BEFORE THE MAINE BOARD OF ENVIRONMENTAL PROTECTION

Verso (formerly International Paper	)	ANDROSCOGGIN RIVER
Company), Jay,	)	APPEALS
ME0001937 and W000623–5N–F–R	)	
____________________________________	)	

DIRECT TESTIMONY OF DEBORAH FRENCH MCCAY

(Note: All of Dr. French McCay's testimony is applicable to both the general discussion on the TMDL and to the specific appeal of the Verso permit)

My name is Deborah French McCay. I am a Principal at Applied Science Associates, Inc. I have been asked by the Natural Resources Council of Maine ("NRCM") to provide testimony on the importance of dissolved oxygen to the recovery of cold water fisheries in the Androscoggin River and to testify that actual reductions in total suspended solids ("TSS"), biochemical oxygen demand ("BOD") and phosphorus are needed for the Androscoggin's ecosystem to recover. Without these reductions, sediment oxygen demand ("SOD") levels will not drop. The construction of an additional oxygen injector will only mask the river's problems, not solve them.

EXECUTIVE SUMMARY

In order for the water quality in the Androscoggin River and Gulf Island Pond to improve, pollution levels from the pulp and paper mills on the river must be significantly, consistently, and permanently reduced. This is particularly true for Verso's pulp and paper mill in Jay, Maine (the "Jay mill"), which, according to data from the Maine Department of Environmental Protection ("DEP"), contributes substantially more pollution to the river than the Rumford Paper Company mill (the "Rumford mill"). Indeed, assuming that the Rumford mill does not increase its pollution discharges (which have improved in recent years and are significantly below the limits contained in their permits), the water quality in the Androscoggin River and Gulf Island Pond would be improved markedly if Verso's permit limits were reduced to realistically achievable limits.

I recommend that the total limits on combined pollution from the two mills be no more than 10,000 per day for TSS and 4,000 pounds per day for BOD. I will show the evidence supporting these numbers in my testimony, and Neil McCubbin, a world-renowned expert in pulp and paper mill technology, has assured NRCM that these numbers are attainable if the Jay mill improves its performance to that of other comparable mill, such as the Rumford mill, which is already there or nearly there.

The computer model used by the DEP, which would allow much higher levels of pollution than those above, is flawed, as I discuss in detail in my testimony. The model seriously underestimates the contributions of TSS and BOD from the mills to SOD in Gulf Island Pond.[1] Therefore, the model also erroneously concludes that even if TSS and BOD from the mills are significantly reduced, SOD will continue to cause violations of Class C minimum dissolved oxygen standards in Gulf Island Pond. The DEP therefore actually recommends allowing *increased* pollution loads from the mills and making up for it with a new oxygen bubbler. Use of instream bubblers of the type the DEP proposes is unusual and is a mistake. It will only mask the problems in the river (and may not even do that successfully), not solve them.

I do not believe the DEP's conclusion based on its flawed TMDL model that SOD will remain at high levels even if the mill TSS and BOD pollution going into the river is reduced. If the mills reduce their pollution significantly, at least to the levels I have

[1] SOD is simply organic matter in the bottom sediments that bacteria consume, and as they do this they use oxygen in the water, just as we breathe oxygen to get energy from food we eat. Through this process SOD, is contributing to violations of the Class C minimum dissolved oxygen standard in the deeper parts of Gulf Island Pond.

recommended as a starting point, I believe that SOD levels will decrease and water quality and dissolved oxygen levels will improve.

BACKGROUND AND EXPERIENCE

I received my Ph.D in Biological Oceanography, at the Graduate School of Oceanography, University of Rhode Island, in 1984. Since then, I have been employed by Applied Science Associates, Inc. ("ASA"), where my work is focused on evaluating impacts of pollutants in aquatic environments. Much of my work involves development and application of mathematical models of pollutant transport and biological effects on aquatic organisms.

