the Missouri Water Quality Standards for the TMDL on East Whetstone Creek.

Table 1: Instream Chronic Criteria for limited Warm-Water Fishery East Whetstone near Mountain Grove

	<i>Beyond Mixing Zone beginning .25 mile after Classified portion of creek begins</i>
<i>Dissolved Oxygen (mg/L) May-October</i>	5.0
<i>Dissolved Oxygen (mg/L) November-April</i>	5.0
<i>Total Ammonia (mg/L), May-October (pH 7.8, Temperature 26° C)</i>	2.0
<i>Total Ammonia (mg/L), November-April (pH 7.8, Temperature 6° C)</i>	3.3
<i>Ammonia-Nitrogen (mg/L) (NH3-N) May – October (total ammonia/1.2)</i>	1.67
<i>Ammonia-Nitrogen (mg/L) (NH3-N) November – April (total ammonia/1.2)</i>	2.75

In the immediate discharge area, East Whetstone Creek is unclassified, in that during most times of the year, the creek normally does not contain enough water to support aquatic life. About one mile downstream from the Mountain Grove WWTF, the East Whetstone Creek becomes a

⁷ 10 CSR 20-7.031(4)(J)

⁸ 10 CSR 20-7.031(4)(A)(3)

classified stream. Classified streams may cease to flow during portions of the year, but will maintain permanent pools which can support aquatic life. At this point the mixing zone begins according to Missouri Water Quality Standards. The mixing zone comprises the full width of the stream for one-quarter of a mile. At the end of the mixing zone is where Water Quality Standards must be met. Because East Whetstone Creek is effluent dominated during low flow conditions, this can cause harmful conditions for aquatic life in the classified section of the stream, as well as for whatever frequents the unclassified portion of the stream. To alleviate low dissolved oxygen levels (a result of high BOD levels in the effluent issuing from the Mountain Grove WWTF) addition of aeration of the effluent will be included in the permit. This can be accomplished through a variety of means. Aeration methods to consider can include an aerated outfall, aeration using compressed air (this would require electricity to run and may not be feasible in that location) or construction of a stair step structure to mix oxygen into the effluent. Whatever method is used, the addition of oxygen to the effluent would raise dissolved oxygen levels in the effluent and help the stream meet Water Quality Standards.

Model Assumptions and Predictions

This waterbody segment was modeled using the QUAL2E model. The Mountain Grove West WWTF is the only point source in this model. Upon permit renewal, the East lagoon discharge will be treated at the mechanical plant, and the flow is to be combined with that of the West facility. The 7Q10 Low Flow in East Whetstone Creek is zero, or for modeling purpose close to zero.

Based on the QUAL2E model, the allowable load of 303(d) pollutants that will just meet Water Quality Standards are as follows:

Summer:

Dissolved Oxygen = **8 mg/L**

CBOD = **20 mg/L**

NH₃-N = **3 mg/L**

Winter:

Dissolved Oxygen = **5 mg/L**

CBOD = **30 mg/L**

NH₃-N = **5 mg/L**

4. Calculation of Loading Capacity

Loading Capacity is the maximum amount of pollutant loading a water body can receive without violating water quality standards. (40 CFR 130.2(f)). The Loading Capacity is equal to the Waste Load Allocation, the Load Allocation, and the margin of safety. (Load Allocation takes into account background and non-point sources contributing to the impairment. See **5. Load Allocation**.) In this case, the Load Allocation component is zero because the 7Q10 flow is nil, the stream flow is equal to the facility flow. The Loading Capacity is calculated as follows:

$$\begin{aligned}
 & \text{WLA} + \text{LA} + \text{MOS} = \text{LC} \\
 & \text{(design stream flow in cfs)(instream pollutant concentration in mg/L)(5.395*) which is Wasteload} \\
 & \quad \text{Allocation} \\
 & \quad + \\
 & \text{(upstream design flow in cfs)(upstream water quality in mg/L)(5.395) which is Load Allocation} \\
 & \quad + \\
 & \text{(margin of safety)}
 \end{aligned}$$

*5.395 is the constant used to convert mg/L to pounds/day.

