# Mousam River TMDL
# Town of Sanford
# Final Report
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Paul Mitnik, P.E.
Bureau of Land and Water Quality
Division of Environmental Assessment
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## Executive Summary


1. The Mousam River in Sanford is a non-attainment segment in Maine’s section 303d (Clean Water Act) list.   A 3.7-mile segment in Sanford fails to meet criteria for dissolved oxygen and certain toxic substances.

2. As required in the Clean Water Act, a Total Maximum Daily Load (TMDL) was developed for BOD, phosphorus, ammonia nitrogen, and seven toxic substances by MDEP.  Water quality data was collected in two sampling events in the summer of 1999. The data was used to calibrate and verify a water quality model.

3. Both the water quality data and the water quality model confirm that this 3.7-mile segment of the Mousam River in Sanford fails to meet minimum class C dissolved oxygen criteria (5 ppm and 60% of saturation).  Values as low as 3.9 ppm were measured in the July data when Sanford was discharging 10% to 20% of their licensed permitted waste load.  The model predicts dissolved oxygen as low as 1.5 ppm could potentially occur if Sanford was discharging its full permitted waste load.

4. The major impact to this 3.7-mile river segment by pollution categories is from nutrients (respiration of bottom-attached algae) and nitrogenous BOD (ammonia), which are responsible for about ½ and ¼ of the total dissolved oxygen depletion, respectively. The major impact to this river segment by sources is Sanford, which the model predicts is responsible for about $^{2}/_{3}$ of total dissolved oxygen depletion at full licensed load.  Non-point source pollution does not appear to be a significant contributor to dissolved oxygen depletion in the TMDL segment.

5. Low dissolved oxygen in the Mousam River above Sanford’s discharge is probably due partially to natural sources and also nutrient rich runoff from the urban areas of Sanford and Springvale.  Data collected in the summer of 2000, that compared the Mousam background to other neighboring rivers (Great Works, Littlefield), appeared to indicate that the Mousam is comparative or better.

6. Sanford’s preferred alternative of constructing a 15-mile outfall to the ocean which would relocated their discharge point 3000 feet off shore from Kennebunk beach does not appear to be feasible due to legal and political issues.

7. The possibility of relocating Sanford’s outfall to another portion of the Mousam River below Estes Lake also does not appear to be feasible due to two factors. (1) Data collected in the lower Mousam in the summer of 2000 reveals that the river is currently not meeting class B dissolved oxygen criteria.   (2) The lower Mousam River is nearly entirely impounded and offers a low assimilative capacity for organic wastes.

8. A number of options were investigated that allows Sanford to keep its outfall in its current location and still maintain water quality standards. The following actions are recommended.

1. Implement stormwater best management practices on urban Sanford and Springvale.
2. Reduce non-point mass discharges of lead by 24% and arsenic by 64% through #1.
3. To facilitate compliance with stringent license requirements and address growth and possible future treatment plant expansions, Sanford should consider investigating additional holding capacity and / or partial land application of effluent.
4. The Sanford WWTP should be licensed as follows:

## Sanford S. D. Waste Discharge License Effluent Limits

### Summer

| Flow 3.48 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppm) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | Daily Max. | Mo.Ave. | Weekly Ave | Daily Max. | | |
| BOD5 | 261 | 392 | 522 | 10 | 15 | 20 | 5/1 to 9/30 | 3 / week |
| NH3-N | | 14.5 | | | | | 5/15 to 9/30 | 3 / week |
| Total Phos. | 3 | | | | | | 5/1 to 9/30 | 3 / week |
| TSS | 290 | 435 | 580 | 10 | 15 | 20 | 5/1 to 9/30 | 3 / week |
| Dissolved Oxygen | | Maintain at > 7.5 ppm | | | | | 5/1 to 9/30 | Daily |

### NonSummer

| Flow 4.4 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppm) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | Daily Max. | Mo.Ave. | Weekly Ave | Daily Max. | | |
| BOD5 | 1101 | 1651 | 1835 | 30 | 45 | 50 | 10/1 to 4/30 | 3 / week |
| NH3-N | 276 | | | 11.3 | | | 10/1 to 5/14 | 3 / week |
| Total Phos. | 23 | | 46 | | | | 10/1 to 4/30 | 1 / week |
| TSS | 1101 | 1651 | 1835 | 30 | 45 | 50 | 10/1 to 4/30 | 3 / week |