One area of my expertise is in evaluating oil and chemical releases. I was principal investigator and project manager for the Natural Resource Damage Assessment Model for Coastal and Marine Environments ("NRDAM/CME") and the Natural Resource Damage Assessment Model for Great Lakes Environments ("NRDAM/GLE"). These models are used in "Type A" assessments of damages due to spills of toxic substances under regulations imposed by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA") and of oils under regulations imposed by the Oil Pollution Act of 1990 ("OPA"). Through my work, I developed physical fates and biological effects model components of the NRDAM/CME, NRDAM/GLE, and ASA's derivative models, the Spill Impact Model Application Package (SIMAP) for oil spills and the analogous CHEMical Model Application Package (CHEMMAP) for chemical spills, which estimate pollutant–induced losses in productivity, fisheries yield and wildlife.

I also evaluate impacts of development and pollutant releases on aquatic habitats, fish and invertebrates, and ecosystems. I have performed many assessments of potential environmental impacts of development, dredging, air emissions (ultimately contaminating surface waters), water intakes, and thermal and other discharges into aquatic environments containing organic wastes and pollutants. A copy of my current professional *curriculum vitae* is attached as NRCM Exhibit 1.

THE ANDROSCOGGIN RIVER IN GULF ISLAND POND DOES NOT MEET DISSOLVED OXYGEN STANDARDS

Based on actual data, not modeling, the DEP has determined that the Androscoggin River in Gulf Island Pond does not meet dissolved oxygen standards. It is my understanding that the Androscoggin, a Class C river, is required by Maine law (38 M.R.S. § 465) to meet a minimum level of dissolved oxygen of 5.0 ppm or 60% saturation, whichever is higher. In addition, the river must meet a 30–day average standard of 6.5 degrees whenever the river is at 22 degrees Celsius or less. The DEP has not yet provided any data on whether this standard has been attained in Gulf Island Pond, so I will not be referring to it in this testimony.

According to a January 23, 2007, letter from the current DEP Commissioner, David Littell, attached as NRCM Exhibit 2, Gulf Island Pond violated the required minimum level of dissolved oxygen on at least 37 days during 2005 at the Deep Hole Site and 13 days at the Dam Site monitoring station. According to the DEP technical staff, 31 days of these violations were due to dissolved oxygen levels dropping below 5 ppm, and 6 days of violations occurred when the dissolved oxygen level was above 5 ppm but below 60% saturation. An e–mail from Carl Marsano of the DEP is attached as NRCM Exhibit 3.

In the summer of 2006, although the DEP has not yet completed its data analysis, industry data show that violations continue to occur. A spreadsheet and report containing data on the dissolved oxygen and temperature profiles in Gulf Island Pond, submitted by Acheron Engineering, Environmental & Geologic Consultants, is attached as NRCM Exhibit 4. Dissolved oxygen levels obtained in weekly sampling events dropped below the required 5 ppm on a number of days. Data from the DEP's continuous monitoring, which samples dissolved oxygen every day and through all hours of the day, were not available at the time of drafting this testimony.

DISSOLVED OXYGEN VIOLATIONS AND THE HARM TO COLD WATER FISH

According to the DEP, the dissolved oxygen violations in Gulf Island Pond occur in a four–mile stretch of the river in the deeper segments of the pond. A copy of the 2005 Total Maximum Daily Load ("TMDL") for the Androscoggin River is attached as NRCM Exhibit 5. *See* NRCM 5 at 1. Why do we care about dissolved oxygen in deep parts of Gulf Island Pond? In the summer when it is hot, cold water fish such as trout and land–locked salmon need to go into deeper waters to find the cool temperatures they need to survive. When dissolved oxygen levels are low in the deeper waters, they cannot do this. Thus, there are very few trout in the Androscoggin below the Jay and Rumford mills (collectively, the "mills"). Above these mills, there is a thriving trout fishery. *See Angling on the Androscoggin,* MaineToday.com (Oct. 24, 2001), attached as NRCM Exhibit 6. *See* Map of the Androscoggin River, attached as NRCM Exhibit 7. Although there is a good small mouth bass fishery in the lower Androscoggin below the mills, these fish are far more tolerant of pollution, low–dissolved oxygen, and warm water. It is my understanding that Maine law (38 M.R.S. § 465) requires Class C waterbodies, such as the Androscoggin River to support cold water species, such as trout and landlocked salmon.

