

# Water Quality Data Analysis and Review

## Lower Androscoggin River

February 8, 2010

Prepared and Submitted by:  
**Friends of Merrymeeting Bay & Applied Biomonitoring**  
In Accordance with:  
**Public Law 163, LD 330**

### **An Act To Change the Classification of Certain Waters of the State**

**Sec.24. Lower Androscoggin River water quality sampling; report; legislation.** The Department of Environmental Protection, with the assistance of and in consultation with volunteer river monitors, shall establish and implement a water quality sampling program for the lower Androscoggin River from Gulf Island Dam to the line formed by the extension of the Bath-Brunswick boundary across Merrymeeting Bay in a northwesterly direction.

**1. Timing.** The water quality sampling program must occur during the 2009 sampling season.

**2. Purpose.** The purpose of the water quality sampling program implemented under this section is to allow additional water quality data to be collected to determine if the section of the Androscoggin River from Worumbo Dam in Lisbon Falls to the line formed by the extension of the Bath-Brunswick boundary across Merrymeeting Bay in a northwesterly direction meets, or can reasonably be expected to meet, the criteria for reclassification from Class C to Class B...



**Androscoggin River**  
**Water Quality Data Analysis and Review**  
**To Upgrade the Lower Section of River from Class C to Class B**  
**February 8, 2010**

***Introduction***

Clean rivers enhance the local economy and vitality of the communities surrounding them. A clean, healthy river attracts people, new businesses, and increases property value. An upgrade of the Androscoggin will not have an adverse impact on current industrial uses along the river since Class B conditions have been met for years in the course of “business as usual.”

DEP classification proposal submission guidelines state:

***“Maine’s Water Quality Classification System is goal-based. When proposing an upgrade in classification, recommend waters that either presently attain or with reasonable application of improved treatment or Best Management Practices (BMPs), could reasonably be expected to attain, the standards and criteria of a higher proposed class.”***

In accordance with LD 330 Section 24 passed in 2009, additional water quality data were collected on the lower Androscoggin from April-October of 2009 in an effort to better substantiate a classification upgrade proposal for boosting the lower river to Class B from Class C. This Friends of Merrymeeting Bay (FOMB) effort was done in cooperation with DEP partly under the auspices of their Volunteer River Monitoring Program (VRMP).

Intense data gathering and results from 2009 support earlier water quality data gathered in previous years by FOMB on the lower Androscoggin. Excluding heavy precipitation events, data show excellent compliance with Class B standards.

38 M.R.S.A. § 464 (F) (4)

***“When the actual quality of any classified water exceeds the minimum standards of the next highest classification, that higher water quality must be maintained and protected. The board shall recommend to the Legislature that water be reclassified in the next higher classification.”***

While 2009 was one of the wettest summers on record with June and July the wettest months, the National Weather Service also recorded some of the highest temperatures ever for Portland in April and August (and November). USGS daily flow records from their Auburn station show below normal flows for April, May and part of June, higher than mean flows for part of June, July, August and early September and lower than mean flows for the second half of September. Neither lengthy nor expensive flow models nor, awaiting the confluence of low flows and high temperatures, can by law obstruct the timely passage of “goal oriented” upgrades. This method of ratcheting up water quality is fundamental not only to Maine statute but to the Clean Water Act.

Frequent sampling of the lower Androscoggin in 2009 shows water conditions meet Class B standards nearly all of the time. **Analyzed data support and we recommend, an upgrade of water quality classification from Class C to Class B for the lower Androscoggin between Worumbo Dam and Merrymeeting Bay.**

### ***Approach***

Dissolved oxygen (mg/L) and *E. coli* (# colonies/100 ml) water quality data were collected from various locations in the Androscoggin River during 2009. These data, along with collection dates/times, weather conditions, and other notations, were tabularized then analyzed to determine if the waterways meet the criterion to be reclassified as Class B. The criteria for reclassification are:

Dissolved Oxygen:  $\geq 7$ ppm instantaneous reading

*E. coli*: 64 colonies /100 ml geometric mean; 256 colonies/100ml instantaneous reading

The following comparisons were made:

1. *E. coli* methodologies: IDEXX v. Coliscan
2. *E. coli* data v. standard for Class B
  - 2009 data
  - Historical trends (2006 through 2009)
  - Comparison also of all sites
  - Geometric means by station and year for three historical sites
  - Geometric means for all sites, each year, all data and excluding heavy rain events
  - Geometric means by year-all sites combined
3. DO methodologies: Winkler titration v. DO meter data
4. DO data v. standard for Class B
  - 2009 data
  - Historical trends (2003 through 2009)
  - Comparison also of all sites
  - Yearly DO geometric means for combined sites
5. Shore v. mid-stream sample grabs at depth

### ***Results - E. coli***

Two graphs were generated showing the relationship between the IDEXX and Coliscan methodologies. The first compares the values reported by the different methodologies. These are values from all of the sampling sites where the two measurements were made. The first graph shows extreme variability in the paired measurements over time. A correlation was made to determine the level of agreement between the two methods. Results of the analysis, as provided in the second graph, show that the correlation coefficient ( $R^2$ ) is 0.30, suggesting a poor relationship between the two methods. A review of the data showed that the Coliscan data were highly variable, with values ranging from 1 to 6000 colonies/100 ml while the IDEXX data were considerably tighter (ranging from about 5 to 1500 colonies/100 ml; with the majority between 50 and 200 colonies/100 ml). These data suggest that the IDEXX methodology may be more accurate than the Coliscan.

Based on the above analysis, only data collected using IDEXX were evaluated. Eleven (11) sites were sampled during the 2009 season:

Durham Boat Launch (DBL)  
Pejepscot Boat Launch (PBL)  
Fish Park Up [above dam] (FPU)  
Fish Park Down [below dam] (FPD)  
Brunswick Water Works (BWW)  
Brunswick Interstate Ledges (BIL)

Brunswick Canoe Portage (BCP)  
Brunswick Canoe Mooring (BCM) [off BCP]  
Brunswick Water St. Boat Launch (BWS)  
Water St. Mooring (WSM) [off BWS]  
Brunswick Bay Bridge (BBB)

The graphs for these data show the instantaneous values and the geometric mean for the sampling season. The geometric means were calculated both using all data and also excluding data collected within 48 hours of a heavy rain event since the latter are considered a function of combined sewer overflow (CSO) and treated separately from classification. The instantaneous data show excellent compliance with the criterion. Four sites were out of compliance once during the sampling season; one site was out of compliance twice. Most of these events (4) occurred in August in the midst of many days of record heat (Portland Climate Data for the Year 2009, National Weather Service, Gray, Maine). None of the geometric means, either those calculated using all data or only the non-rain event data, were out of compliance. The following table summarizes the number of non-compliance events and the sampling dates for the different sites over the 2009 sampling period:

	<b>2009 <i>E. coli</i> non-compliance events</b>	
	<b><i>Instantaneous</i></b>	<b><i>Geometric mean</i></b>
Durham Boat Launch (DBL)	None	None
Pejepscot Boat Launch (PBL)	None	None
Fish Park Up [above dam] (FPU)	None	None
Fish Park Down [below dam] (FPD)	None	None
Brunswick Water Works (BWW)	None	None
Brunswick Interstate Ledges (BIL)	None	None
Brunswick Canoe Portage (BCP)	1; 8/23/09	None
Brunswick Canoe Mooring (BCM) [off BCP]	1; 8/23/09	None
Brunswick Water St. Boat Launch (BWS)	2; 5/17/09 8/23/09	None
Water St. Mooring (WSM) [off BWS]	1; 8/23/09	None
Brunswick Bay Bridge (BBB)	1; 7/27/09	None

A complete listing of the *E. coli* data collected for these sites during 2009 are provided.

Historical data were available for three sites to evaluate trends over time: Pejepscot Boat Landing, Brunswick Water Street Boat Launch, and Brunswick Bay Bridge. Four types of graph were prepared for these data: the instantaneous data for each site (one site per page), instantaneous data for all sites graphed together, the geometric means for each site over times (all sites on one page), and a summary graph showing the geometric mean by year. The means were calculated using all available data for the year. These graphs show that the majority of the instantaneous data are in compliance, with minor exceptions occurring in 2006 and 2009. None of the geometric means by station and year are out of compliance. Similarly, all of the geometric means (for both all data, and no rain event data) determined for the years 2006 through 2009 are in compliance with both the Class C and Class B criteria.

