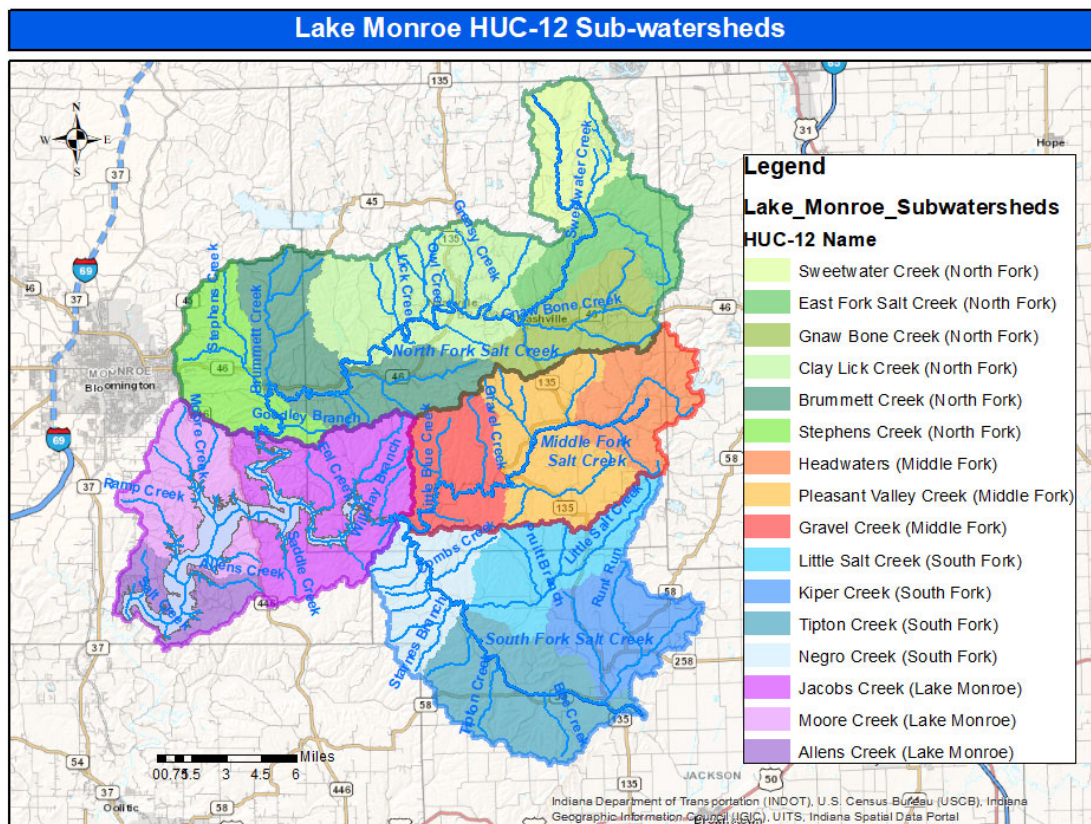


# Appendix I – HUC12 Subwatershed Ranking Methodology

## 1 HUC-12 Subwatershed Comparison and Ranking

Data from the desktop survey, windshield survey, monthly tributary sampling, spring sampling blitz, fall sampling blitz, and the Brown County Regional Sewer District E. coli study were compiled by subwatershed in order to make comparisons between the different subwatersheds and identify priority areas. The Lake Monroe watershed was divided into 16 HUC-12 subwatersheds.

Figure 1-1 Lake Monroe HUC-12 Subwatershed Map



In order to make comparisons across variable data sets, a ranking system was used where the highest value represents the highest impact (worst water quality) and the lowest value represents the lowest impact (best water quality).

The following data sets were evaluated:

- IDEM's 303(d) Impaired Waterbodies List
- Point Source Assessment

- Land Cover Assessment
- Nutrient, Suspended Sediment, and E. coli Load Assessment
- Watershed Visual Assessments
  - Streambank Erosion Assessment
  - Adequate Buffer Zone Assessment
  - Livestock Access Assessment
- Fall Sampling Blitz Water Quality Assessment
- Spring Sampling Blitz Water Quality Assessment
- Habitat Assessment
- Brown County RSD E. Coli Assessment

### Methodology

For each data set, a value was calculated for each subwatershed in order to evaluate relative prioritization. In some cases, the value was a simple count (e.g. number of impaired waterbodies). For data sets like visual assessments, the value was a percentage of total sites in that subwatershed (e.g. percent of stream sites with severe erosion) in order to account for differences in the number of sites per subwatershed. For water quality data, results were compared to water quality targets in order to determine the percentage of samples in a subwatershed that exceeded the water quality target (e.g. percentage of samples exceeding E. coli target of 235 CFU/100 ml).

