Burnt Mill Creek 2005 Water and Sediment Quality Report

Michael A. Mallin and Virginia L. Johnson
Center for Marine Science
University of North Carolina Wilmington

4.0 Water Quality

Since 1997 the Burnt Mill Creek watershed has been sampled by UNCW just upstream of Ann McCrary Pond on Randall Parkway (BMC-AP1), about 40 m downstream of the pond outfall (BMC-AP3). Ann McCrary Pond is a large (28.8 acres) regional wet detention pond draining 1,785 acres, with an apartment complex at the upper end near BMC-AP1. The pond itself usually maintains a thick growth of submersed aquatic vegetation, particularly *Hydrilla verticillata, Egeria densa, Alternanthera philoxeroides, Ceratophyllum demersum* and *Valliseneria americana*. A survey in late summer 1998 indicated that approximately 70% of the pond area was vegetated. There have been efforts to control this growth, including addition of triploid grass carp as grazers. Our survey also found that this pond is host to *Lilaeopsis carolinensis*, which is a threatened plant species in North Carolina. The ability of this detention pond to reduce suspended sediments and fecal coliform bacteria, and its failure to reduce nutrient concentrations, was detailed in a scientific journal article (Mallin et al. 2002b).

In 2005 sampling began on the inflow (BMC-KA1) and outflow (BMC-KA3) channels of the Kerr Avenue constructed wetland. This new sampling was begun as a part of a larger project (with NCSU funded by the EPA 319 Program) to provide stream restoration to Burnt Mill Creek. Construction of the 0.7 acre Kerr Avenue Wetland was funded by the N.C. Wetlands Restoration Program, now known as the Ecosystem Enhancement Program. Wetland construction was completed in November 2000 and the first aquatic macrophyte planting (sponsored by Cape Fear River Watch) occurred later that month (various rushes, sedge, pickerelweed, lizard's tail, water tupelo, wax myrtle, black gum, pond pine, bald cypress, etc.). Since then there have been many supplemental plantings as well as tree donations. The vegetation coverage is presently so dense that macrophytes from this site have been transplanted into other wetland restoration sites. The wetland has a forebay to collect sediment, and the system is designed to retain and treat the first 0.5 inches of a rainfall event before an overflow channel is utilized. This BMP lies in the headwaters of Burnt Mill Creek, which is on the State 303(d) list for poor biological condition. Another new station is located along the main stem of the creek in Wallace Park (BMC-WP) and an older station is also on the creek at the bridge at Princess Place (BMC-PP - Fig. 4.1).

Kerr Avenue Wetland: This represents the first statistically comparative data useful for assessing the efficacy of this pond as a pollutant removal device. Results of the seven sampling trips showed that turbidity and suspended solids were low both entering and leaving the pond, with no significant difference (Table 4.1). One nutrient parameter, ammonium, was significantly lowered by the pond, while there was no difference in the other nutrient species (which were not in high concentrations entering the pond). BOD5 and BOD20 were not elevated entering the pond and there was no significant difference in concentrations leaving the pond. Fecal coliform bacteria were somewhat elevated entering the pond, and had similar concentrations leaving the pond. The presence of a number of dumpsters surrounding the site, and consequent small

mammal foraging and defecating, may be a localized source of fecal coliform bacteria and organic nutrients.

Ann McCrary Pond: Turbidity and suspended solids concentrations entering and leaving the pond were low to moderate. Fecal coliform concentrations entering Ann McCrary Pond at BMC-AP1 were very high, however (Table 4.1), possibly a result of pet waste runoff from the apartment complex and runoff from urban upstream areas. All seven samples collected in 2005 at BMC-AP1 had counts exceeding 200 CFU/100 mL; however, only one sample at BMC-AP3 exceeded the standard. There were minor algal blooms at BMC-AP1 in June and August, but three major (chlorophyll *a* > 40 μg/L) and two minor (chlorophyll *a* > 20 μg/L) at BMC-AP3, the largest amount of bloom activity we have witnessed since the inception of this project in 1997. The efficiency of Ann McCrary Pond as a pollutant removal device was poor last year. Fecal coliforms were significantly reduced during passage through the pond (Table 4.1). Total suspended solids and turbidity were low entering the pond this year and there was no significant difference in removal of these two parameters. Neither ammonium, nitrate, total nitrogen, orthophosphate nor total phosphorus were significantly reduced during passage through the pond this year (Table 4.1). As in previous years, it is likely that inputs of nutrients have entered the pond from a suburban drainage stream midway down the pond across from our former BMC-AP2 site (Fig. 4.1), short circuiting the ability of the pond to remove nutrients. Also, intensive waterfowl use of the pond, particularly at a tributary near the outfall, may have contributed to nutrient loading in the pond and along its shoreline. There was no significant decrease in conductivity through the pond. Dissolved oxygen significantly increased through the pond, probably because of in-pond photosynthesis and aeration by passage over the final dam at the outfall. There was a significant increase in pH, probably due to utilization of CO_2 during photosynthesis in the pond.