Summer:

$$LC_{CBOD} = (1.8 \text{ cfs} * 20 \text{ mg/L} * 5.395) + (0) = \mathbf{194.2 \text{ lb/day}}$$

$$LC_{NH3-N} = (1.8 \text{ cfs} * 3 \text{ mg/L} * 5.395) + (0) = \mathbf{29.1 \text{ lb/day}}$$

Winter:

$$LC_{CBOD} = (1.8 \text{ cfs} * 30 \text{ mg/L} * 5.395) + (0) = \mathbf{291.3 \text{ lb/day}}$$

$$LC_{NH3-N} = (1.8 \text{ cfs} * 5 \text{ mg/L} * 5.395) + (0) = \mathbf{48.55 \text{ lb/day}}$$

5. Load Allocation (Non-point Source Load)

Load allocation includes all existing and future non-point sources and natural background (40 CFR § 130.2(g)). There are two Concentrated Animal Feeding Operations in the watershed of the impaired segment of East Whetstone Creek. Both are dairies with 140 and 145 dairy cows respectively. Both are no-discharge systems operating under a Department of Natural Resources permit and both have a Natural Resources Conservation Service (NRCS) Animal Waste Management System Plan. The Load Allocation is zero.

$$LA_{CBOD} = \mathbf{0 \text{ lb/day}}$$

$$LA_{NH3-N} = \mathbf{0 \text{ lb/day}}$$

6. Waste Load Allocation (Point Source Loads)

Waste Load Allocations are the proportion of a receiving water's loading capacity that is allocated to one of its existing or future sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)). The Mountain Grove East and West WWTFs are the only point source loads discharging to the impaired segment of East Whetstone Creek. To provide adequate DO concentration (no less than 2 mg/L) in the unclassified section of the stream to support aquatic life, Mountain Grove WWTP must build an aeration system to maintain an effluent DO concentration of no less than 8 mg/L. These re-aeration controls will be required in the re-issued NPDES permit as a part of the mechanical plant upgrade.

The point source waste load allocation is calculated by the following formula:

$$\mathbf{WLA = LC - LA - MOS}$$

The Load Allocation is zero, as previously described.

Summer:

$WLA_{CBOD} = 194.2 - 19.4 = 174.8 \text{ lb/day}$

$WLA_{NH3-N} = 29.1 - 2.9 = 26.2 \text{ lb/day}$

Winter:

$WLA_{CBOD} = 291.3 - 29.1 = 262.2 \text{ lb/day}$

$WLA_{NH3-N} = 48.55 - 4.85 = 43.7 \text{ lb/day}$

The Waste Load Allocation for the West Plant is 174.8 lb/day for summer. The WLA for the East Plant is zero lb/day.

Summary of Loads

The Loads to East Whetstone Creek for this TMDL are summarized in the table below:

Loads to East Whetstone Creek near Mountain Grove, Missouri (in pounds/day)

	Parameter	Point Load (WLA)	Margin of Safety (MOS)	TMDL
Summer	CBOD	174.8	19.4	194.2
	Ammonia-Nitrogen	26.2	2.9	29.1
Winter	CBOD	262.2	29.1	291.3
	Ammonia-Nitrogen	43.7	4.85	48.55

7. Margin of Safety

The Margin of Safety (MOS) is the prescribed mechanism to account for the uncertainty in determining the amount of pollution load and its effect on water quality. There are two ways for incorporating a Margin of Safety in a TMDL:

- Implicitly by incorporating the MOS using conservative model assumptions to develop allocations
- Explicitly by specifying a portion of the total TMDL as the MOS, and allocating the remainder to sources

In this study, an explicit Margin of Safety (MOS) was chosen to reflect this uncertainty. Using Best Professional Judgement, the MOS was set at 10% of the Loading Capacity.

Summer:

$MOS_{CBOD} = 19.4 \text{ lb/day}$

$MOS_{NH3-N} = 2.9 \text{ lb/day}$

Winter:

$MOS_{CBOD} = 29.1 \text{ lb/day}$

$MOS_{NH3-N} = 4.85 \text{ lb/day}$

8. Seasonal Variation

Seasonal variation was simulated in the QUAL2E model via the use of lower water temperatures, lower ammonia and CBOD (which are used to calculate BOD) decay coefficients and adjustments to seasonal low flow values. Seasonal limits for BOD are necessary because decay of this substance is biologically mediated and varies with water temperature and because dissolved oxygen gas saturation varies with water temperature.

9. Implementation and Monitoring Plans

Implementation will be accomplished through permit action. The results of this TMDL will be used to determine their permit limits. This is a phased TMDL. Upon expiration of their permit in 2002, the Mountain Grove WWTF will upgrade from its present mechanical plant and lagoon system to the mechanical plant also treating the lagoon discharge including some form of aeration to correct the low dissolved oxygen problem in the creek. They will be given three years to accomplish this. This will be Phase 1. Since this is a phased TMDL, Phase 2 will be monitoring on a regular basis to assess compliance with Missouri Water Quality Standards. This TMDL will be incorporated into Missouri's Water Quality Management Plan.

10. Reasonable Assurances

The department has the authority to write and enforce NPDES permits. Inclusion of effluent limits as determined from the allocations and established in this TMDL into a state NPDES permit should provide reasonable assurance that instream water quality standards will be met.