In all cases, subwatersheds were compared to evaluate relative prioritization. Each subwatershed was assigned a rank for each parameter with “1” indicating the highest water quality (least exceedances) and “16” indicating the lowest water quality (most exceedances).

Once all subwatersheds were ranked for all parameters, parameters were divided into two major categories:

1. Level of Degradation based on water quality parameters
2. Level of Vulnerability based on land usage assessments

With all parameters equally weighted, the average for each category was calculated and the subwatersheds were ranked according to their Level of Degradation (Category 1) and Vulnerability (Category 2). The ranks of these two categories were then averaged to give an overall Rank Score. As with the individual parameter rankings, the most impacted subwatershed received the highest rank (most concerns) and the least impacted received the lowest rank (least concerns).

## 1.1 HUC-12 Water Quality Degradation Assessment

Parameters used to calculate Water Quality Degradation Rank were the number of 303(d) impaired water bodies and the percentage of exceedances for E. coli, Total Nitrogen, Nitrates, Total Phosphorus, Soluble Reactive Phosphorus, and Total Suspended Solids from the monthly tributary monitoring, fall blitz monitoring, spring blitz monitoring, and BCRSD monitoring (E. coli only).

### **Impaired Water Bodies**

Impairments listed in the IDEM 303(d) list of impaired water bodies were tabulated for each subwatershed. Based on the 303(d) list of impaired water bodies, Jacobs Creek had the most impairments (4), followed by Moore Creek (3), Allens Creek (3), Negro Creek (2), and Little Salt Creek (1).

*Table 1-1 HUC-12 Subwatershed Comparison of 303(d) Impairments*

<b>HUC-12-Subwatershed</b>	<b>303(d) Waterbodies and Impairments</b>	<b># Impairments</b>	<b>303(d) Rank</b>
Kiper Creek (SF)	None	0	1
Little Salt Creek (SF)	Little Salt Creek (E. Coli)	1	12
Tipton Creek (SF)	None	0	1
Negro Creek (SF)	South Fork Salt Creek (Dissolved Oxygen, Biological Integrity)	2	13
Headwaters Middle Fork (MF)	None	0	1
Pleasant Valley Creek (MF)	None	0	1
Gravel Creek (MF)	None	0	1
Sweetwater Creek (NF)	None	0	1
East Fork Salt Creek (NF)	None	0	1
Gnaw Bone Creek (NF)	None	0	1
Clay Lick Creek (NF)	None	0	1
Brummett Creek (NF)	None	0	1
Stephens Creek (NF)	None	0	1
Jacobs Creek (LM)	Crooked Creek (E. Coli), Lake Monroe Upper Basin (Algae, Mercury in Fish, and Taste and Odor)	4	16
Moore Creek (LM)	Lake Monroe Lower Basin (Algae, Mercury in Fish, and Taste and Odor)	3	14
Allens Creek (LM)	Lake Monroe Lower Basin (Algae, Mercury in Fish, and Taste and Odor)	3	14

## **Fall Blitz Water Quality Assessment**

Water quality data collected at 88 sites within the Lake Monroe watershed during the fall sampling blitz on September 18, 2020, were compared against chosen water quality targets. These thresholds were used to discern areas of poor water quality. If the measured parameter did not meet the threshold requirement, the sample was counted as exceeding the threshold. Each of the data sets was analyzed to determine what percentage of samples did not meet the threshold requirement in each HUC-12 subwatershed and therefore how many times poor water quality was indicated for each specific parameter. Table 1-2 summarizes the percentage of exceedances for each parameter in each subwatershed. Table 1-3 assigns a rank for each parameter with “1” indicating the highest water quality (least exceedances) and “16” indicating the lowest water quality (most exceedances).

*Table 1-2 HUC-12 Subwatershed Exceedances Using Fall Blitz Data*

<b>Subwatershed</b>	<b># Fall Samples</b>	<b>% Fall Samples E Coli &gt; 235 CFU/100ml</b>	<b>% Fall Samples TSS &gt; 30 mg/L</b>	<b>% Fall Samples TP &gt; 0.020 mg/L</b>	<b>% Fall Samples SRP &gt; 0.005 mg/L</b>	<b>% Fall Samples TN &gt; 0.690 mg/L</b>	<b>% Fall Samples NO3 &gt; 0.633 mg/L</b>
Kiper Creek (SF)	11	9%	0%	9%	45%	0%	0%
Little Salt Creek	8	25%	0%	0%	25%	25%	25%
Tipton Creek (SF)	7	14%	0%	29%	57%	14%	14%
Negro Creek (SF)	2	0%	0%	50%	50%	0%	0%
Headwaters	4	75%	25%	50%	0%	0%	0%
Pleasant Valley	7	14%	14%	14%	14%	0%	0%
Gravel Creek (MF)	4	0%	0%	50%	25%	25%	0%
Sweetwater Creek	6	17%	0%	0%	33%	0%	0%
East Fork Salt	3	0%	33%	33%	33%	33%	33%
Gnaw Bone Creek	6	17%	0%	0%	17%	0%	0%
Clay Lick Creek	14	21%	0%	7%	14%	7%	7%
Brummett Creek	7	0%	0%	0%	14%	0%	0%
Stephens Creek	7	43%	0%	43%	29%	14%	0%
Jacobs Creek (LM)	0	0%	0%	0%	0%	0%	0%
Moore Creek (LM)	1	0%	0%	0%	0%	0%	0%
Allens Creek (LM)	1	0%	0%	100%	100%	0%	0%