### Toxic Substances

| Flow 4.4 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppb) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | | Mo.Ave. | Weekly Ave | Daily Max. | | |
| Arsenic | 0.02 | | | 0.8 | | | All Year | 1 / week |
| Silver | | | 0.036 | | | 1.5 | All Year | 1 / week |
| Selenium | 0.72 | | | 29 | | | All Year | 1 / week |
| Copper | 0.34 | | 0.47 | 14 | | 19 | All Year | 1 / week |
| Lead | 0.015 | | | 0.6 | | | All Year | 1 / week |
| Zinc | 3.74 | | | 153 | | | All Year | 1 / week |
| Aluminum | 9.39 | | | 384 | | | All Year | 1 / week |

## High Flow Tier Limits

In order to facilate emptying of wastewater lagoons which increases their summer storage capacity, SSD is allowed to discharge the following limits from Feb 15 to April 15, whenever flow as measured at Route 4 > 100 cfs.

| **Flow 8.8 mgd** | Mass Limits (lb/day) | | | Concentration Limits (ppb) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | Daily Max. | Mo.Ave. | Weekly Ave | Daily Max. | | |
| BOD5 | 2202 | 3303 | 3670 | 30 | 45 | 50 | 2/15 to 4/15 | 3 / week |
| NH3-N | 612 | | | 12.5 | | | 2/15 to 4/15 | 1 / week |
| Total Phos. | 23 | | 46 | | | | 2/15 to 4/15 | 1 / week |
| TSS | 2202 | 3303 | 3670 | 30 | 45 | 50 | 2/15 to 4/15 | 3 / week |
| Arsenic | 0.04 | | | 0.8 | | | 2/15 to 4/15 | 1 / week |
| Silver | | | 0.07 | | | 1.5 | 2/15 to 4/15 | 1 / week |
| Selenium | 1.45 | | | 30 | | | 2/15 to 4/15 | 1 / week |
| Copper | 0.68 | | 0.95 | 14 | | 19 | 2/15 to 4/15 | 1 / week |
| Lead | 0.03 | | | 0.6 | | | 2/15 to 4/15 | 1 / week |
| Zinc | 7.49 | | | 153 | | | 2/15 to 4/15 | 1 / week |
| Aluminum | 18.77 | | | 384 | | | 2/15 to 4/15 | 1 / week |

**License Conditions**

1. Sanford is required to cease discharge whenever river flow as measured at Route 4 < 20 cfs
2. Install permanent staff gage at Route 4
3. The gage at Route 4 should be calibrated yearly by USGS or a qualified hydrologist
4. River flow should be reported daily year round.

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6/29 12

7/13 13

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8/2, 8/10, 8/17, 9/7 14


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# TMDL Summary – Submittal Template

### Description of Waterbody, Pollutants of Concern, Pollutant Sources and Priority Ranking

- The segment of interest is a 3.7 mile segment of the Mousam River located in Sanford, Maine. The TMDL listing is for segment WBS#628R. For a more detailed description, refer to the Modeling Report Introduction (page 1).
- The pollutants of concern are BOD, ammonia, phosphorus, and seven toxic substances (arsenic, silver, copper, lead, selenium, aluminum, and zinc).
- The Sanford Sanitary District is the major source of most of the pollutants, except natural sources account for most of the river arsenic and non-point sources account for most of the river lead. Sanford's effluent is lowly diluted and at maximum design flow accounts for 21% to 25% of the river flow.
- The priority ranking of the TMDL was medium with a completion date scheduled for 2003 to 2008. The schedule was hastened due to Sanford's request to get updated water quality information on the Mousam River, that will inform them of the necessary treatment requirements needed in the plant upgrade.

### Description of the Applicable Water Quality Standards and Numeric Water Quality Target

- Dissolved Oxygen – Class C criteria require a daily minimum dissolved oxygen of 5 ppm and 60% of saturation and a monthly average dissolved oxygen of 6.5 ppm.
- Ammonia – The summer TMDL for ammonia is limited by dissolved oxygen depletion as nitrogenous BOD. The non-summer TMDL is limited by toxic concerns and EPA's toxic AWQC apply (see table 6, page 25 of Modeling Report).
- Toxic Substances - The TMDL's for the seven other toxic substances are based upon EPA's AWQC (see table 7, page 27 of Modeling Report).

