

## Flint River Embayment Wheeler Reservoir Intensive Basin Survey 2009

Tennessee River Basin

**WHEL-2:** Flint R approx 1 mi upstream of confluence with TN River (Madison Co 34.51073/-86.51411)

### BACKGROUND

The Alabama Department of Environmental Management (ADEM) began monitoring lake water quality statewide in 1985, followed by a second statewide survey in 1989. In 1990, the Reservoir Water Quality Monitoring Program (now known as the Rivers and Reservoirs Monitoring Program (RRMP) was initiated by ADEM.

The current objectives of this program are to provide data that can be used to assess current water quality conditions, identify trends in water quality conditions and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2012 Monitoring Strategy (ADEM 2012).

In 2009, ADEM monitored the Flint River tributary embayment of Wheeler Reservoir as part of the intensive basin assessment of the Tennessee River under the RRMP. This site was selected using historical data and previous assessments. The purpose of this report is to summarize data collected in the Flint River embayment (WHEL-2) during the 2009 growing season (Apr-Oct). This is the second intensive basin assessment of the Tennessee River since ADEM began sampling on a basin rotation. Monthly and/or mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chlorophyll *a* (chl *a*); algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] from 2009 were compared to ADEM's 2003 data and established criteria.

### WATERSHED CHARACTERISTICS

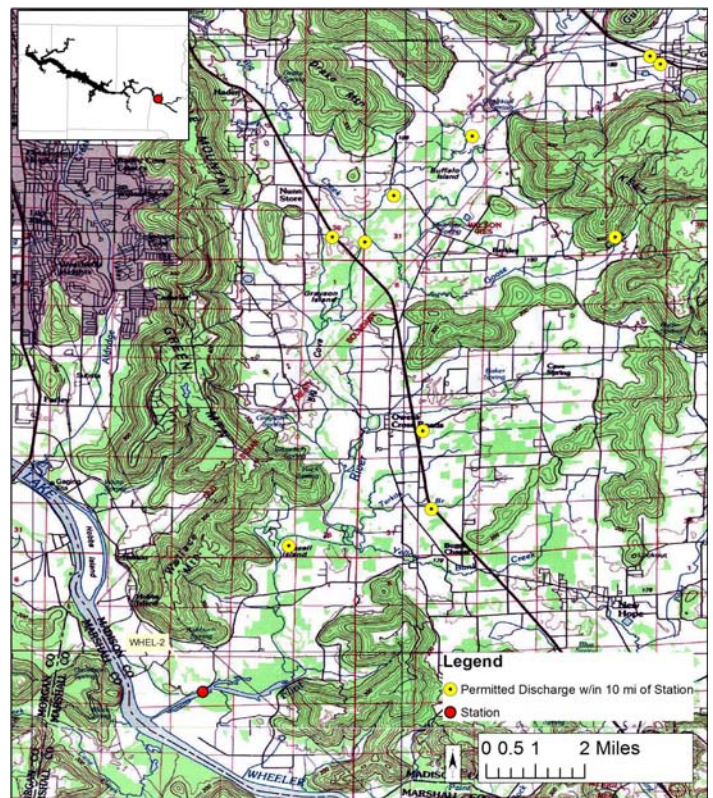
Watershed land uses are summarized in Table 1. Flint River is classified as a *Fish & Wildlife (F&W)* stream located in the Eastern Highland Rim ecoregion (71g). Based on the 2006 National Land Cover Dataset, land use within the 568 mi<sup>2</sup> watershed is predominantly agriculture [hay/pasture (27%) and crops (25%)] (Fig. 3). As of October 1, 2013, ADEM has issued a total of 133 NPDES permits within the watershed. Ten of those permits are located within 10 mi of the station (Fig. 2).

### SITE DESCRIPTION

The Flint R embayment at WHEL-2 is located south of Madison, AL. The upper portion of the watershed also includes parts of Huntsville. The riverine embayment flows into the Tennessee River near river mile 339. Flint R has a mean bottom depth of 4.75 m (Table 2) at the sampling location.



**Figure 1.** Photo of Flint R at WHEL-2



**Figure 2.** Map of Flint R embayment of Wheeler Reservoir. Though additional permits may occur in the watershed (Table 1), only permitted discharges within 10 miles upstream of the station are displayed on the map.