Table 1-3 HUC-12 Subwatershed Ranking Using Fall Blitz Data

Subwatershed	Fall Blitz E. Coli Rank	Fall Blitz TSS Rank	Fall Blitz TP Rank	Fall Blitz SRP Rank	Fall Blitz TN Rank	Fall Blitz NO3 Rank
Kiper Creek (SF)	8	1	8	13	1	1
Little Salt Creek (SF)	14	1	1	8	14	15
Tipton Creek (SF)	9	1	10	15	12	14
Negro Creek (SF)	1	1	13	14	1	1
Headwaters Middle Fork	16	15	13	1	1	1
Pleasant Valley Creek (MF)	9	14	9	4	1	1
Gravel Creek (MF)	1	1	13	8	14	1
Sweetwater Creek (NF)	11	1	1	11	1	1
East Fork Salt Creek (NF)	1	16	11	11	16	16
Gnaw Bone Creek (NF)	11	1	1	7	1	1
Clay Lick Creek (NF)	13	1	7	4	11	13
Brummett Creek (NF)	1	1	1	4	1	1
Stephens Creek (NF)	15	1	12	10	12	1
Jacobs Creek (LM)	1	1	1	1	1	1
Moore Creek (LM)	1	1	1	1	1	1
Allens Creek (LM)	1	1	16	16	1	1

Based on the percentage of exceedances using the fall blitz data, the HUC-12 subwatershed of greatest concern is East Fork Salt Creek followed by Tipton Creek, Little Salt Creek, and Stephens Creek.

### **Spring Blitz Water Quality Assessment**

Water quality data collected at 122 sites within the Lake Monroe watershed during the spring blitz on April 2, 2021, were compared against chosen water quality targets. These thresholds were used to discern areas of poor water quality. If the measured parameter did not meet the threshold requirement, the sample was counted as exceeding the threshold. Each of the data sets was analyzed to determine what percentage of samples did not meet the threshold requirement in each HUC-12 subwatershed and therefore how many times poor water quality was indicated for each specific parameter. Table 1-4 summarizes the percentage of exceedances for each parameter in each subwatershed. Table 1-5 assigns a rank for each parameter with “1” indicating the highest water quality (least exceedances) and “16” indicating the lowest water quality (most exceedances).

Table 1-4 HUC-12 Subwatershed Ranking Using Spring Blitz Data

HUC-12 Subwatershed	# Spring Samples	% Spring Samples E Coli > 235 CFU/100ml	% Spring Samples TSS > 30 mg/L	% Spring Samples TP > 0.020 mg/L	% Spring Samples SRP > 0.005 mg/L	% Spring Samples TN > 0.690 mg/L	% Spring Samples NO3 > 0.633 mg/L
Kiper Creek (SF)	11	9.1%	0%	45%	9%	0%	0%
Little Salt Creek	9	0.0%	0%	11%	0%	0%	0%
Tipton Creek (SF)	8	0.0%	0%	75%	25%	63%	25%
Negro Creek (SF)	6	0.0%	0%	17%	0%	0%	0%
Headwaters	6	0.0%	0%	33%	17%	0%	0%
Pleasant Valley	11	0.0%	0%	36%	36%	0%	0%
Gravel Creek	4	0.0%	0%	75%	0%	0%	0%
Sweetwater	8	0.0%	0%	88%	38%	0%	0%
East Fork Salt	7	0.0%	0%	100%	43%	0%	0%
Gnaw Bone Creek	13	0.0%	0%	100%	54%	0%	0%
Clay Lick Creek	17	0.0%	0%	94%	35%	0%	0%
Brummett Creek	8	0.0%	0%	75%	25%	0%	0%
Stephens Creek	6	0.0%	0%	83%	50%	17%	0%
Jacobs Creek	3	0.0%	0%	100%	67%	0%	0%
Moore Creek	3	0.0%	33%	100%	33%	0%	0%
Allens Creek (LM)	2	0.0%	0%	50%	50%	0%	0%