### Loading Capacity – Linking Water Quality and Pollutant Sources

The scientific basis for developing the TMDL includes the collection of data and development of a water quality model to predict the acceptable pollutant loadings that will still allow for attainment of all water quality criteria. This analysis is discussed in detail in the Modeling Report.

### Load Allocations and Waste Load Allocations

The allowable waste load allocations and load allocations are summarized in tabular form for all pollutants of concern (see Modeling Report tables 6a to 6c on page 25 and table 7 on page 27). LA reductions of 24% and 64%, respectively are needed to meet the TMDL's for lead and arsenic, respectively. WLA reductions of 40% and up to 90% are needed for summer TMDL's for phosphorus and ammonia, respectively. In addition the TMDL requires an earlier date (15 to 30 days) for initializing the more stringent summer treatment requirements for Sanford and requires a higher trigger flow (20 rather than 10 cfs) for initiating a zero discharge requirement for the Sanford S D.

**Margin of Safety**
The TMDL requires Sanford to cease discharge at river flows under 20 cfs. A margin of safety is provided for most pollutants under a river flow of 20 cfs. The water quality model predicts a minimum dissolved oxygen of 5.8 ppm should occur which exceeds the minimum requirement of 5 ppm. Hence a margin of safety is provided for BOD, ammonia, and total phosphorus. In addition, a margin of safety is provided for selenium, copper, zinc, aluminum, and silver at flows under 20 cfs, since the ambient levels will be well under the WQC.

An explicit margin of safety of 10% of Sanford's allocation is provided for summer BOD, non-summer ammonia. In addition, a large margin of safety that varies from 30% to 50% is provided for most pollutant parameters under the higher tier discharge condition, since a quintupling of the river trigger discharge flow only results in a doubling of allowable effluent flow.

In addition concentration limits are proposed as licensed conditions for BOD. Since the treatment plant is typically well under their design flow in the summer, this should result in some additional buffer.

**Seasonal Variation**
Seasonal variations have been considered in the TMDL due to separate TMDL's that were established for the summer and non-summer. The dissolved oxygen non-attainment is limited to the summer period and hence the TMDL for phosphorus and BOD are limited to the summer. The ammonia TMDL in the summer is based upon nitrogenous BOD depletion that affects attainment of dissolved oxygen criteria and the non-summer due to toxic concerns.

In addition, the late winter and early spring period (Feb 15 to April 15) was set for releasing more effluent to the river to prepare the treatment system for the storage capacity that will be needed to meet the cease discharge requirements. This time period ordinarily has river conditions of very high flows and very low temperatures, which are best suited to accommodate more effluent.

**Monitoring Plan for Phased TMDL (NOT APPLICABLE)**
A monitoring plan is not required, since the TMDL is not phased. MDEP plans to sample the river again after the TMDL is implemented. A sampling plan can be developed then.

**Implementation Plan**
The WLA reductions will be implemented through NPDES permitting. Recommended license limits can be found in table 8 of the report (page 28).

**Reasonable Assurances**
LA reductions are needed for lead and arsenic. Sanford is being required to meet the AWQC and natural levels of lead and arsenic, respectively at end of pipe. These are stringent requirements and lower levels are probably not achievable. The LA reductions

being required for lead and arsenic will be accomplished through stormwater NPDES permitting and remediation being undertaken at the town landfill.

**Public Participation**

The availability of the TMDL for public comment was advertised in the legal notices section of two newspapers in southern Maine. The TMDL has also been available in electronic form on the web in DEP's homepage. In addition, DEP has had many meetings with the Sanford Sanitary District personnel and their consultant (Wright Pierce Engineers) throughout the development and public comment period of the TMDL. MDEP's responses to public comment for the draft TMDL is contained in the appendix to the modeling report.