## METHODS

Water quality assessments were conducted at monthly intervals, April-October. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2009), Surface Water Quality Assurance Project Plan (ADEM 2008a), and Quality Management Plan (ADEM 2008b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions. Monthly concentrations of these parameters were graphed with ADEM's previously collected data to help interpret the 2009 results. Carlson's TSI was calculated from the corrected chl *a* concentrations.

## RESULTS

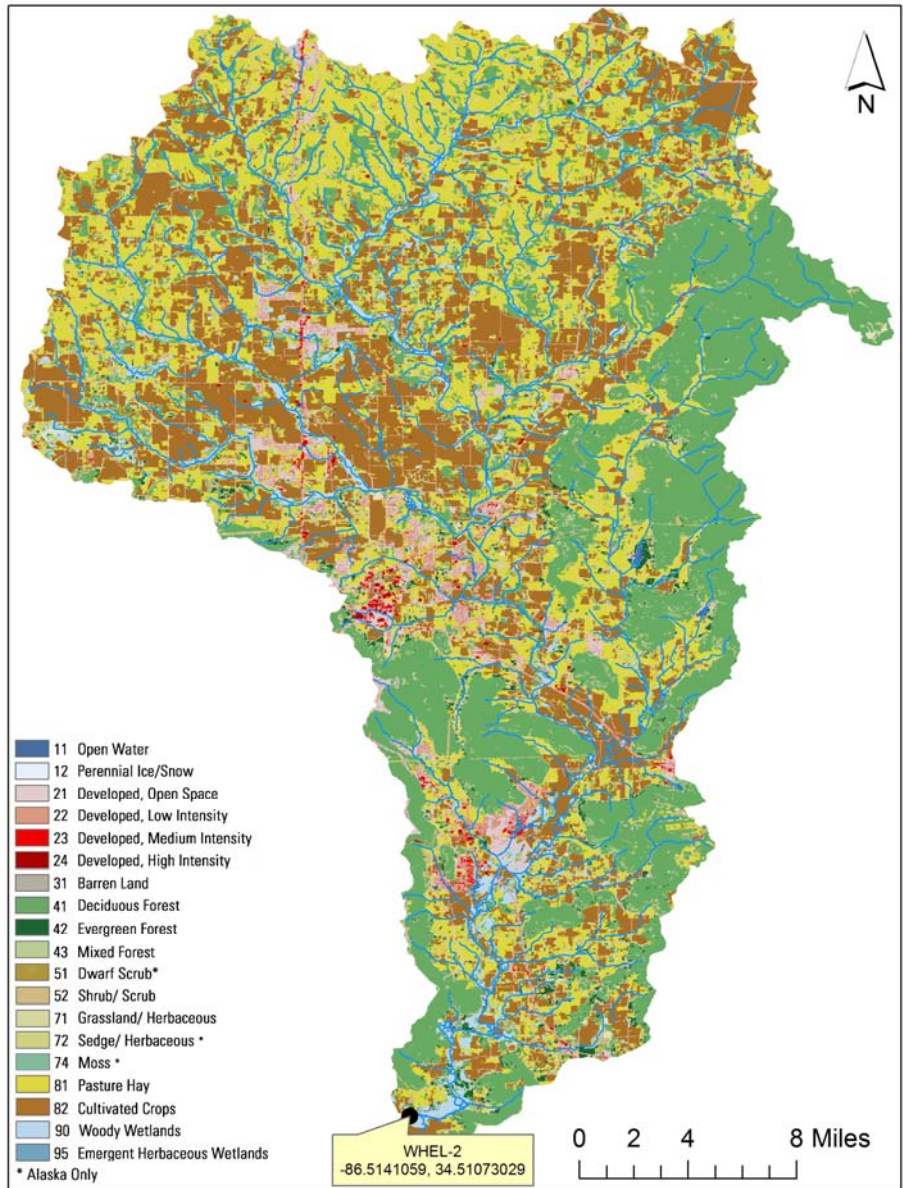
The following discussion of results is limited to those parameters which directly affect trophic status or parameters which have established criteria. Results of all water chemistry analyses are presented in Table 2. The axis ranges of the graphs in Figs. 4-6 were set to maximum values reservoir-wide so all embayment reports on the same reservoir could be compared.