### ***Results - Dissolved Oxygen***

A comparison of the Winkler titration and DO meter shows very good correlation between the two methodologies. The paired data were graphed and a regression analysis performed. Results of the analysis yield an  $R^2$  value of 0.78. Based on these results both the Winkler and DO meter

data were evaluated. Ten (10) sites were sampled during the 2009 season; no DO measurements were taken at the Brunswick Water Works site.

Durham Boat Launch (DBL)	Brunswick Canoe Portage (BCP)
Pejepscot Boat Launch (PBL)	Brunswick Canoe Mooring (BCM) [off BCP]
Fish Park Up [above dam] (FPU)	Brunswick Water St. Boat Launch (BWS)
Fish Park Down [below dam] (FPD)	Water St. Mooring (WSM) [off BWS]
Brunswick Interstate Ledges (BIL)	Brunswick Bay Bridge (BBB)

The graphs for these data show the instantaneous values for the sampling season. The instantaneous data show excellent compliance with the criterion. Only two measurements were out of compliance: Durham Boat Launch and Brunswick Canoe Mooring, both on 8/23/09 during a period of record breaking heat. The following table summarizes the number of non-compliance events and the sampling dates for the different sites over the 2009 sampling period:

	<b>2009 DO non-compliance events</b>
Durham Boat Launch (DBL)	1; 8/23/09 (6.6ppm)
Pejepscot Boat Launch (PBL)	None
Fish Park Up [above dam] (FPU)	None
Fish Park Down [below dam] (FPD)	None
Brunswick Interstate Ledges (BIL)	None
Brunswick Canoe Portage (BCP)	None
Brunswick Canoe Mooring (BCM) [off BCP]	1; 8/23/09 (6.6ppm)
Brunswick Water St. Boat Launch (BWS)	None
Water St. Mooring (WSM) [off BWS]	None
Brunswick Bay Bridge (BBB)	None

A complete listing of the DO data collected for these sites during 2009 are provided.

Historical data were available for three sites to evaluate trends over time: Durham Boat Launch, Pejepscot Boat Launch, and Pleasant Point. Note 2009 Pleasant Point data were collected after the recommended time of 0800 hrs. and are, therefore, not included in most of our 2009 analyses. [Note: Pleasant Pt., Brunswick Bay Bridge and Brunswick Water St. and Mooring sites are all in tidewater. These sites may not be nearly so affected by diurnal DO fluctuations as sites above Brunswick/Topsham dam may be. At these shallow tidal sites, DO may be reduced more by higher temperatures warming the water during a daytime low tide than by the more typical nighttime sag.] Pleasant Pt. data are provided because this site has already been upgraded to a Class B waterway and they make a good comparison to the sites under evaluation. These graphs show that nearly all of the instantaneous data for each of the sites are in compliance. The exceptions occur at Durham Boat Launch, with three non-compliance events occurring in 2003, and one in fall of 2009. A comparison of the DBL and PBL to a current Class B waterway shows that since 2003 dissolved oxygen concentrations in these three waterways have been consistently similar. The graph comparing averages for all data by year shows that since 2003, the lower Androscoggin River has been in compliance with both Class C and Class B criteria.

### ***Shore v. Mid-stream Sampling***

Mid-stream sampling on a large river adds more time, logistical problems and hazards to a river monitoring program whether sampling from a bridge or a boat. Past FOMB sampling efforts have all been from shore. In 2009 in response to the DEP new VRMP protocols two mooring sites were added off of shore sites. Paired shore and mid-stream sampling were conducted at these two sites during the 2009 sampling season:

Brunswick Canoe Portage (shore) and Brunswick Canoe Mooring (mid-stream)  
Brunswick Water St. Boat Launch (shore) and Water St. Mooring (mid-stream)

Regression analysis of the paired data show excellent correlations between the shore and mid-stream sampling locations:

	<b>E. Coli</b>	<b>DO</b>
BWS vs WSM	9 pairs of data $R^2 = 0.98$	5 pairs of data $R^2 = 0.90$
BCP vs BCM	4 pairs of data $R^2 = 0.92$	2 pairs of data $R^2 = 1.0$