11. Public Participation

This water quality limited segment is included on the approved 1998 303(d) list for Missouri. The Department of Natural Resources developed these TMDLs. Six public meetings to allow input from the public on impaired waters were held between Aug. 18 and Sept. 22, 1999. No comments pertaining to East Whetstone Creek were received during the public meetings. This TMDL document was sent to EPA for examination and then the edited draft was placed on public notice from November 9, 2001 to December 9, 2001. Groups receiving the public notice announcement include the Missouri Clean Water Commission, the affected facility, the Water Quality Coordinating Committee, the TMDL Advisory Committee, the appropriate Missouri legislators, Stream Team volunteers in the watershed, and the others that routinely receive the public notice of NPDES permits. Comments from the US EPA and a private individual were received. Copies of the notice, the comments and the Department's response to the comments will be on file with the Department of Natural Resources.

12. Administrative Record and Supporting Documentation:

An administrative record on the East Whetstone Creek TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources, including the following:

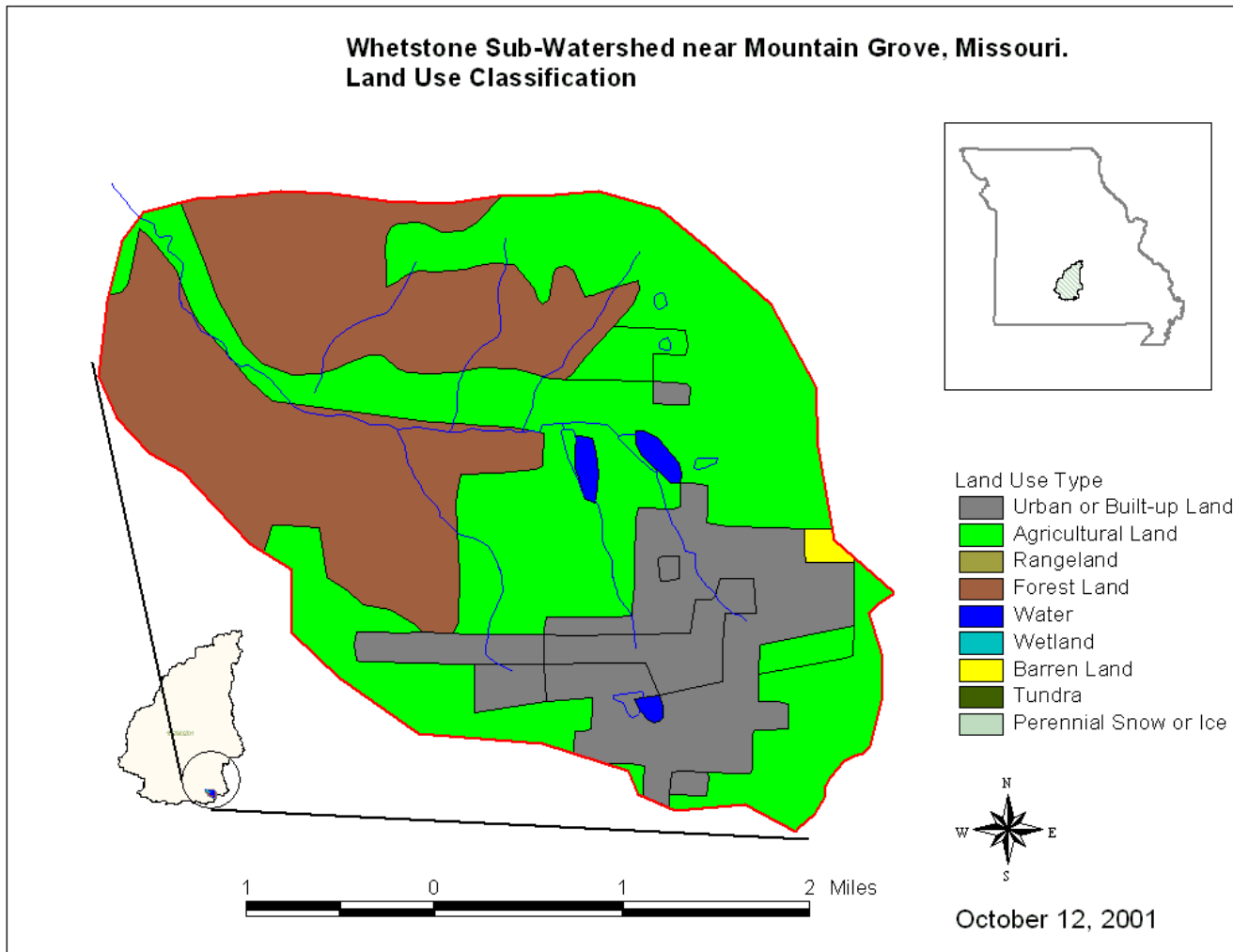
Land use map

Topographical maps of impaired segment with Sampling Station Number
Graphs
Land Use information
Wright County Conservation District docket for conservation practices
Missouri Revised Statutes Sections 173.005 and Section 262.200
Input information
Permit for Mountain Grove WWTF
East Whetstone Creek Information Sheet