**Table 1: Summary of Watershed WHEL-2**

Basin	Tennessee R
Drainage Area (mi <sup>2</sup> )	568
Ecoregion <sup>a</sup>	71g
% Land use	
Open Water	<1%
Developed	Open Space 6%
	Low Intensity 2%
	Medium Intensity <1%
	High Intensity <1%
Barren Land	<1%
Forest	Deciduous Forest 27%
	Evergreen Forest 1%
	Mixed Forest 2%
	Shrub/Scrub 4%
	Herbaceous 1%
	Hay/Pasture 27%
	Cultivated Crops 25%
Wetlands	Woody 4%
	Emergent Herb. <1%
# NPDES Permits <sup>b</sup> TOTAL 133	
	401 Water Quality Certification 5
	Construction Stormwater 77
	Mining 3
	Industrial General 26
	Industrial Individual 3
	MS4 1
	Municipal Individual 13
	Underground Injection Control 5

a. Eastern Highland Rim

b. # NPDES permits downloaded from ADEM's NPDES Management System database, Oct 1, 2013.



**Figure 3.** Land use within the Flint River watershed at WHEL-2.

The mean growing season TN value was higher in 2009 than in 2003 (Fig. 4). Monthly TN concentrations generally decreased through July and then generally increased, reaching the highest concentration in October.

Contrary to mean TN concentration, the mean growing season TP concentration was lower in 2009 (Fig. 4). Monthly TP concentrations were generally low and peaked in September.