"SOD" IS A SIGNIFICANT CONTRIBUTOR TO LOW DISSOLVED OXYGEN CONDITIONS

The DEP states that the largest contributor to the non–attainment of dissolved oxygen standards is SOD. A copy of the 2002 Modeling Report ("Modeling Report") is attached as NRCM Exhibit 8. *See* NRCM 8 at 3. SOD is simply organic matter in the bottom sediments that lowers oxygen levels in the water because bacteria consume the organic matter and respire as they do, just as we breathe oxygen to derive energy from the food we eat. Although I do not believe the DEP's model is accurate enough to estimate the amount of SOD's contribution to dissolved oxygen violations with the precision that it claims, the fact that dissolved oxygen deficits occur so frequently in the deeper waters of the pond, and magnitude of the estimated SOD oxygen uptake rates, suggest that SOD is a significant problem.

THE DEP'S CONCLUSION THAT SOD LEVELS WOULD NOT IMPROVE IF POLLUTION FROM THE MILLS WERE SIGNIFICANTLY REDUCED IS SERIOUSLY FLAWED

However, it is highly unlikely that SOD will remain at the high levels that the DEP's model predicts if pollution from the mills is significantly reduced, and I believe pollution *must* be significantly reduced from the mills in order for the SOD levels to drop and the river to recover from decades of abuse. The DEP's conclusion that even if point sources were significantly reduced or eliminated, SOD will not improve significantly and non–attainment will continue is highly questionable. In general, the model on which that conclusion is based is an over–simplification of an extremely complex system and seriously flawed. The model underestimates the amount that SOD would be reduced if point source discharges are lowered. I discuss the specific flaws in the model in more detail below.

The TMDL model includes equations that describe physical, chemical and biological processes in the water of the river and at the interface between the water and the bottom sediments. Figure 7a of the Modeling Report, attached as NRCM Exhibit 9, shows the design of the model as a schematic. The model contains equations that describe the growth and death of algae (phytoplankton) and consequent uptake and release of oxygen, the uptake and release of nutrients (nitrogen and phosphorus compounds) by algae, the transformation of organic forms of nutrients to inorganic forms ("remineralization") by bacteria, and the rate of reaeration of dissolved oxygen in the water column from the atmosphere. The loadings of nutrients (including inorganic phosphorus (ortho–phosphorus, PO_4) and organic phosphorus, which are limiting to the growth of algae in the river), Carbonaceous Biochemical Oxygen Demand ("CBOD"), which is a measurement of the amount of dissolved oxygen that would be consumed by all organic materials in a point source discharge after they decay in the water, and TSS (which also includes organic material that consumes dissolved oxygen) are inputs to the model. The model includes assumed rates of oxygen use by CBOD and TSS based on rates observed in other aquatic systems and rough calculations for the Androscoggin River system. All the rates vary with temperature, because growth of algae and bacteria is faster at higher temperature. The temperature corrections are also based on observations in other systems.

The first major limitation of the model is that it does not explicitly resolve (i.e., include equations describing) the complex chemical and biological processes occurring in interaction with the sediments. The rates of movement of algae, nutrients and dissolved oxygen (called "flux") to and from the sediments are assumed inputs to the model. Thus, the model uses assumed settling rates for each of algae, inorganic phosphorus (ortho–phosphorus, PO_4), organic phosphorus, inorganic nitrogen (as ammonia), and organic nitrogen, all of which are highly variable with environmental conditions, over time, and dependant on the pollutant loadings; and so highly uncertain. Second, inorganic phosphorus and nitrogen are normally dissolved compounds, and so do not actually "settle." However, in order to make the inorganic phosphorus levels in the model fit data on actual levels of inorganic phosphorus in the river water, the modeler needed to assume a "settling rate," hypothesizing that this inorganic phosphorus was first absorbed by particulates in the water, and so could settle, or that algae on the bottom were taking up this phosphorus. *See* Modeling Report at 39. There are many unsubstantiated assumptions of this sort used in the model application to Gulf Island Pond.

The most important flux with respect to dissolved oxygen concentrations is the SOD. This is treated as a rate of dissolved oxygen uptake by the sediments (e.g., grams per square meter per day), simulating the processes in the sediments whereby bacteria break down organic matter and consume oxygen. The SOD rate is modified by water temperature to simulate the rate of higher bacterial activity at higher temperature. In the equation for calculating dissolved oxygen concentration in the river water, the SOD term is much larger than the other terms, so the model results are extremely sensitive to the assumed SOD rate.