13. Appendices

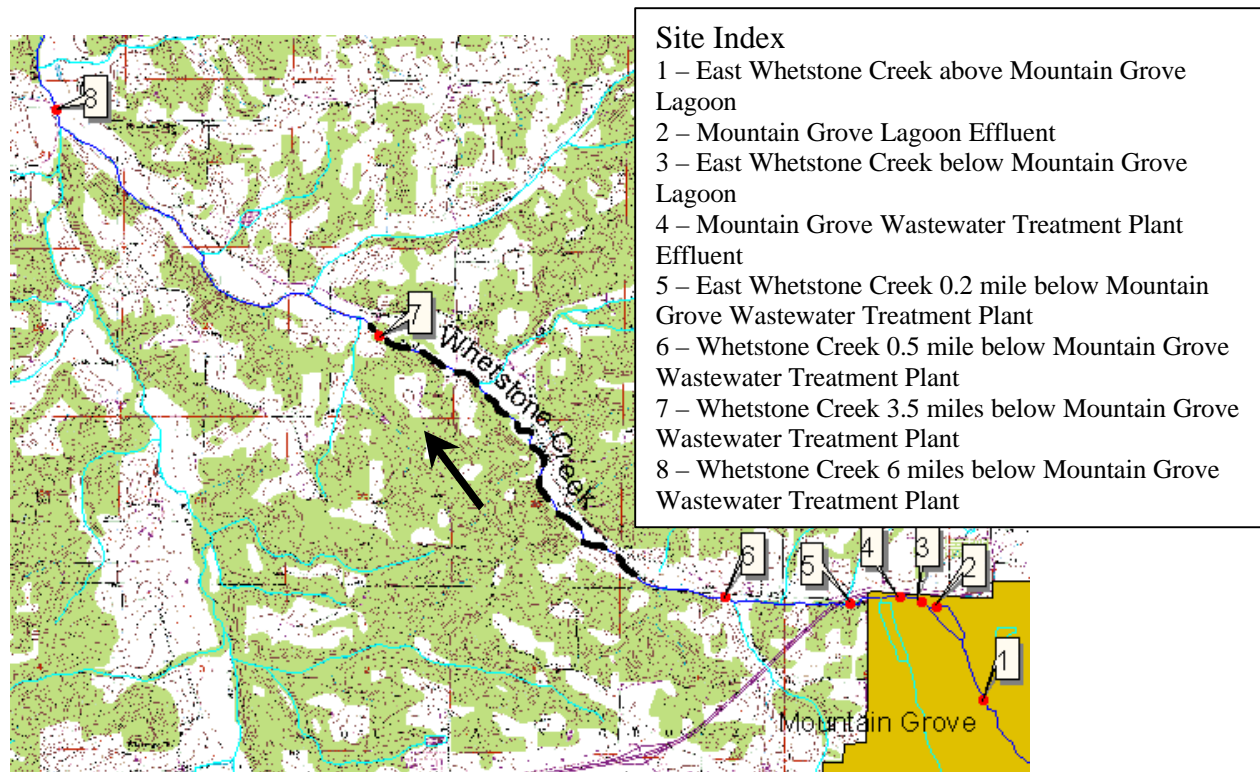
Appendix A: Land Use Map
Appendix B: Location Maps
Appendix C: Graphs
Appendix D: Land Use Distribution Tables