# Modeling Report and Analysis
## Introduction

The Mousam River originates at Mousam Lake in Shapleigh and Acton, Maine. It flows through York County, the southern most county in Maine, for its entire length of 23 miles. Its mouth is in tidal waters in Kennebunk. Two segments of the Mousam River are listed on Maine's section 303d (Clean Water Act) non-attainment list, one of which is in Sanford and the other in tidal waters in Kennebunk. This report discusses the Total Maximum Daily Load (TMDL) needed for the river segment in Sanford, which is directly above Estes Lake. Since Estes Lake serves as a rather large boundary to absorb pollutants, water quality problems at Sanford do not affect water quality at Kennebunk.

The section 303d lists phosphorus and toxics as pollutants for which the TMDL should address. BOD and ammonia are also included in this assessment. The section of river considered originates in Sanford at the Route 4 bridge and ends at Estes Lake covering a distance of 3.7 miles. The town of Sanford discharges to this segment. Sanford is a tertiary treated plant that has advanced treatment for BOD and phosphorus. The current phosphorus requirements are related to controlling algae blooms in Estes Lake rather limiting algae in the TMDL river segment. BOD limits were derived using a desk-top modeling analysis in the early 1980's. Little data has been historically collected on the river and it has not been known whether or not current treatment requirements are stringent enough to meet water quality requirements here. There has historically also been a problem with Sanford's compliance with numerical ambient water quality criteria for some toxic substances, of which ammonia has been the most frequent non-compliance problem.

The treatment plant has requirements in their waste discharge license to cease discharge whenever the river flow at Sanford is less than 10 cfs. Historically, the river flow has rarely been under 10 cfs. This flow effectively becomes the regulatory 7Q10 flow when considering point source water quality impacts. Even at 10 cfs the dilution of river water to effluent at Sanford's summer licensed flow (3.5 mgd) is only 2.8:1. It can be deduced that with so little dilution, compliance with water quality criteria will be difficult. The river classification is class C here, requiring minimum dissolved oxygen levels of 5 ppm and 60% of saturation at all times and monthly average dissolved oxygen to exceed 6.5 ppm at all times.

The town of Sanford is considering upgrade options to firstly comply with waste discharge license requirements and secondly comply with all other statutory water quality requirements. The modeling discussed in this report will investigate options to assist the town of Sanford in its decision making process.

## Summary of 1999 Water Quality Data

Two water quality intensive surveys each of three consecutive days were undertaken by MDEP in the summer of 1999 with assistance from the Sanford Sanitary District personnel and USEPA. The surveys involved collecting water quality data at 11 river locations for dissolved oxygen and temperature twice per day (early AM and mid-afternoon) and phosphorus (total and ortho-), nitrogen (kjeldhal, ammonia, and nitrite plus nitrate), algae as chlorophyll a, and ultimate BOD. Flow was gaged at two locations and the Sanford Sanitary District effluent was measured for the same parameters. The first survey was undertaken July 6-8 and the second August 25-27. Flow conditions for the summer of 1999 were generally low throughout the state, but flow here generally did not fall under 15 to 18 cfs. Cross sectional data was collected at sixteen locations during low flow conditions on various days. There was generally coverage at two or three different flow conditions.

The July data had some non-attainment of class C minimum dissolved oxygen criteria (5 ppm) at two locations below the Sanford discharge, where values as low as 3.9 ppm were recorded and one location above Sanford's discharge where a 4.8 ppm was recorded. The August data had no violations of the 5 ppm but marginally met the minimum 60% criteria with levels of 61% recorded at two locations below Sanford's discharge and one location above Sanford's discharge. The river temperatures for the July data set were typically around 3 $^{o}$C warmer than the August data set, which partially explains the lower observed dissolved oxygen readings in the July data.

During both surveys Sanford was typically discharging 10% to 20% of their allowable permitted BOD and phosphorus load. Sanford's discharge did slightly increase ambient BOD and phosphorus levels, but both BOD and phosphorus levels in the river below their outfall were not particularly high. It is obvious that this segment of river has very limited assimilative capacity.

The overall quality of the data is considered excellent. The only problem encountered was that the August data set had varying river flows over any given day, due to dam maintenance activities upstream of the study reach. This diminished the quality of the August data, since steady state flows are ordinarily desired. As a result, the July data will be used for model calibration and relied upon more heavily, and the August data for model verification.