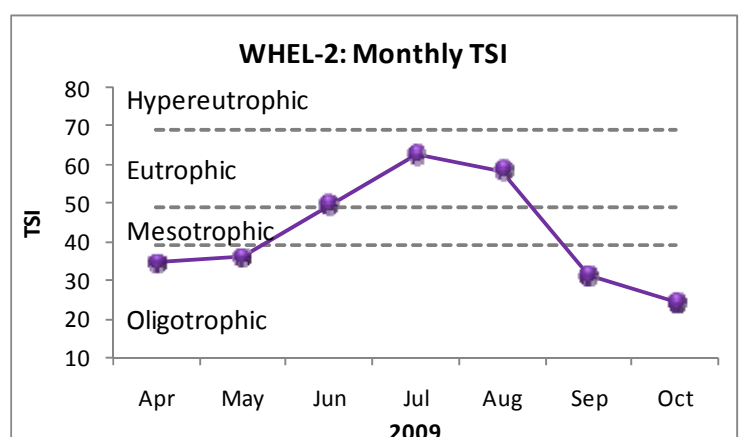
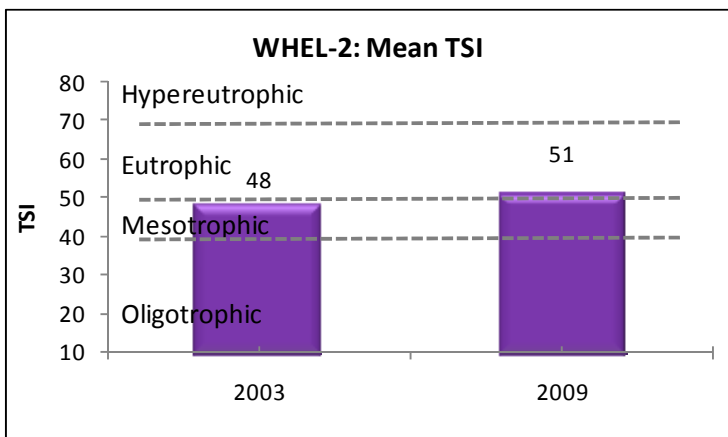
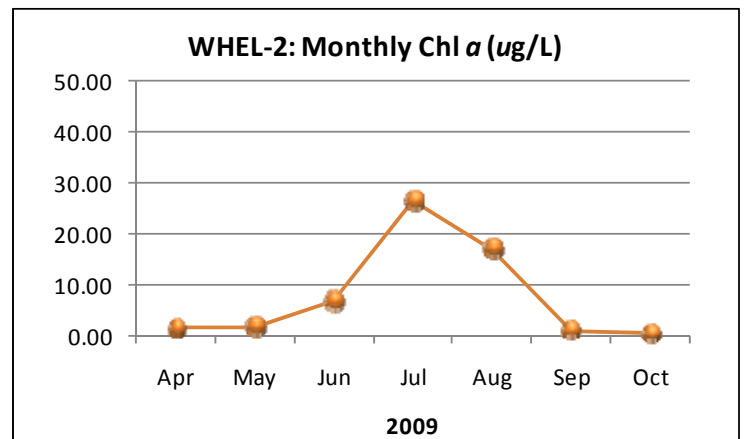
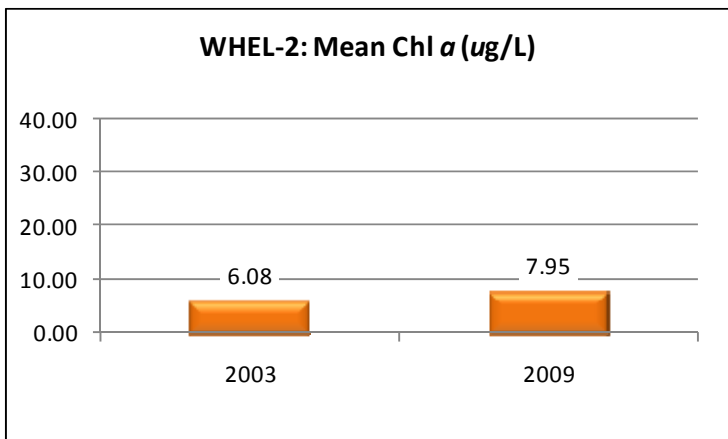
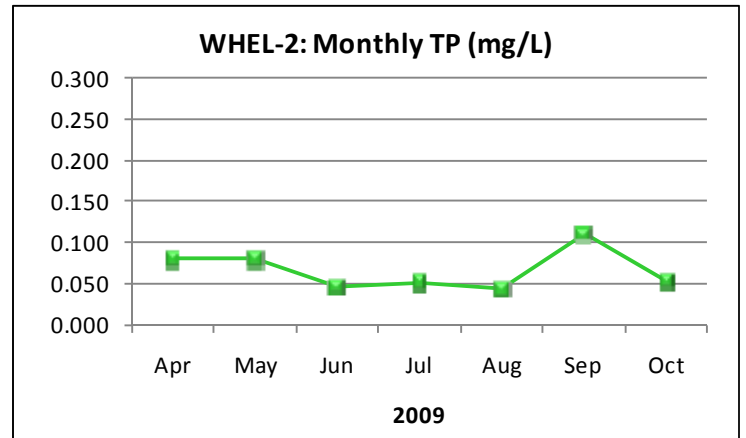
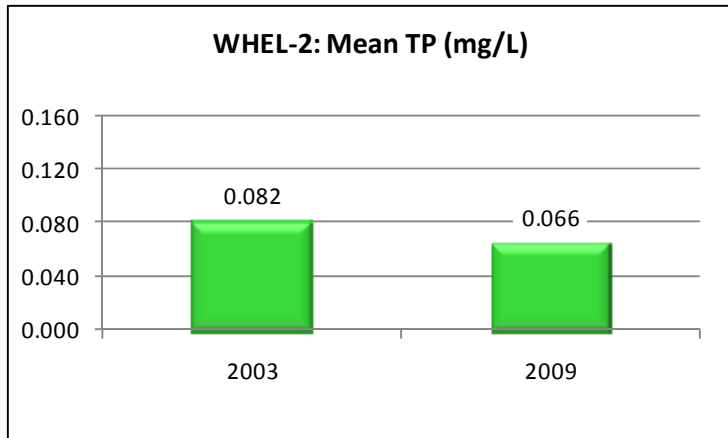
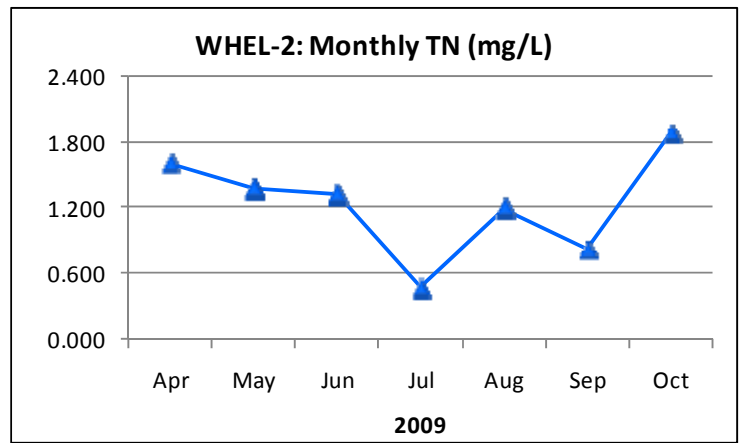
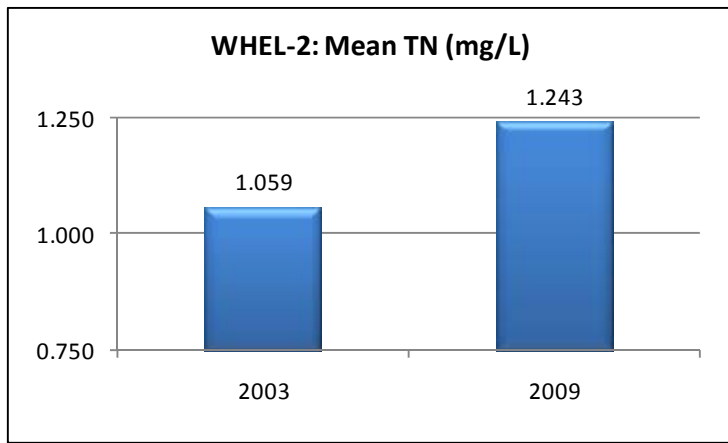
In 2009, the growing season mean chl *a* value was higher than 2003 (Fig. 4). Monthly chl *a* concentrations peaked in July.