APPENDIX A LAND USE MAP



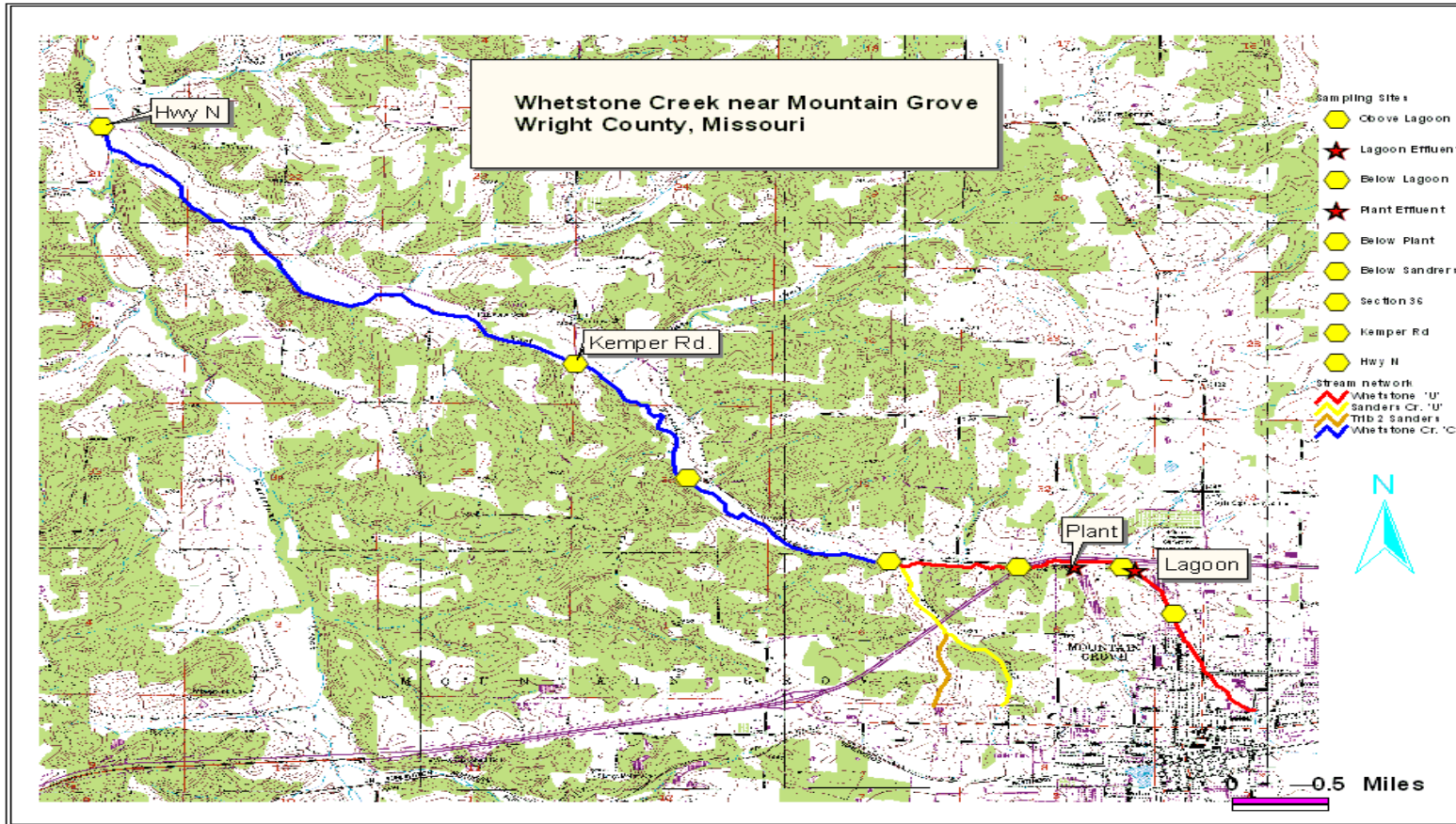
Appendix B Location Maps

Map of Impaired Portion of East Whetstone Creek Showing Location of Sampling Sites –Map 1



Legend: **—** Impaired Section
 → Direction of Flow

**MAP SHOWING CLASSIFIED PORTION OF EAST WHETSTONE CREEK
MAP 2**



Appendix C Graphs (Concentration)

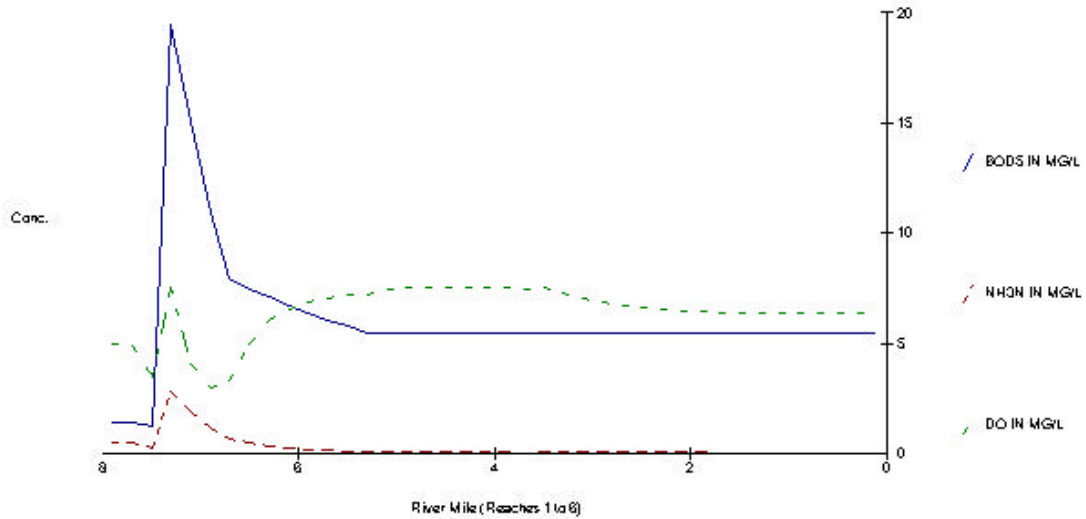


Fig 1: Plot of BOD5, NH3-N and Dissolved Oxygen simulated with an input of 8 mg/L DO, 20 mg/L CBOD5, and 3 mg/L NH3-N.