The DO regression for BCP vs BCM must be reviewed with caution because only two pairs of data were available, which always results in an  $R^2$  of 1.0. However, looking at the actual values (7.7 vs 7.6; 9.2 vs 9.2) shows there is excellent correlation between the two monitoring locations. Previous work by FOMB using Acoustic Doppler Current Profilers and salinity meters in a multi-year circulation study of Merrymeeting Bay (Circulation Patterns of Merrymeeting Bay and its Tidal Tributaries, 2009. [www.friendsofmerrymeetingbay.org](http://www.friendsofmerrymeetingbay.org) ) indicated thorough mixing of the water column with no evidence of stratification. Since BWS and WSM are tidewater sites, that there is no significant difference in monitoring results comes as no surprise. These results suggest it is not necessary to collect data at both the shore and mid-stream locations for water quality measurements when shore collection is sufficient.

Similarly, a review of the instantaneous data for both *E. coli* and DO suggest that bi-weekly or even monthly monitoring may not be necessary, particularly if samples are collected more than 48 hours after a heavy rain event. A monthly or every-other month approach may be more appropriate, allowing consistent coverage of multiple sites by volunteers without causing the burnout felt by all participants maintaining the intense 2009 schedule.

### ***Sampling Protocols***

In 2009 and all past sampling years FOMB volunteers have trained annually in cooperation with Friends of Casco Bay (FOCB) utilizing DO training and sampling protocols from the FOCB EPA Quality Assurance Program Plan (QAPP). In 2009 FOMB Androscoggin volunteers also participated in and qualified under the DEP Volunteer River Monitoring Program (VRMP) trainings. Working with the DEP, a Sampling and Analyses Plan (SAP) was developed for FOMB. Under the VRMP, FOMB also followed most VRMP SAP Quality Assurance/Quality

Control (QA/QC) protocols for all sampling and for lab procedures in analyses of bacteria samples.

Three sample sites were considered approved by DEP who wanted sampling done in mid-stream, typically either from a bridge or boat. Two of the four bridges in this lower Androscoggin sector occurred immediately below dams and were liable to yield unusually high oxygenated water. Of the other two bridges, one was over very fast moving turbulent water (also likely to be higher in DO) and the fourth was quite high and prone to high-speed traffic possibly endangering volunteers. FOMB chose instead to set two buoyed moorings (BCM and WSM) in more typical mid-stream locations, to which a sampler could tie their boat. A third approved site was at the end of a jetty (BBB) extending towards mid-stream. Other sites were from shore and samplers used poles to extend DO meters further from shore, also a standard operating procedure in areas where wading is not an option.

Standard QA/QC procedures included regular replicate sampling by all monitors, lab splits and lab blanks. Early, mid and end of season split bacteria sample analyses were conducted with Brunswick Wastewater Treatment Plant. Splits showed no significant differences.

### ***Recommendations***

1. Despite better correlation in other programs, Coliscan sample results did not correlate well here with the EPA certified IDEXX E coli tests. **We recommend switching methods to IDEXX although costs are approximately double.**
2. DO sampling method results are quite similar. **While use of a DO meter will be very useful for covering many sites in a short time, the continued use of Winkler Titration is recommended as the program mainstay.** DO meters also have the ability to read Specific Conductivity, but are very costly and can be prone to technical problems. DO meters are typically calibrated by the Winkler Titration method.
3. Mid-stream and shore sampling results are quite similar. The lower Androscoggin is well mixed. Shore sampling is much quicker and safer for volunteers. **In the interests of speed and safety we recommend using only shore sampling since results are not affected.**
4. Distribution of sampling sites provided excellent and improved coverage of the study area. Excluding the two mooring sites there are two sites in tidewater above Merrymeeting Bay at Pleasant Point. There are three sites in the impoundment between the Brunswick-Topsham and Pejepscot dams and two sites in the short impoundment between Pejepscot and Worumbo dams. Durham Boat Launch remains the lower most site between Worumbo and Lewiston Falls. FOMB has one more DO monitor in the Lewiston area (Auburn Boat Launch-2009 DO values ranged from 7.6 in September to 11.6 in October averaging 9.6 overall) and the Androscoggin River Association is sampling at several sites in that area for DO and bacteria. **We recommend continued monitoring of DO and *E. coli* at DBL, PBL, FPU, FPD, BIL, BCP, BWS and BBB.**
5. Sampling bi-weekly does not seem to provide necessary meaningful data and strains the volunteer monitoring network. **Our recommendation is to drop back to the original monthly sampling schedule (plus unusual rain or drought events) while maintaining the increased number of stations noted in # 4.**
6. October data from 2008 and 2009 (not included here) give some indication that termination of chlorination by treatment plants at the end of September could adversely

affect bacteria levels in October. **Considering these data combined with increased late season recreational use of the cleaner river and increased air temperatures, we recommend extending wastewater chlorination procedures through October.**