To address possible toxic water quality concerns, the Sanford Sanitary District personnel collected background water samples at three river locations and effluent testing for eight different toxic substances (silver, arsenic, selenium, copper, lead, zinc, aluminum, and ammonia). Clean sampling techniques were utilized and the data was collected at 15 independent sampling dates (including the intensive survey dates) from 2/2/99 to 4/5/00 so that seasonality of the data could be covered. The quality of this data is also considered excellent, and may be the most comprehensive sampling effort undertaken by a licensee that is registered in the toxics program. The toxics data revealed attainment of all numeric criteria in the Mousam River above Sanford's outfall except arsenic and lead.

For a detailed description of all the data, one should consult the Mousam River (Sanford) Data Report (DEPLW1999-28, Dec 1999).

## Water Quality Model

The USEPA supported model QUAL2EU was used in the analysis of the Mousam River. QUAL2EU is a comprehensive and versatile water quality model that can simulate up to 15 water quality constituents. Its application is limited to well-mixed water bodies whose transport and chemical properties can only vary longitudinally along the main direction of flow. Hydraulically QUAL2EU is limited to steady state simulations or time periods during which stream flow, boundary conditions, and input loads must remain constant with time. The various sources and sinks of dissolved oxygen are represented in the water column as nitrogen and phosphorus cycles, algal photosynthesis and respiration, nitrogenous and carbonaceous BOD decay, and atmospheric reaeration. In addition the sediment impacts such as oxygen demand and nutrient fluxes can be simulated.

The initial step in the developing of a model is breaking the segment of interest into a series of reaches. The water within a given reach must have similar chemical and physical properties and a change in these properties result in the formation of another reach. This resulted in the formation of 18 reaches for the 3.7 mile segment of the Mousam River in Sanford (figure 1). The model begins at the Route 4 bridge and terminates at the entrance to Estes Lake.

There are two components of the water quality model that must be accurately developed before the model can be used for predictive capability. The first is the transport or defining how the physical properties such as water velocity, river width and depth vary with river flow. The second is the chemical calibration of the model, which defines how the sediment and water column constituents react to affect the various modeled parameters. Ordinarily the effects of the various chemical constituents upon river dissolved oxygen levels is the primary interest in a modeling analysis.

## Model Transport

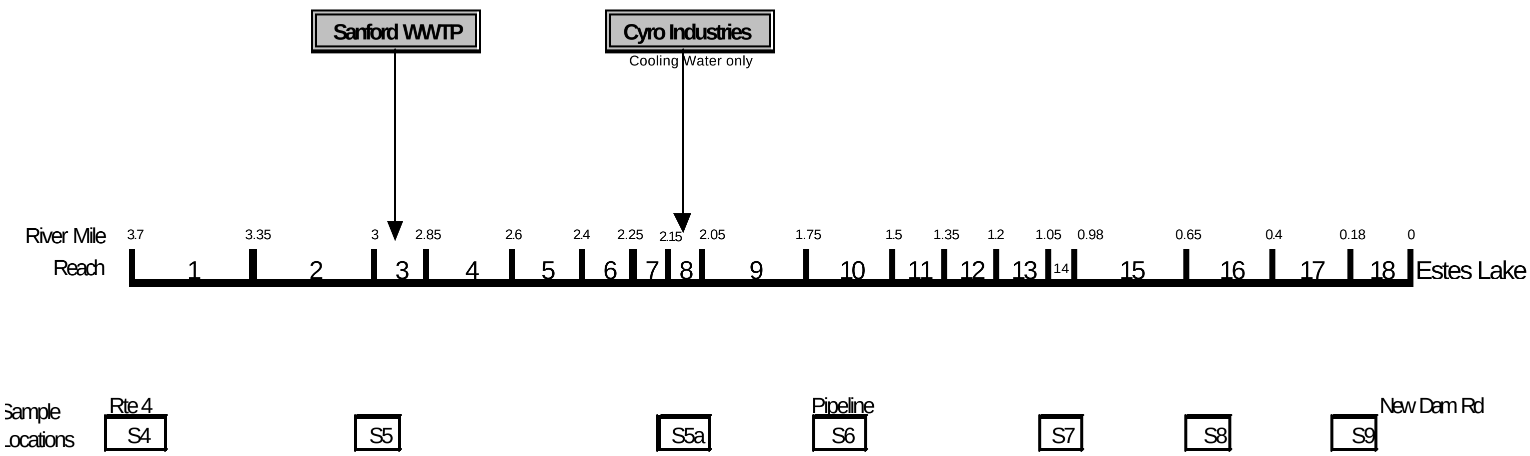
In the hydraulic component of the model, river velocity and depth relationships are developed as a function of flow. Transect data were used as a basis for deriving the relationships. QUAL2EU offers two options for the transport of pollutant parameters; a power equation and the Manning equation for open channel flow. The power equation option was chosen for the Mousam River model. This computes velocity and depth as a function of flow with the following equation:

$$\mathbf{V = A_1 Q^{B}{}_1 \quad and \quad D = A_2 Q^{B}{}_2}$$

where V = velocity; D = depth; Q = flow, and $A_x$, $B_x$ are coefficients that are empirically derived from transect data

The hydraulic coefficients used in the model are summarized in table 1 (below).

**Figure 1 Model Reach Setup for Mousam River at Sanford**



| Table 1 Hydraulic Coefficients | | | | |
|---|---|---|---|---|
| | coef v | exp v | coef d | exp d |
| Reach | $A_1$ | $B_1$ | $A_2$ | $B_2$ |
| 1 | 0.2701 | 0.491 | 0.1219 | 0.4535 |
| 2 | 0.2701 | 0.491 | 0.1219 | 0.4535 |
| 3 | 0.2701 | 0.491 | 0.1219 | 0.4535 |
| 4 | 0.1176 | 0.4503 | 0.222 | 0.5 |
| 5 | 0.8299 | 0.0946 | 0.0595 | 0.7 |
| 6 | 0.322 | 0.281 | 0.082 | 0.7 |
| 7 | 0.022 | 1 | 1.2 | 0 |
| 8 | 0.3658 | 0.2575 | 0.0825 | 0.7 |
| 9 | 0.0867 | 0.5 | 0.3484 | 0.4 |
| 10 | 0.0308 | 0.7259 | 1.0124 | 0.1283 |
| 11 | 0.00783 | 1 | 1.65 | 0 |
| 12 | 0.01054 | 1 | 1.65 | 0 |
| 13 | 0.00828 | 1 | 3.1 | 0 |
| 14 | 0.00368 | 1 | 1.9 | 0 |
| 15 | 0.00206 | 1 | 2.3 | 0 |
| 16 | 0.00173 | 1 | 3.6 | 0 |
| 17 | 0.00094 | 1 | 4.7 | 0 |
| 18 | 0.00081 | 1 | 5.6 | 0 |

The model results of the July data reveal that a rather rapid river time of travel of about 3.5 hours occurs for the first 1.3 miles from Sanford's outfall down to station S6 (pipeline). Only an additional 3 hours travel time occurs to station S7 (where backwater affects of Estes Lake are evident) for a total of 6.5 hours. Here the backwaters to Estes Lake results in slower currents and cumulative travel times from Sanford's outfall of about 18 hours at station S8 and 36 hours at station S9 (Dam Rd Bridge) are estimated.

Flow gaging was undertaken at two locations. At the Route 4 bridge, the Sanford Sanitary District in conjunction with USGS maintains a flow gage. In addition, the DEP measured flow at sample site S6 (pipeline crossing). The measurements indicate that there is some increase in river flow, that is probably due to groundwater inflows along the study reach even at drought flow conditions. Incremental groundwater contributions of 1 cfs / river mile and 0.8 cfs / river mile were assigned to the July and August data sets, respectively.

## Chemical Calibration of the Water Quality Model

In the development of the model, there are some inputs which are directly measured and others which are not easily measured but must be "calibrated." The chemical calibration of the model involves adjusting various parameter rates until the model output for all modeled chemical constituents such as BOD, dissolved oxygen, algae as chlorophyll a and nutrients match the observed data. It is a multi-step process in which each chemical parameter of interest, which is believed to have a significant effect upon river dissolved oxygen, is calibrated.