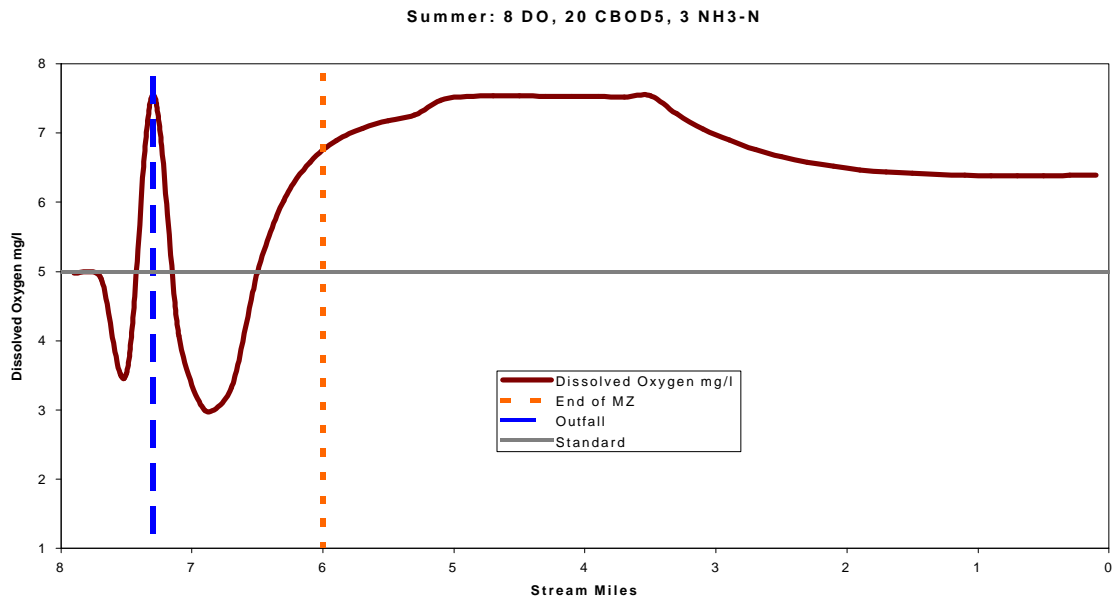


Fig 2: Graph of Summer DO simulated at 8, 20, 3, for DO, CBOD5, and NH3-N respectively.