Lower Burnt Mill Creek: Both the Wallace park (BMC-WP) and the Princess Place location (BMC-PP) experienced several water quality problems during the sample period (Appendix B). Dissolved oxygen was substandard (between 2.0 and 5.0 mg/L) three of six times at BMC-WP and four of seven times at BMC-PP. No problems were seen with turbidity or suspended solids. Nutrients were unremarkable at either site except for an unusual maximum of TN (which was mainly organic nitrogen) at BMC-PP in May. No algal blooms exceeded the State standard for chlorophyll *a* at Wallace Park, although an unusually high pulse of chlorophyll *a* (646 μg/L) occurred at Princess Place in May, when the field team reported the waters there to be unusually brown and foamy. This bloom accounted for the unusually high TN levels there (TP levels were also elevated to 0.230 mg/L).

An important issue, from a public health perspective, was the excessive fecal coliform counts, which maintained geometric means (958 CFU/100 mL at BMC-WP and 479 CFU/100 mL at BMC-PP) well in excess of the State standard for human contact waters (200 CFU/100 mL). Fecal coliform counts were greater than 200 CFU/100 mL in five of six months at Wallace Park and five of seven months at Princess Place, respectively. It is notable that fecal coliform bacteria, ammonium, nitrate, TP and orthophosphate concentrations all increased along the passage from BMC-AP3 to the Princess Place location, while dissolved oxygen decreased (Table 4.1). BOD5 and BOD20 analyses were performed at Wallace Park, with no unusually high concentrations reported.

Table 4.1. Mean and (standard deviation) of water quality parameters in upper Burnt Mill Creek, Jan. – Sep. 2005. Fecal coliforms as geometric mean; N/P as median.

Parameter	KA-1	KA-3	BMC-AP1	BMC-AP3
DO (mg/L)	4.1 (1.2)	4.9 (1.3)	7.5 (0.8)	10.1 (1.3)*
Cond. (µS/cm)	333 (20)	358 (32)	259 (62)	242 (20)
pH	6.7 (0.4)	6.8 (0.2)	7.3 (0.4)	7.7 (0.2)*
Turbidity (NTU)	6 (3)	5 (2)	11 (19)	6 (3)
TSS (mg/L)	3.5 (0.5)	3.3 (1.0)	9.1 (15.9)	13.9 (10.2)
Nitrate (mg/L)	0.052 (0.031)	0.054 (0.034)	0.117 (0.108)	0.076 (0.083)
Ammonium (mg/L)	0.177 (0.084)	0.023 (0.008)*	0.051 (0.036)	0.036 (0.017)
TN (mg/L)	0.717 (0.181)	0.533 (0.207)	0.676 (0.191)	0.993 (0.362)
OrthoPhos. (mg/L)	0.006 (0.002)	0.007 (0.003)	0.019 (0.022)	0.007 (0.004)
TP (mg/L)	0.053 (0.026)	0.062 (0.016)	0.061 (0.043)	0.070 (0.046)
N/P molar ratio	110.7	26.6	37.6	35.4
Chlor. *a* (µg/L)	0.7 (0.7)	4.8 (5.5)	8.4 (8.6)	45.4 (40.6)
Fec. col. (/100 mL)	587	436	793	112*
BOD5	1.1 (0.6)	1.2 (0.4)	ND	ND
BOD20	4.3 (1.9)	4.1 (1.1)	ND	ND

* Indicates statistically significant difference between inflow and outflow at $p<0.05$
ND = not done

Table 4.2. Mean and (standard deviation) of water quality parameters in lower Burnt Mill Creek, Jan. – Sep. 2005. Fecal coliforms as geometric mean; N/P as median.