A water quality model should be "calibrated" and "verified" before it is suitable to be used for predictions. A minimum of two data sets is needed for this. The better of the two data sets is ordinarily used as the calibration data set. As discussed earlier, the July data are the better of the two data sets, due to steady flow conditions and higher water temperature (which better represents a worst case condition). The model is calibrated when all adjustments result in the best possible fit of all chemical parameters. The model is verified when a second independent data set (August data) again results in a reasonable fit of the model to observed chemical parameters when using similar (preferably the same) calibrated parameter rates. Only the measured inputs are changed on the verification data set.

The following inputs were directly measured or determined for the Mousam River model
1. River flow and groundwater inflow
2. River temperature
3. Upstream boundary conditions
4. Downstream boundary conditions (Estes Lake)
5. Point source inputs (Sanford)

After inputting the appropriate measured values, the model was calibrated in the following steps:
1. Calibrate carbonaceous BOD by adjusting the BOD decay rates
2. Calibrate chlorophyll a, nitrogen and phosphorus series simultaneously
3. Calibrate dissolved oxygen by adjusting reaeration rate

A summary of parameter rates used in the water quality model (table 2) indicates that the majority of rates were assigned as recommended in the literature. Where it was possible literature default values were used.

The model calibration / verification for CBOD, phosphorus, and chlorophyll a was rather routine and good calibrations were achieved (see figures A1 to A4). The calibration for nitrogen series (organic-N, ammonia-N, and nitrate-N) was somewhat problematic (figures A5 to A10). A reasonable calibration could be achieved for the July data set, but rather high nitrogenous BOD decay rates of 4 per day were necessary for some of the reaches. This is outside the upper range recommended by the QUAL2E (2 per day) but within the upper range suggested in other literature (10 per day). When the same nitrogen parameter rates were used for the August data set, the model results were initially high for ON and low for NH3-N. A high rate of ON hydrolysis to NH3-N and lower rate of NBOD decay was necessary for the August data set to reach a reasonable calibration. The model verification for the August data is graphed with both the calibrated rates used in the July data (dashed lines) and the mentioned adjustments (solid lines).

It is evident that the nitrogen cycle parameter rates are an important part of water quality model and dissolved oxygen depletion within the Mousam River below the Sanford outfall. One possibility for the higher nitrification rates assigned to the July data set is the lack of a good ammonia mass balance in the river below Sanford's outfall. For example, the July model mass balance for ammonia may be higher than actual values and was possibly compensated for (in the model) by assignment of a higher nitrification rate. It is possible that unsteady flows from the treatment plant could have contributed to this.

The July flow data from the Sanford facility shows lower early morning flows (midnight to 6AM) than the August data set. The assignment of daily average flows to this data could be overestimating nitrogen, in particular at the first two downstream stations (S5a, S6), which represent only slightly over 3 hours of river travel time. Hence a better effort to calibrate the nitrogen is not possible using QUAL2EU, due to the steady state limitation of input loads. Another possibility is the unsteady river flows in the August data contributed to the different rates observed in that data.

For the calibration of daily average dissolved oxygen desk top models for reaeration employed internally within QUAL2EU, typically as functions of river depth and velocity, gave poor results, since the model typically overestimated dissolved oxygen by a lot. Reaeation rates had to be directly assigned based upon matching the model output to field results of dissolved oxygen data. There are large populations of bottom-attached algae and macropyhtes in this river stretch, which often lower river velocity and reaeration. With the mentioned adjustments, reasonable calibrations were achieved (figures A11, A12). It can be observed that the August input with the adjusted nitrification rates gave a better fit to the dissolved oxygen data than the unadjusted rates.

Since the model gives results as a daily average, a diurnal adjustment must be made to the model to obtain the daily minimum dissolved oxygen. Bottom attached algae that occurs on the Mousam River results in dissolved oxygen reaching a minimum in the early morning due to extended nighttime respiration and dissolved oxygen reaching a maximum in mid-afternoon from extended photosynthesis. Average diurnal ranges on the Mousam were as much as 4.3 ppm at station S7 and as little as 0.1 ppm at station S9.