Summer: 8 DO, 20 CBOD5, 3NH3-N

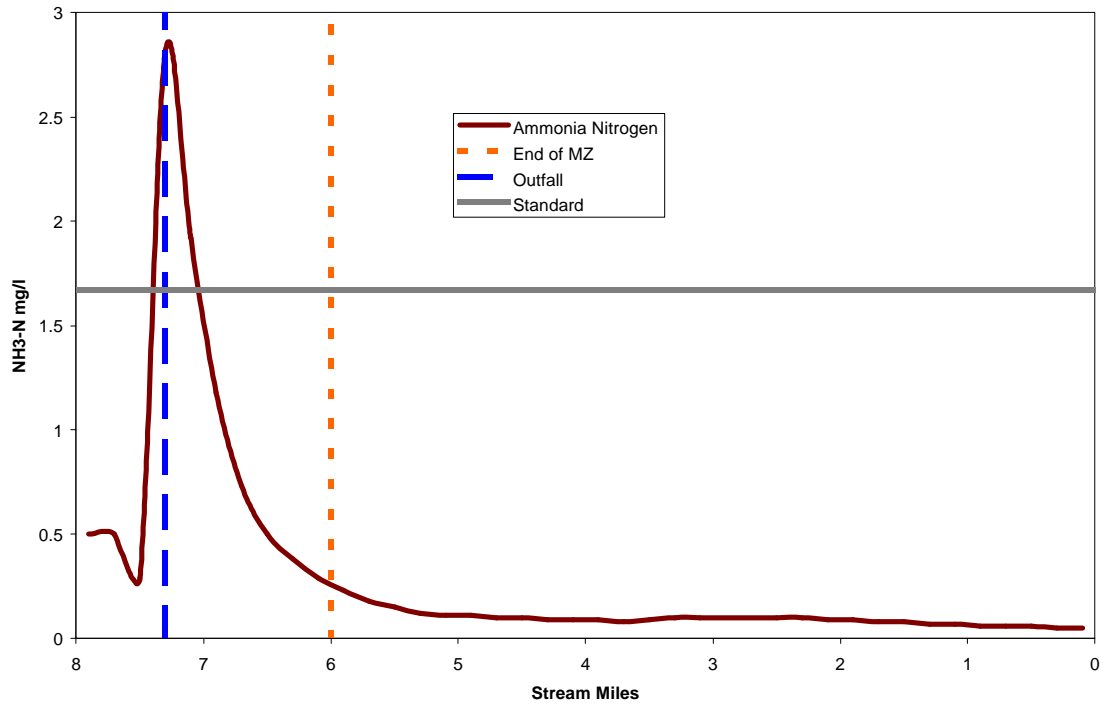


Fig 4: Graph of Summer NH3-N

(Concentration)

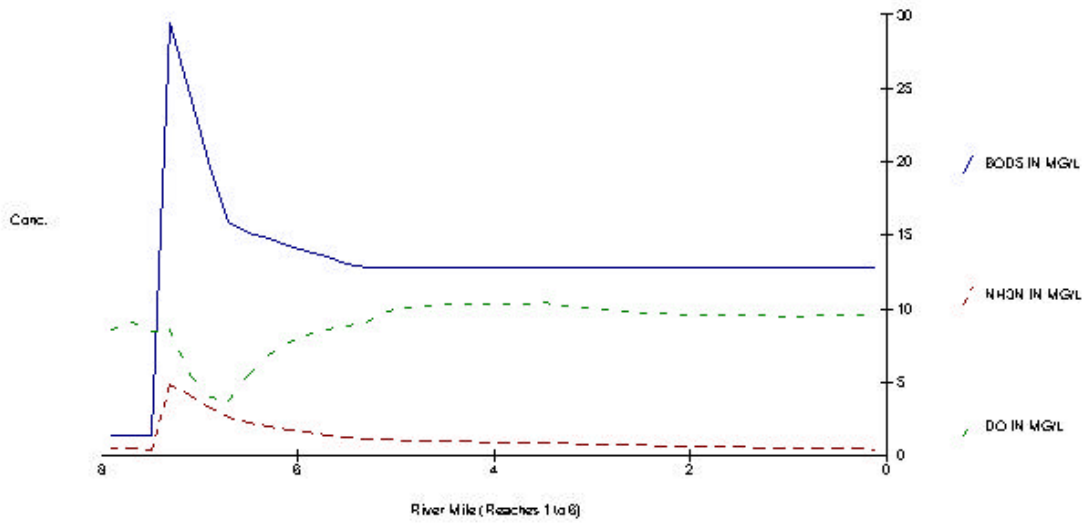
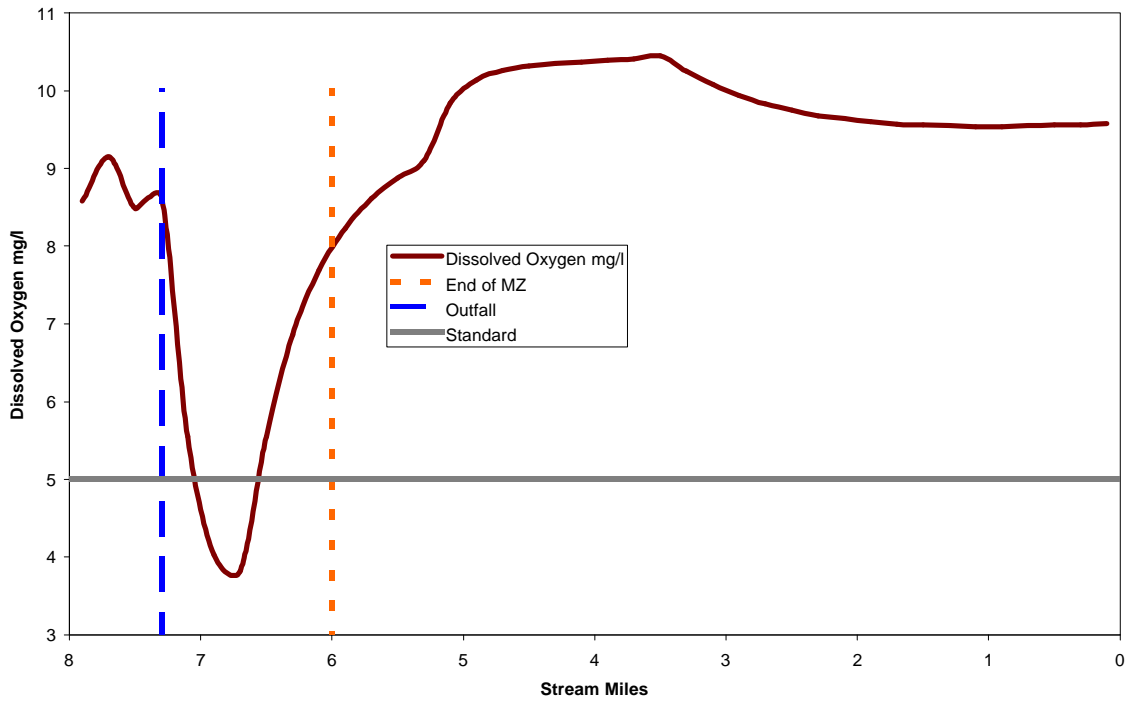
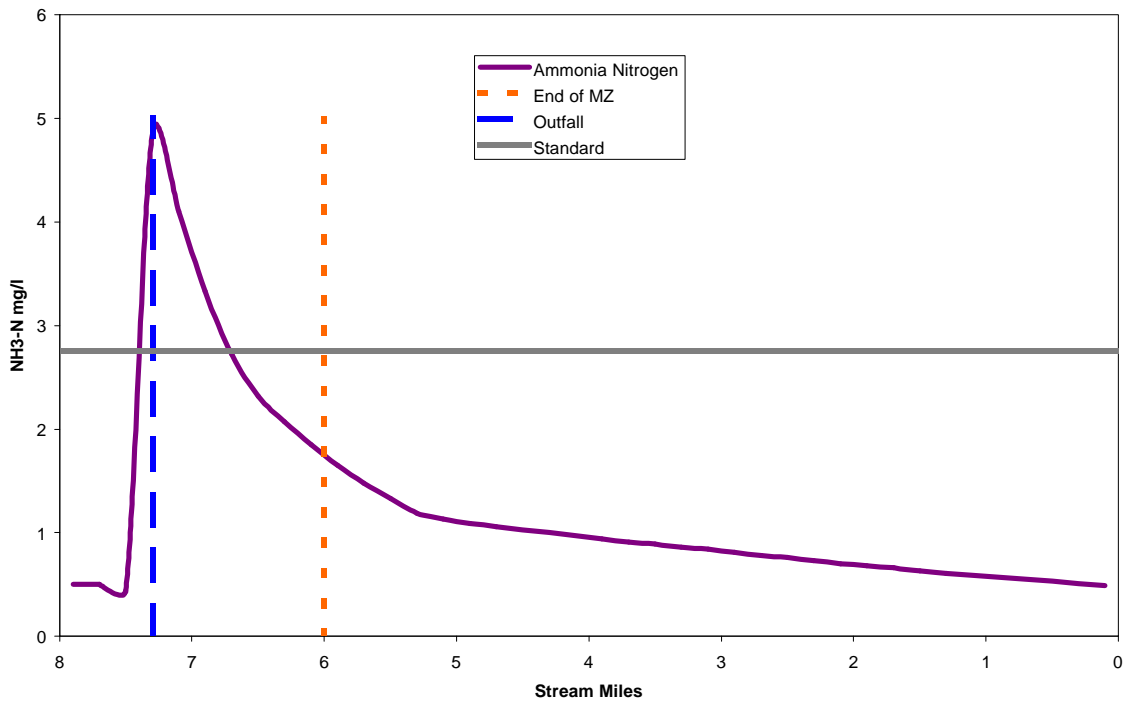