Table 1-5 HUC-12 Subwatershed Ranking Using Spring Blitz Data

Subwatershed	Spring Blitz E. Coli Rank	Spring Blitz TSS Rank	Spring Blitz TP Rank	Spring Blitz SRP Rank	Spring Blitz TN Rank	Spring Blitz NO3 Rank	Spring Blitz Average Rank
Kiper Creek (SF)	16	1	5	4	1	1	6
Little Salt Creek (SF)	1	1	1	1	1	1	2
Tipton Creek (SF)	1	1	9	6	16	16	8
Negro Creek (SF)	1	1	2	1	1	1	1
Headwaters Middle Fork (MF)	1	1	5	5	1	1	2
Pleasant Valley Creek (MF)	1	1	4	10	1	1	3
Gravel Creek (MF)	1	1	9	1	1	1	3
Sweetwater Creek (NF)	1	1	11	11	1	1	4
East Fork Salt Creek (NF)	1	1	16	12	1	1	5
Gnaw Bone Creek (NF)	1	1	16	15	1	1	4
Clay Lick Creek (NF)	1	1	12	9	1	1	4
Brummett Creek (NF)	1	1	9	6	1	1	3
Stephens Creek (NF)	1	1	10	13	15	1	7
Jacobs Creek (LM)	1	1	16	16	1	1	6
Moore Creek (LM)	1	16	16	8	1	1	7
Allens Creek (LM)	1	1	6	13	1	1	3

Based on the spring blitz data, the highest priority HUC-12 subwatershed is Tipton Creek followed by Moore Creek, Stephens Creek, and Jacobs Creek.

There were noticeable differences between the spring and fall blitz events, potentially due to the dramatically different weather conditions. The Fall Blitz was conducted during a period of low flow when only 88 stream sites could be sampled while the Spring Blitz was conducted during a period of relatively high flow when 123 stream sites were sampled.

**Brown County RSD E. Coli Water Quality Assessment**

The Brown County Regional Sewer District (BCRSD) collected and analyzed water samples for E. Coli concentration at 19 sites within the Brown County portion of the Lake Monroe watershed on a weekly basis for five weeks. These results were compared to the state standard of 235 CFU/100 ml and compiled by subwatershed. Based on these results, the subwatersheds with the most significant E. coli levels were the three subwatersheds of Middle Fork Salt Creek – Headwaters Middle Fork, Pleasant Valley Creek, and Gravel Creek – along with Brummett Creek in the North Fork subwatershed. E. Coli was also detected above the state water quality target in more than 50% of samples in Gnaw Bone Creek and Clay Lick Creek. It should be noted that there was only one sample site in the South Fork subwatershed and no sample sites in the Lake Monroe Basin subwatershed.

*Table 1-6 HUC-12 Subwatershed E. Coli Assessment Using BCRSD Data*

HUC-12 Subwatershed	# BCRSD Samples	Average E. Coli Result (CFU/100 ml)	% Samples E Coli > 235 CFU/100ml	BCRSD E Coli Rank
Kiper Creek (SF)				
Little Salt Creek (SF)	5	177	20%	9
Tipton Creek (SF)				
Negro Creek (SF)				
Headwaters Middle Fork (MF)	5	656	80%	13
Pleasant Valley Creek (MF)	15	494	80%	13
Gravel Creek (MF)	5	536	80%	13
Sweetwater Creek (NF)	5	166	40%	10
East Fork Salt Creek (NF)				
Gnaw Bone Creek (NF)	15	267	53%	12
Clay Lick Creek (NF)	30	356	50%	11
Brummett Creek (NF)	5	515	80%	13
Stephens Creek (NF)				
Jacobs Creek (LM)				
Moore Creek (LM)				
Allens Creek (LM)				



## Water Quality Degradation Summary

Overall, the Tipton Creek subwatershed (South Fork) scored the highest (worst) for water quality degradation, followed by East Fork Salt Creek (North Fork), Stephens Creek (North Fork), Clay Lick Creek (North Fork), and Little Salt Creek (South Fork). This indicates that these five subwatersheds have the poorest water quality.

Jacobs Creek (LM) was expected to have a number of E. coli exceedances due to its listing on the 303(d) impaired water body list but no samples in the subwatershed tested above the state limit of 235 CFU/100 ml.