The SOD rate is a model input assumption, rather than a variable that changes with loads of pollution to the river, which would be necessary to have a model capable of accurately predicting dissolved oxygen levels in the water. SOD actually represents the use of dissolved oxygen by decay of organic matter accumulated on the sediments over some period of time. If the model actually included equations for the supply and decay of organic matter on the bottom, as opposed to assuming a fixed rate (SOD), it would be forced to account for the mass balance of materials, i.e., it would not be able to consume more oxygen than the actual supply rate of the organic matter to the sediments and the ability of bacteria on the bottom to consume that organic matter. If the supply rate of organic matter to the sediments increased, a sediment model would increase the use of DO, up to a limit where some of the material would be buried instead of oxidized. On the other hand, if the supply of SOD decreased over time, as it would if loadings of CBOD, TSS and/or phosphorus decreased, the consumption rate of DO on the sediments would decrease in response. In other words, the TMDL model as is stands does not have feedback in the SOD term. Thus, it cannot be predictive of conditions other than those to which the model was fit by calibration.

<u>The model is not predictive of conditions with different pollutant loading rates.</u>

While the TMDL model generally fits the August 2000 data, in light of the major differences in conditions in the river between the summer of 2000 and that of 2004 when more data were collected, *see* TMDL at 4, as well as the need to recalibrate the model to fit data from 1984[2], *see* Modeling Report at 23, the August 2000 data is not representative of dissolved oxygen concentrations in every year. Significantly more measurements than are presently available would be required for developing model inputs and calibrating a model predictive of years other than 2000, where the model was

[2] The fact that the model need to be recalibrated for 1984 data should have been a red flag that there were serious problems with the model calibration and that its usefulness was limited.

fitted. In any model application, inputs that are significantly above or below the ranges used in the model calibration produce highly uncertain model results. Consequently, considerable caution should be used when applying the model to predict results from inputs significantly higher or lower than the calibration ranges. The TMDL model is tenuous for prediction of other summers even with similar amounts of pollution, and certainly not reliable for predicting conditions when significantly different amounts of pollution are used as model inputs. Unfortunately, this is exactly what the DEP has tried to do with this model, using it to try to predict dissolved oxygen levels in the river from pollution amounts much greater than the conditions under which the model was calibrated to zero pollution discharge, much less pollution than the conditions under which the model was calibrated.

<u>SOD sources and causes of low dissolved oxygen conditions</u>

In applying the TMDL model first developed in the early 1980s to other loading conditions, such as removal of all point sources, the SOD rate was held constant regardless of change in the assumed loadings. Because of this assumption and since the majority of the dissolved oxygen uptake is by SOD, it was erroneously concluded that the high SOD use of dissolved oxygen in the "zero point source discharges" model was historically–accumulated SOD.

This error was recognized in the 2002 modeling report, and an attempt was made to vary the SOD by loading rate for predictions of conditions other than the current ones for which the model was calibrated. However, that analysis is incomplete for the reasons previously discussed: the model does not completely account for the decrease in SOD that would result from decreased loadings because it does not include feedback balancing.

An analysis made by the DEP modeler indicated that the current SOD (based on very limited data) was in balance with loadings, as 85% of the observed SOD could be accounted for by pollutant loads (what accounted for the remaining 15% of the SOD was called "unknown," and assumed to be from natural loadings and the presence of the Gulf Island Dam). The modeler estimated that about 65% of the SOD could be accounted for by settling of algae. *See* Modeling Report at 42. The modeler further estimated that point sources are responsible for 90% of the phosphorus (the paper mills accounting for 77%) entering Gulf Island Pond. *See* Modeling Report at 80. Thus, one infers that since algal growth is limited by phosphorus, 50% (0.77 x 65%) of the SOD is due to algae produced by the total phosphorus input by paper mill point sources.