Parameter	BMC-WP	BMC-PP
DO (mg/L)	5.0 (1.2)	5.5 (2.7)
Cond. (µS/cm)	358 (18)	353 (40)
pH	7.0 (0.1)	7.1 (0.2)
Turbidity (NTU)	8 (3)	6 (3)
TSS (mg/L)	6.5 (4.0)	8.9 (9.7)
Nitrate (mg/L)	0.143 (0.091)	0.116 (0.084)
Ammonium (mg/L)	0.108 (0.040)	0.091 (0.055)
TN (mg/L)	0.872 (0.174)	1.697 (2.245)
OrthoPhos. (mg/L)	0.008 (0.003)	0.012 (0.009)
TP (mg/L)	0.067 (0.021)	0.107 (0.059)
N/P molar ratio	51.4	30.5
Chlor. *a* (µg/L)	7.2 (4.4)	98.3 (241.6)
Fec. col. (/100 mL)	958	479
BOD5	1.4 (0.5)	ND
BOD20	5.5 (1.2)	ND

ND = not done

4.1 Sediment Metals and PAH Concentrations

As part of the stream restoration effort funded through NCSU and EPA 319 program, we collected sediment samples on one occasion throughout Burnt Mill Creek for analysis of sediment metals and polycyclic aromatic hydrocarbons (PAHs). The State of North Carolina has no official guidelines for sediment concentrations of metals and organic pollutants in reference to protection of invertebrates, fish and wildlife. However, academic researchers (Long et al. 1995) have produced guidelines (Appendix D) based on extensive field and laboratory testing that are used by the US Environmental Protection Agency in their National Coastal Condition Report II (US EPA 2004).

Table 4.3. Guideline values for sediment metals and organic pollutant concentrations (ppm, or μg/g, dry wt.) potentially harmful to aquatic life (Long et al. 1995; U.S. EPA 2004).

ERL (Effects range low) concentrations below ERL are those in which harmful effects on aquatic communities are rarely observed. ERM (Effects range median) concentrations above ERM are those in which harmful effects would frequently occur. Concentrations between ERL and ERM are those in which harmful effects occasionally occur.

Metal	ERL	ERM
Arsenic (As)	8.2	70.0
Cadmium (Cd)	1.2	9.6
Chromium (Cr)	81.0	370.0
Copper (Cu)	34.0	270.0
Lead (Pb)	46.7	218.0
Mercury (Hg)	0.15	0.71
Nickel (Ni)	20.9	51.6
Silver (Ag)	1.0	3.7
Zinc (Zn)	150.0	410.0
Total PCBs	0.0227	0.1800
Total PAHs	4.02	44.80
Total DDT	0.0016	0.0461

Most of the stations had sediment metals concentrations that were well below levels considered potentially toxic to benthic organisms. An exception was lead, which exceeded the ERL (Table 4.3) at the Wallace Park station BC-WP (Table 4.4). Lead concentrations at KA1 and Princess Place (BC-PP) approached harmful concentrations but did not exceed them. Mercury did not exceed the ERL but concentrations were close to it at BC-PP (Table 4.4). All of the PAH sediment samples exceeded the ERM (Table 4.4).

Table 4.4. Concentrations of sediment metals and polycyclic aromatic hydrocarbons (PAHs) in Burnt Mill Creek, 2005 (as mg/kg = ppm). Concentrations in bold type exceed the level at which harmful effects to benthic organisms may occur, and *italicized* concentrations are near potentially harmful levels (see Table 4.3 for more detail).

Parameter	KA1	KA3	AP1	AP3	WP	PP
Antimony	0.147	<0.077	<0.078	<0.90	<0.08	0.127
Arsenic	<0.125	<0.125	<0.128	<0.127	<0.143	<0.151
Beryllium	0.060	0.026	<0.026	0.026	0.270	0.248
Cadmium	0.172	0.039	<0.026	0.067	0.727	0.471
Chromium	4.740	0.979	0.211	1.450	11.60	6.93
Copper	7.48	7.69	0.834	3.25	20.8	8.73
Lead	*24.20*	4.38	2.08	8.49	**95.60**	*33.90*
Mercury	<0.003	<0.003	<0.003	0.006	*0.134*	0.094
Nickel	3.910	0.701	0.224	1.150	2.830	3.040
Selenium	0.132	<0.127	<0.128	0.133	<0.151	<0.140
Silver	<0.125	<0.127	<0.128	<0.127	<0.143	<0.151
Thallium	<0.026	<0.026	<0.020	0.025	0.063	<0.060
Zinc	48.80	14.00	5.38	20.50	74.20	30.40
Total PAH	**8,873**	**8,847**	**287**	BDL	**2,202**	**115**
TN	3,475	3,281	138	238	2.0	2.3
TP	120.0	74.2	27.0	45.3	474.0	352.0
TOC	79.4	46.5	39.7	99.5	431.0	408.0