*Table 1-7 HUC-12 Subwatershed Water Quality Degradation Ranking*

<b>HUC-12 Subwatershed</b>	<b>Level of Degradation</b>
Kiper Creek (SF)	5
Little Salt Creek (SF)	12 – High
Tipton Creek (SF)	16 – High
Negro Creek (SF)	2
Headwaters Middle Fork (MF)	10 - Medium
Pleasant Valley Creek (MF)	8 - Medium
Gravel Creek (MF)	5
Sweetwater Creek (NF)	3
East Fork Salt Creek (NF)	15 - High
Gnaw Bone Creek (NF)	8
Clay Lick Creek (NF)	13 - High
Brummett Creek (NF)	1
Stephens Creek (NF)	14 - High
Jacobs Creek (LM)	3
Moore Creek (LM)	7 - Medium
Allens Creek (LM)	11 - Medium

0-6 Low, 7-11 Medium, 12-16 High

Table 1-8 HUC-12 Subwatershed Water Quality Degradation Parameters

HUC-12 Sub-watershed	# Parameters	303(d) Rank	Fall Blitz E Coli Rank	Fall Blitz TSS Rank	Fall Blitz TP Rank	Fall Blitz SRP Rank	Fall Blitz TN Rank	Fall Blitz NO3 Rank	Spring Blitz E Coli Rank	Spring Blitz TSS Rank	Spring Blitz TP Rank	Spring Blitz SRP Rank	Spring Blitz TN Rank	Spring Blitz NO3 Rank	BCRSD E Coli Rank
Kiper Creek (SF)	14	1	8	1	8	13	1	1	16	1	5	4	1	1	
Little Salt Creek (SF)	15	12	14	1	1	8	14	15	1	1	1	1	1	1	9
Tipton Creek (SF)	14	1	9	1	10	15	12	14	1	1	9	6	16	16	
Negro Creek (SF)	14	13	1	1	13	14	1	1	1	1	2	1	1	1	
Headwaters Middle Fork (MF)	15	1	16	15	13	1	1	1	1	1	5	5	1	1	13
Pleasant Valley Creek (MF)	15	1	9	14	9	4	1	1	1	1	4	10	1	1	13
Gravel Creek (MF)	15	1	1	1	13	8	14	1	1	1	9	1	1	1	13
Sweetwater Creek (NF)	15	1	11	1	1	11	1	1	1	1	11	11	1	1	10
East Fork Salt Creek (NF)	14	1	1	16	11	11	16	16	1	1	16	12	1	1	
Gnaw Bone Creek (NF)	15	1	11	1	1	7	1	1	1	1	16	15	1	1	12
Clay Lick Creek (NF)	15	1	13	1	7	4	11	13	1	1	12	9	1	1	11
Brummett Creek (NF)	15	1	1	1	1	4	1	1	1	1	9	6	1	1	13
Stephens Creek (NF)	14	1	15	1	12	10	12	1	1	1	10	13	15	1	
Jacobs Creek (LM)	14	16	1	1	1	1	1	1	1	1	16	16	16	1	1
Moore Creek (LM)	14	14	1	1	1	1	1	1	1	16	16	8	1	1	
Allens Creek (LM)	14	14	1	1	16	16	1	1	1	1	6	13	1	1	

## 1.2 HUC-12 Vulnerability Assessment

The level of vulnerability represents observed sources of pollutants in the watershed and utilizes all windshield survey data – erosion, riparian buffer, livestock access – as well as NPDES facilities, land cover, and habitat data. Individual rankings are averaged and compared between watersheds to calculate a degradation rank.

The level of vulnerability represents observed sources of pollutants in the watershed and utilizes all windshield survey data – erosion, riparian buffer, livestock access – as well as NPDES facilities, land cover, and habitat data. Individual rankings are averaged and compared between watersheds to calculate a vulnerability rank.

### **Point Source Pollution (NPDES)**

The number of facilities with point discharge permits (NPDES) was tabulated for each subwatershed to evaluate relative prioritization. Based on NPDES permits, the largest impact is from the Clay Lick Creek subwatershed followed by Moore Creek. Additional areas of concern include the Kiper Creek, Gnaw Bone Creek, Brummett Creek, Allens Creek, and Jacobs Creek subwatersheds.

Table 1-9 HUC-12 Subwatershed Comparison of Point Discharge Facilities

HUC-12-Subwatershed	NPDES Permits	# Permits	Rank
Kiper Creek (SF)	Jackson County Regional Sewer District WWTP, Springhill Camps WWTP	2	11
Little Salt Creek (SF)	None	0	1
Tipton Creek (SF)	None	0	1
Negro Creek (SF)	None	0	1
Headwaters Middle Fork (MF)	None	0	1
Pleasant Valley Creek (MF)	None	0	1
Gravel Creek (MF)	None	0	1
Sweetwater Creek (NF)	None	0	1
East Fork Salt Creek (NF)	None	0	1
Gnaw Bone Creek (NF)	Gnaw Bone WWTP, Camp Moneto WWTP	2	11
Clay Lick Creek (NF)	Nashville WWTP, Greg Rose Properties WWTP, Wrights Auto Parts, Shelby Materials	4	16
Brummett Creek (NF)	Brown County State Park WWTP, Unionville Elementary WWTP	2	11
Stephens Creek (NF)	None	0	1
Jacobs Creek (LM)	Salt Creek Services WWTP	1	10
Moore Creek (LM)	Paynetown SRA WWTP, SCI RSD WWTP, CBU Drinking Water Plant	3	15
Allens Creek (LM)	USFS Hardin Ridge WWTP, Hardin-Monroe WWTP	2	11

## Land Cover Assessment

Nonpoint source pollution is most likely to come from agricultural land or developed land (as opposed to forest, water/wetlands, or scrub/shrub). The percentage of agricultural and developed land was tabulated for each subwatershed to evaluate relative prioritization.