Mean TSI was eutrophic in 2009, an increase in trophic status since 2003. Monthly TSI in Flint R was eutrophic Jun-August and oligotrophic the other months (Fig. 4).

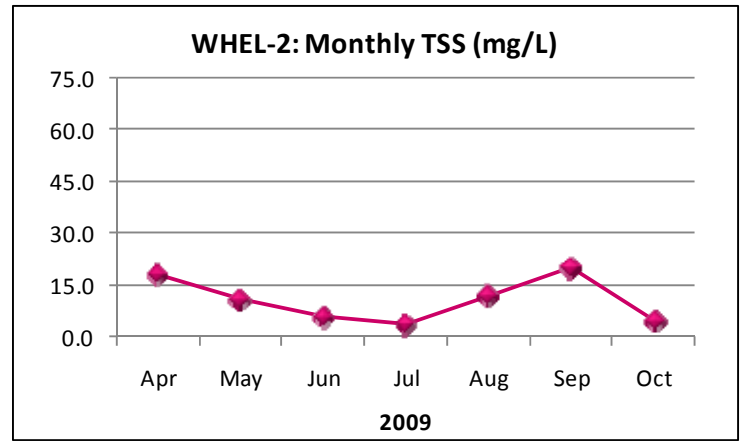
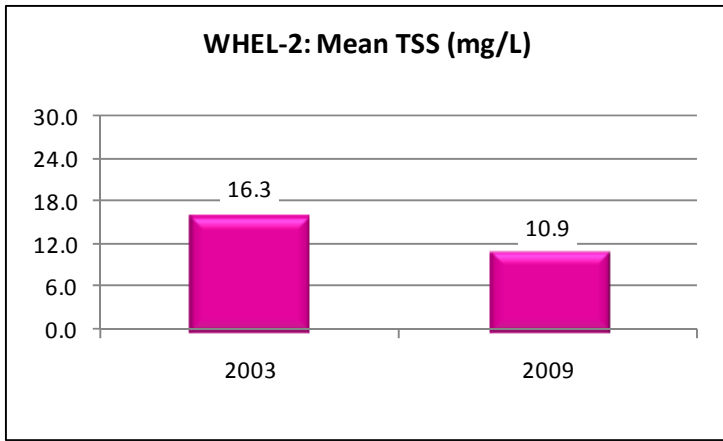
The mean growing season TSS value was lower in 2009 than 2003 (Fig. 5). Monthly TSS concentrations were highest in April and September and low most other months sampled.

AGPT results show that WHEL-2 was phosphorus limited in both 2003 and 2009 (Table 3). Though higher in 2003, the mean maximum standing crop (MSC) value in 2009 was below the 5.0 mg/L value that Raschke and Schultz (1987) defined as protective of reservoir and lake systems.