However, the SOD accounted for by point source loadings of total phosphorous from the mills (50% of the SOD by my calculations based on the modeler's data) is a minimal estimate of the total effects of the mill loadings on SOD. Additional loads of CBOD (the DEP estimated 83% from the paper mills) and TSS (the DEP estimated 35% from the paper mills) are going directly to the sediments. *See* Modeling Report at 80. As these additional loads from the mills consume oxygen both in the water and when they reach the sediments, and it is likely that much of the mill waste as CBOD and TSS settles to the sediments before completely decaying, I believe that the portion of the SOD actually resulting from point source loads from the paper mills certainly greatly exceeds 50%. It is simply common sense that if the loadings are significantly decreased, both consumption of oxygen in the water column and SOD will decrease, and oxygen conditions in the river will improve.

POLLUTANT LOADINGS IN THE RIVER MUST DECREASE TO IMPROVE DISSOLVED OXYGEN CONDITIONS

One might be tempted to conclude that because the mills claim they have reduced pollution and because the dissolved oxygen problems in Gulf Island Pond have not gone away over so many years, that the DEP's assertion that SOD will never go away even if the mills reduced their discharges to zero is correct. After all, the mills claim they have greatly reduced their pollution loads to the river. Even a quick examination of TSS and BOD loads from the mills reveal that this is not the case, however. Figures charting the BOD and TSS loads for the Jay mill and the Rumford mill combined are attached as NRCM Exhibits 10 and 11. There is no consistent downward trend in pollution from the mills. It is my belief that until there are real reductions that are sustained over a long period of time, the dissolved oxygen problems in the river will not improve. There must be significant reductions for the problems in the river to get better, reductions at least to below the lowest levels under which real world data show that non–attainment occurs in Gulf Island Pond (below about 10,000 pounds of TSS and about 4,000 pounds of BOD combined for the two mills).

Since there are clearly problems at these levels of loading, it makes absolutely no sense to allow significantly more than this to be discharged to Gulf Island Pond, which would be allowed by the permit limits proposed in the TMDL. The DEP's license limits for Rumford and Jay would allow a monthly average discharge of 30,690 pounds per day of TSS on an annual basis, 15,730 lbs per day of BOD in the summer months, and 32,100 pounds of BOD per day for the rest of the year. If the DEP's proposed modification for the Jay mill's permit were adopted, then the mills could discharge 12,830 pounds per day of BOD in summer and 22,400 pounds per day of BOD for the rest of the year. Allowable TSS levels would not change. How can one expect the Androscoggin river to get cleaner and water quality to improve with such high permit limits, so much higher than what has been shown to cause non–attainment with the 5 ppm standard in the past?

When one views the pollutant loads of TSS and BOD from the two mills separately, one can clearly see that the Jay mill is the by far the larger polluter of the two mills, particularly in terms of TSS. See NRCM Exhibits 12 and 13. Therefore, the Jay mill clearly is the bigger problem.

THE LOWER ANDROSCOGGIN RIVER COUD SUPPORT COLD WATER SPECIES OF FISH IF POLLUTANT LOADS WERE REDUCED

There is no reason why the lower Androscoggin River should not have better dissolved oxygen levels and support strong populations of cold water species of fish, such as trout and landlocked salmon, except for the heavy pollutant loads. Clearly, the river above the mills supports strong trout fisheries, as do other similar rivers. Wyman Lake, which is a large deep impoundment on the Kennebec of similar dimensions to Gulf Island Pond, has good dissolved oxygen levels in the impoundment above the dam all the way down to a depth of more than 120 feet (*See* dissolved oxygen data on Wyman Lake, attached as NRCM Exhibit 14) and supports a good fishery for trout species according to Barry Mower of Maine DEP.

Thus, the presence of a dam and impoundment does not cause low dissolved oxygen problems *per se*, and these problems do not exist in similar Maine river impoundments to Gulf Island Pond that do not receive as heavy pollution loads as the Androscoggin. These nearby healthy river systems are real–world models for the ability of the lower Androscoggin to be restored to (at least) Class C standards, and the ability to support salmon and trout populations, if pollutant loads are lowered.