The four subwatersheds with the highest percentage of combined agricultural and developed land were Kiper Creek, Tipton Creek, Allens Creek, and Stephens Creek. The five subwatersheds with moderate percentage of combined agricultural and developed land were Little Salt Creek, Pleasant Valley Creek, Sweetwater Creek, Brummett Creek, and Moore Creek.

*Table 1-10 HUC-12 Subwatershed Land Cover Assessment*

HUC-12 Subwatershed	% Agricultural	% Developed	% Agricultural or Developed	Land Cover Rank
Kiper Creek (SF)	24.6%	4.8%	29.4%	16
Little Salt Creek (SF)	8.0%	1.7%	9.8%	10
Tipton Creek (SF)	21.5%	2.6%	24.1%	15
Negro Creek (SF)	1.8%	1.0%	2.7%	2
Headwaters Middle Fork (MF)	5.8%	1.7%	7.5%	6
Pleasant Valley Creek (MF)	8.7%	1.8%	10.5%	10
Gravel Creek (MF)	2.4%	0.7%	3.0%	2
Sweetwater Creek (NF)	5.8%	2.8%	8.6%	8
East Fork Salt Creek (NF)	5.1%	1.2%	6.3%	4
Gnaw Bone Creek (NF)	4.2%	2.1%	6.4%	4
Clay Lick Creek (NF)	5.2%	2.6%	7.8%	7
Brummett Creek (NF)	6.8%	2.2%	8.9%	8
Stephens Creek (NF)	7.1%	4.1%	11.2%	13
Jacobs Creek (LM)	0.4%	0.8%	1.2%	1
Moore Creek (LM)	7.4%	2.4%	9.8%	10
Allens Creek (LM)	9.4%	2.6%	12.0%	14

### **Streambank Erosion (Windshield Survey)**

Visual assessments of streambank erosion showed the highest percentage of sites with erosion in the Tipton Creek, Gravel Creek, and Stephens Creek subwatersheds followed by Brummett Creek and Gnawbone Creek, Kiper Creek, and Headwaters Middle Fork. One limitation to the data is that fewer sites were evaluated in the Lake Monroe Basin. In that subwatershed, roads tend to run along ridgetops and there are also fewer roads simply because Lake Monroe makes up a large percentage of the watershed (20%). This analysis also does not account for lakeshore erosion which is significant in the Lake Monroe Basin.

*Table 1-11 HUC-12 Subwatershed Streambank Erosion Assessment*

<b>HUC-12 Subwatershed</b>	<b>Minor Erosion (1-2 ft)</b>	<b>Major Erosion (3+ ft)</b>	<b>Any Erosion (1+ ft)</b>	<b># Sites Assessed</b>	<b>Erosion Rank</b>
Kiper Creek (SF)	64%	29%	93%	14	<b>10</b>
Little Salt Creek (SF)	72%	6%	78%	18	<b>6</b>
Tipton Creek (SF)	55%	45%	100%	20	<b>14</b>
Negro Creek (SF)	42%	33%	75%	12	<b>4</b>
Headwaters Middle Fork (MF)	67%	27%	93%	15	<b>10</b>
Pleasant Valley Creek (MF)	52%	30%	83%	23	<b>8</b>
Gravel Creek (MF)	54%	46%	100%	13	<b>14</b>
Sweetwater Creek (NF)	71%	18%	88%	17	<b>9</b>
East Fork Salt Creek (NF)	42%	33%	75%	12	<b>4</b>
Gnaw Bone Creek (NF)	65%	29%	94%	17	<b>12</b>
Clay Lick Creek (NF)	46%	35%	81%	26	<b>7</b>
Brummett Creek (NF)	77%	19%	97%	31	<b>13</b>
Stephens Creek (NF)	63%	38%	100%	8	<b>14</b>
Jacobs Creek (LM)	33%	17%	50%	6	<b>2</b>
Moore Creek (LM)	50%	13%	63%	8	<b>3</b>
Allens Creek (LM)	33%	0%	33%	3	<b>1</b>

### **Riparian Buffer (Windshield Survey)**

Visual assessment of the width of riparian buffer showed the highest percentage of sites with insufficient buffer (less than 20 feet) in the Pleasant Valley Creek subwatershed followed by Gnaw Bone Creek, Clay Lick Creek, Brummett Creek, and Kiper Creek.