7. Data show rain events to be largely responsible for breaches of classification standards. **We recommend the accelerated use of Best Management Practices and system upgrades to properly deal with the adverse affects of CSOs.**
8. Intense data gathering and results from 2009 support earlier water quality data gathered in previous years by FOMB on the lower Androscoggin. Excluding heavy precipitation events, data show excellent compliance with Class B standards. There are only occasional samples not meeting Class B criteria and these could indicate unusual anthropogenic sources (i.e. mechanical failure or spill) or as was the case in 2009, record high temperatures. As we noted to the Board on 10/2/08:

“The water quality of the Androscoggin sections proposed for an upgrade, exceed the current classification and meet those of Class B. This request to upgrade from C to B is supported by the State antidegradation policy as quoted below:

38 M.R.S.A. § 464 (F) (4)

*“When the actual quality of any classified water exceeds the minimum standards of the next highest classification, that higher water quality must be maintained and protected. The board **shall recommend** to the Legislature that water be reclassified in the next higher classification.”*

Clean rivers enhance the local economy and vitality of the communities surrounding them. A clean, healthy river attracts people, new businesses, and increases property value. An upgrade of the Androscoggin will not have an adverse impact on current industrial uses along the river since Class B conditions have been met for years in the course of “business as usual.” While higher discharge limits exist for a number of licensees, these artificially high numbers can not be used... to create a ceiling on water quality improvements that prevents reclassification to higher levels already obtained.

In the Department’s own submission guidelines they state:

**“Maine’s Water Quality Classification System is goal-based. When proposing an upgrade in classification, recommend waters that either presently attain or with reasonable application of improved treatment or Best Management Practices (BMPs), could reasonably be expected to attain, the standards and criteria of a higher proposed class.”**

Intense sampling of the lower Androscoggin in 2009 shows water conditions meet Class B standards nearly all of the time. Analyzed data support an upgrade. **We recommend an upgrade of water quality classification from Class C to Class B for the lower Androscoggin between Worumbo Dam and Merrymeeting Bay.**

### ***Acknowledgements***

This work could not have been done without the assistance of many. Thanks to volunteer monitors and laboratory analysts: Sarah Cowperthwaite, Ed Friedman, Misty Gorski, Lin

Hutchins, Ruth Innes, Kathleen McGee, Nancy Murphy, Diane and Douglas Richmond, and Kermit Smyth.

Thanks also to John Lichter and the Bowdoin College Environmental Studies department for lab space, Frank McVey, Jennifer Nicholson, and Greg Thulen of the Brunswick Sewer District (wastewater treatment plant) for cooperating on QA/QC, property owner Josh Francis for access at BIL, Chet Gillis and Steve Pelletier for mooring placement, Marine Warden Dan Devereaux for BCM access, Sandra Salazar of Applied Biomonitoring for analyses and reporting, Peter Milholland and Friends of Casco Bay for recurrent training, Jeff Varricchione, Mary Ellen Dennis, Lisa Vickers and Michele Windsor of the DEP for VRMP training and QAPP (or SAP-Sampling & Analysis Plan) preparation, Dave Jefferson at IDEXX and finally, Bath Savings Institution for funding our IDEXX Colilert system.

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***Appendices:***

1. Legislation –LD330 Section 24
2. Location Map-Lower Androscoggin River (with sample sites)
3. Location Map-Google Earth aerial
4. USGS 2009 Androscoggin Flows-Auburn
5. USGS 2009 Kennebec Flows-North Sidney
6. Portland weather data-National Weather Service
7. DEP/FOMB Sampling Analysis Plan (available in H2O quality section of FOMB web Cybary)