THE MAJOR SOURCE OF POLLUTION IS FROM POINT SOURCE LOADINGS FROM THE MILLS

The mills may try to blame other sources of pollution and causes for the problems in Gulf Island Pond and the Androscoggin River, but this is extremely unlikely to be the case. Actual data on loading from the DEP's 2002 Modeling Report show that discharges of TSS and BOD loads from all of the sewage treatment plants combined on the Androscoggin river number in the hundreds of pounds per day, *see* Modeling Report, at Table 9, as compared to thousands of pounds per day as is the case with the mills. Thus, other point sources are simply not significant players. Non–point sources are also unlikely to be significant on a river as large as the Androscoggin that has so much of its watershed undeveloped. In my professional experience, pollution problems on large, mostly undeveloped rivers like the Androscoggin are driven by point sources. I believe that is clearly the case here.

USE OF OXYGENATION SYSTEMS TO REOXYGENATE THE WATER DOES NOT SOLVE THE PROBLEM AND ONLY COVERS IT UP LOCALLY

The instream oxygen diffuser (Gulf Island Pond Oxygenation Project, GIPOP) installed in 1992 did not result in improvement in SOD levels. *See* Modeling Report at 42. As an indication, the SOD rate measured in 1998 was 50% higher than that measured in the early 1980s. Thus, the oxygen diffuser likely balanced the use of dissolved oxygen by additional pollutant loads, but the conditions of the system, in terms of dissolved oxygen conditions and algal growth, have not improved, nor will they be expected to improve. If pollutant loads are allowed to increase, and are mitigated by an additional oxygen diffuser, the problem will only be further masked locally and no improvement of conditions in the river will occur. The river will still not be able to meet Class C criteria and support cold water species of fish.

The existing and proposed oxygen diffusers are simply band aids that artificially raise oxygen levels in spite of pollution. The water is and will remain dirty and filled with excess waste that has other bad characteristics in addition to its ability to deplete oxygen. Pulp and paper mill waste has a strong and unpleasant odor and is widely recognized as an endocrine disruptor in fish. An article on the effects of kraft mill effluents on the sexuality of fishes is attached as NRCM Exhibit 15. Oxygenation will do nothing to reduce these other impacts of pulp and paper mill pollution, which is another reason to require pollution reductions rather than simply requiring construction of an additional aerator or bubbler. If the additional diffuser is used as mitigation, the pollution from the mills will continue to settle in Gulf Island Pond at rates that will not allow the SOD levels to improve, because the organic matter in bottom sediments will not degrade quickly enough before it is replaced with still more organic matter. For these reasons, increased oxygenation as called for in the DEP's TMDL is not an environmentally sound alternative to significant pollution reduction.

CONCLUSION

The Androscoggin River's dissolved oxygen problems are driven primarily by pulp and paper mill pollution, and only through significant pollution reductions will water quality be improved. Low dissolved oxygen levels and violations of the 5 ppm/60% saturation standard in Gulf Island Pond are overwhelmingly caused by TSS, BOD, and phosphorus from the mills. Again, BOD is organic waste in the water that is consumed by bacteria. Aquatic bacteria respire oxygen as they consume the waste, just as we respire oxygen to get energy from food we eat. This lowers oxygen levels in the water. TSS from pulp and paper mills is also largely organic matter that bacteria consume. Phosphorus pollution from the mills lowers dissolved oxygen because it increases algal levels in the water, causing blooms. When algae die off, the organic material in them is consumed by bacteria, which again results in removal of oxygen from the water. Indeed the DEP concluded, based on its modeling, that algal blooms would be eliminated through reduction in the point–source discharges of phosphorus to the pond. The DEP also stated that "reduction of carbonaceous BOD, TSS, and phosphorus, is needed to improve dissolved oxygen levels to attainment of class C criteria" (TMDL at 1).

In conclusion, I believe the DEP's TMDL is fundamentally flawed. All of the real–world data that I have reviewed, the analyses performed by the DEP, and all of my professional experience suggests that the Androscoggin River's dissolved oxygen problems are driven mostly by pulp and paper mill pollution. Because the Jay mill is a far worse environmental performer than the Rumford mill, the Natural Resources Council of Maine has focused its efforts on cleaning up the Jay mill's pollution. The Board should set strict limits on TSS and BOD from this mill that will actually result in reduced pollution to the river. Only through actual pollution reductions will the river be able to recover from decades of abuse.