*Table 1-12 HUC-12 Subwatershed Riparian Buffer Assessment*

<b>HUC-12 Subwatershed</b>	<b>Minimal Riparian Buffer (5-20 ft)</b>	<b>Absent Riparian Buffer (&lt;5 ft)</b>	<b>Insufficient Riparian Buffer (&lt;20 ft)</b>	<b># Sites Assessed</b>	<b>Riparian Buffer Rank</b>
Kiper Creek (SF)	71%	0%	71%	14	12
Little Salt Creek (SF)	11%	28%	39%	18	5
Tipton Creek (SF)	45%	5%	50%	20	6
Negro Creek (SF)	0%	0%	0%	12	1
Headwaters Middle Fork (MF)	47%	13%	60%	15	8
Pleasant Valley Creek (MF)	57%	35%	91%	23	16
Gravel Creek (MF)	15%	8%	23%	13	3
Sweetwater Creek (NF)	29%	24%	53%	17	7
East Fork Salt Creek (NF)	42%	25%	67%	12	9
Gnaw Bone Creek (NF)	41%	41%	82%	17	15
Clay Lick Creek (NF)	38%	38%	77%	26	13
Brummett Creek (NF)	58%	19%	77%	31	13
Stephens Creek (NF)	38%	0%	38%	8	4
Jacobs Creek (LM)	0%	67%	67%	6	9
Moore Creek (LM)	0%	13%	13%	8	2
Allens Creek (LM)	67%	0%	67%	3	9

### **Livestock Access (Windshield Survey)**

Visual assessment of where livestock had access to streams indicate that the issue is most prevalent in the Tipton Creek and Stephens Creek subwatersheds followed by Little Salt Creek, East Fork Salt Creek, and Clay Lick Creek subwatersheds.

*Table 1-13 HUC-12 Subwatershed Livestock Access Assessment*

<b>HUC-12 Subwatershed</b>	<b># Sites with Livestock Access to Streams</b>	<b># Sites Assessed</b>	<b>% Sites with Livestock Access to Streams</b>	<b>Livestock Access Rank</b>
Kiper Creek (SF)	1	14	7%	<b>10</b>
Little Salt Creek (SF)	2	18	11%	<b>14</b>
Tipton Creek (SF)	4	20	20%	<b>15</b>
Negro Creek (SF)	0	12	0%	<b>1</b>
Headwaters Middle Fork (MF)	1	15	7%	<b>10</b>
Pleasant Valley Creek (MF)	1	23	4%	<b>7</b>
Gravel Creek (MF)	0	13	0%	<b>1</b>
Sweetwater Creek (NF)	1	17	6%	<b>8</b>
East Fork Salt Creek (NF)	1	12	8%	<b>12</b>
Gnaw Bone Creek (NF)	0	17	0%	<b>1</b>
Clay Lick Creek (NF)	2	26	8%	<b>12</b>
Brummett Creek (NF)	2	31	6%	<b>8</b>
Stephens Creek (NF)	2	10	20%	<b>15</b>
Jacobs Creek (LM)	1	6	0%	<b>1</b>
Moore Creek (LM)	0	8	0%	<b>1</b>
Allens Creek (LM)	1	3	0%	<b>1</b>



## **Habitat Assessment**

Habitat assessments using the Citizens Quality Habitat Evaluation Index (CQHEI) were completed twice at each blitz sites (once in the fall and once in the spring). Results were compiled and analyzed by subwatershed. Scores were significantly different during the fall and spring blitz, which is partially attributable to the different flow conditions (stream flow was absent or minimal in the fall due to drought conditions while stream flow was moderate in the spring). Based on the fall blitz data, the subwatersheds with the poorest stream habitat were Kiper Creek, Gravel Creek, East Fork Salt Creek, and Brummett Creek. Based on the spring blitz data, the subwatersheds with the poorest stream habitat were Kiper Creek, Tipton Creek, Gravel Creek, and Stephens Creek.