The DO concentration in the WHEL-2 station was above the ADEM criteria limit of 5.0 mg/l at 5.0 ft (1.5 m) in all months (ADEM Admin. Code R. 335-6-10-.09) (Fig. 6).



**Figure 4.** Mean growing season (2003-2009) and monthly (April-October, 2009) TN, TP, chl a and TSI measured in the Flint River embayment of Wheeler Reservoir. Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



**Figure 5.** Mean growing season and monthly TSS measured in the Flint River embayment of Wheeler Reservoir.

**Table 2.** Summary of water quality data collected April-October, 2009. Minimum (Min) and maximum (Max) values calculated using minimum detection limits. Median (Med), mean, and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

WHEL-2	N	Min	Max	Med	Mean	SD
<b>Physical</b>						
Turbidity (NTU)	7	10.3	33.9	14.0	18.8	9.5
Total Dissolved Solids (mg/L) <sup>J</sup>	7	68.0	140.0	124.0	116.3	23.2
Total Suspended Solids (mg/L)	7	4.0	20.0	11.0	10.9	6.3
Hardness (mg/L)	3	52.1	87.3	76.0	71.8	18.0
Alkalinity (mg/L)	7	47.8	117.0	79.9	81.5	21.3
Photic Zone (m)	7	1.54	3.40	2.52	2.54	0.73
Secchi (m)	7	0.47	1.04	0.77	0.72	0.20
Bottom Depth (m)	7	3.90	5.51	4.96	4.75	0.62
<b>Chemical</b>						
Ammonia Nitrogen (mg/L)	7	< 0.006	0.040	0.007	0.010	0.013
Nitrate+Nitrite Nitrogen (mg/L)	7	0.322	1.385	0.936	0.921	0.342
Total Kjeldahl Nitrogen (mg/L)	7	< 0.089	0.670	0.266	0.322	0.217
Total Nitrogen (mg/L)	7	< 0.482	1.882	1.329	1.243	0.470
Dissolved Reactive Phosphorus (mg/L) <sup>J</sup>	7	0.007	0.066	0.030	0.029	0.020
Total Phosphorus (mg/L)	7	0.043	0.110	0.052	0.066	0.025
CBOD-5 (mg/L)	7	< 2.0	2.7	1.0	1.4	0.7
Chlorides (mg/L)	7	3.1	6.1	4.7	4.4	1.1
<b>Biological</b>						
Chlorophyll a (ug/L)	7	0.53	26.70	1.78	7.95	10.15
Fecal Coliform (col/100 mL) <sup>J</sup>	3	7	160	150	106	86

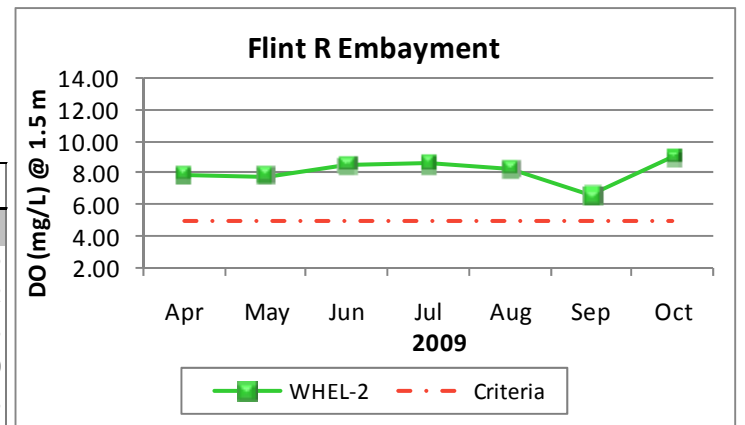
<sup>J</sup>= one or more of the values is an estimate; N= # samples.

**Table 3.** Algal growth potential test results (expressed as mean MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

Year	Mean MSC	Limiting Nutrient
8/19/2003	8.28	PHOSPHORUS
8/18/2009	4.09	PHOSPHORUS

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**Figure 6.** Monthly DO concentrations at 1.5 m (5 ft) for Flint R embayment station of Wheeler Reservoir collected April-October 2009. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth.

## REFERENCES

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