Fig 5: Winter simulation – 5-30-5 mg/l of DO, CBOD5, and NH3-N respectively.

Winter: 5 DO, 30 CBOD5, 5 NH3-N



Winter: 5 DO, 30 CBOD5, 5 NH3-N



**APPENDIX D
LAND USE DISTRIBUTION**

Table 01. Detailed land use distribution.

Land Use Name and Code	Area (acres)
Urban or Built-up Land	
RESIDENTIAL- 11	786
COMMERCIAL AND SERVICES- 12	193
MXD URBAN OR BUILT-UP- 16	103
OTHER URBAN OR BUILT-UP- 17	69
Subtotal	1151
Agricultural Land	
<i>CROPLAND AND PASTURE- 21</i>	<i>2795</i>
ORCH, GROV, VNYRD, NURS, ORN- 22	77
CONFINED FEEDING OPS- 23	53
Subtotal	2925
Forest Land	
DECIDUOUS FOREST LAND- 41	6014
Subtotal	6014
Water	
<i>RESERVOIRS- 53</i>	<i>51</i>
Subtotal	51
Barren Land	
TRANSITIONAL AREAS- 76	29
Subtotal	29
Total	10170

Table 02. Land use distribution by major land use category.

Land Use Name and Code	Area (acres)
Urban or Built-up Land	1151
Agricultural Land	2925
Forest Land	6014

Water	51
Barren Land	29
=====	
Total	10170