*Table 1-14 HUC-12 Subwatershed Habitat Assessment*

<b>HUC-12 Subwatershed</b>	<b>Fall Blitz Average CQHEI Score</b>	<b>Spring Blitz Average CQHEI Score</b>	<b>Fall Blitz CQHEI Rank</b>	<b>Spring Blitz CQHEI Rank</b>	<b>Average CQHEI Rank</b>
Kiper Creek (SF)	54.3	59.9	15	15	15
Little Salt Creek (SF)	62.9	78.2	2	1	1.5
Tipton Creek (SF)	59.2	61.2	7	13	10
Negro Creek (SF)	55.8	70.1	11	6	8.5
Headwaters Middle Fork (MF)	62.8	77.8	3	3	3
Pleasant Valley Creek (MF)	55.8	68.1	11	9	10
Gravel Creek (MF)	54.9	54.8	13	16	14.5
Sweetwater Creek (NF)	62.8	75.8	3	4	3.5
East Fork Salt Creek (NF)	54.3	67	15	10	12.5
Gnaw Bone Creek (NF)	56.9	68.4	9	8	8.5
Clay Lick Creek (NF)	56.9	65.5	9	11	10
Brummett Creek (NF)	54.5	72.5	14	5	9.5
Stephens Creek (NF)	59.3	61.2	6	13	9.5
Jacobs Creek (LM)	60.3	69	5	7	6
Moore Creek (LM)	57.7	65	8	12	10
Allens Creek (LM)	64	78	1	2	1.5

## Water Quality Vulnerability Summary

The Kiper Creek subwatershed (South Fork) scored the highest (worst) for vulnerability, followed by Clay Lick Creek (North Fork), Brummett Creek (North Fork), Tipton Creek (South Fork), and Stephens Creek (North Fork). This indicates that these five subwatersheds have the highest concentration of documented pollution sources.

*Table 1-15 HUC-12 Subwatershed Vulnerability Rank*

Sub-watershed	Vulnerability Rank	Average Score	# Parameters	NPDES Rank	Erosion Rank	Riparian Buffer Rank	Livestock Access Rank	Land Cover Rank	Fall Blitz CQHEI Rank	Spring Blitz CQHEI Rank
Kiper Creek (SF)	16	12.7	7	11	10	12	10	16	15	15
Little Salt Creek (SF)	3	5.6	7	1	6	5	14	10	2	1
Tipton Creek (SF)	13	10.1	7	1	14	6	15	15	7	13
Negro Creek (SF)	1	3.7	7	1	4	1	1	2	11	6
Headwaters Middle Fork (MF)	6	5.9	7	1	10	8	10	6	3	3
Pleasant Valley Creek (MF)	11	8.9	7	1	8	16	7	10	11	9
Gravel Creek (MF)	7	7.1	7	1	14	3	1	2	13	16
Sweetwater Creek (NF)	5	5.7	7	1	9	7	8	8	3	4
East Fork Salt Creek (NF)	9	7.9	7	1	4	9	12	4	15	10
Gnaw Bone Creek (NF)	10	8.6	7	11	12	15	1	4	9	8
Clay Lick Creek (NF)	15	10.7	7	16	7	13	12	7	9	11
Brummett Creek (NF)	14	10.3	7	11	13	13	8	8	14	5
Stephens Creek (NF)	12	9.4	7	1	14	4	15	13	6	13
Jacobs Creek (LM)	2	5.0	7	10	2	9	1	1	5	7
Moore Creek (LM)	8	7.3	7	15	3	2	1	10	8	12
Allens Creek (LM)	3	5.6	7	11	1	9	1	14	1	2

### 1.3 HUC-12 Overall Assessment

Combining the two sets of rankings, the five highest priority HUC-12 subwatersheds are Kiper Creek and Tipton Creek in the South Fork subwatershed; and East Fork Salt Creek, Clay Lick Creek, and Stephens Creek in the North Fork subwatershed.

*Table 1-16 HUC-12 Subwatershed Combined Ranking*

HUC-12 Subwatershed	Level of Degradation	Level of Vulnerability	Sum	Overall Rank
Kiper Creek (SF)	5	16 - High	24	12 - High
Little Salt Creek (SF)	12 - High	3	15	6
Tipton Creek (SF)	16 - High	13 - High	29	16 - High
Negro Creek (SF)	2	1	3	1
Headwaters Middle Fork (MF)	10 - Medium	6	16	9 - Medium
Pleasant Valley Creek (MF)	8 - Medium	11 - Medium	19	11 - Medium
Gravel Creek (MF)	5	7 - Medium	12	4
Sweetwater Creek (NF)	3	5	8	3
East Fork Salt Creek (NF)	15 - High	9 - Medium	24	13 - High
Gnaw Bone Creek (NF)	8 - Medium	10 - Medium	18	10 - Medium
Clay Lick Creek (NF)	13 - High	15 - High	28	15 - High
Brummett Creek (NF)	1	14 - High	15	6
Stephens Creek (NF)	14 - High	12 - High	26	14 - High
Jacobs Creek (LM)	3	2	5	2
Moore Creek (LM)	7 - Medium	8 - Medium	15	6
Allens Creek (LM)	11 - Medium	3	14	5

0-6 Low, 7-11 Medium, 12-16 High

Figure 1-2 Lake Monroe Worst Ranked HUC-12 Subwatersheds