QUAL2EU is a steady state model and does not have the capability to simulate daily dissolved oxygen fluctuations. The diurnal dissolved oxygen range had to be calculated externally from the QUAL2EU modeling framework. An empirical relationship utilizing power equations of the diurnal range of dissolved oxygen to the ambient total phosphorus directly below Sanford's outfall were derived. Since bottom attached plants are a longer-term phenomena than three days, the ambient phosphorus was calculated as a two-week average of Sanford's input. The diurnal adjustment is one-half of the diurnal range and must be subtracted from the QUAL2EU model results to obtain the daily minimum dissolved oxygen. When this calculated difference is compared to the minimum dissolved oxygen data good fits resulted (figures A13, A14).

When the calculated diurnal dissolved oxygen ranges from the power equation were compared to the measured diurnal ranges (figures A15, A16), good fits resulted in all the data points except S7 (river mile 1). A very large diurnal range (4.3 ppm) occurred during the July data set. In contrast, diurnal ranges did not exceed values slightly greater than 2 ppm at all the other locations during both sampling runs. The Mousam River total phosphorus were similar for both data sets (29 ppb July; 25 ppb August). There is no easy explanation for the higher diurnal range at this one location in July. A considerable portion of the dissolved oxygen depletion may be due to wetlands in this area. Another possibility could be the higher May phosphorus levels in the river discharged by Sanford.

**Table 2 Parameter Rates Used in Water Quality Model**

| **Global Algae, Nitrogen, and Phosphorus** | Literature* | | | | |
|---|---|---|---|---|---|
| | Range | Default | Rate Used | Units | Considerations and Logic |
| Oxygen Uptake in Nitrification | 4.33 | 4.33 | 4.33 | | |
| Oxygen Production by Algae | 1.4 - 1.8 | 1.6 | 1.6 | mg O / mg A | Default |
| Oxygen Uptake by Algae | 1.6 | 2.3 | 2 | mg O / mg A | Default |
| Nitrogen Content of Algae | .07 - .09 | 0.085 | 0.085 | mg N / mg A | Default |
| Phosphorus Content of Algae | .01 - .02 | 0.014 | 0.014 | mg P / mg A | Default |
| Algae Maxmum Growth Rate | 1 - 3 | 2 | 2.7 | / day | Model calibration Chl a |
| Algae Respiration Rate | .05 - .5 | 0.15 | 0.05 | / day | Model calibration Chl a |
| Nitrogen Half Saturation Constant | .001 - .15 | 0.025 | 0.025 | mg / l | Default |
| Phosphorus Half Saturation Constant | .001 - .05 | 0.001 | 0.001 | mg / l | Default |
| Linear Algae Shade Coefficient | .002 - .02 | | 0.0289 | 1/ft / ug / l | |
| Nonlinear Shade Coefficient | 0.0165 | 0.0165 | 0.0165 | 1/ft / ug / l | Default |
| Light Function Option | 3 Possibilities | | Option 2 | | Smith's Option |
| Light Saturation Coefficient | .13 - .90 | 0.45 | 0.45 | BTU / $ft^2$-min | Default |
| Daily Averaging Option | 4 Possibilities | | Option 2 | | Computed from daily ave solar radiation |
| Light Averaging Factor | .85 - 1.00 | | 0.9 | | Within range reported in literature |
| Number of Daylight Hours (July / Aug) | Sunrise and sunset data | | 15.25 / 13.5 | hrs | Sunrise and sunset data |
| Total Daily Solar Radiation (July / Aug) | Desk top model | | 2400 / 2100 | BTU / $ft^2$ | Desktop Model |
| Algae Growth Calculation Option | 3 Possibilities | | 2 | | Limiting nutrient option |
| Algae Preference for NH3-N | 0 - 1 | 0.5 | 0.5 | | Default |
| Algae / Temp Solar Radiation Factor | | 0.45 | 0.45 | | Default |
| Nitrification Inhibition | | 10 | 10 | | Default for no inhibition |
| **Algae Coefficients** | | | | | |
| Chlorophyll to Algae Ratio | 10 - 100 | 50 | 50 | ug chl / mg A | Default / Model calibration Chl a |
| Algae Settling Rate | .3 - 60 | 1.64 | 0.1 | ft / day | Model calibration Chl a |
| Non Algae Light Extinction Coefficient | | | 1 | / ft | |

| **Reaction Coefficients** | Literature | | Generally assigned to calibrate CBOD, DO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Range | Default | Rate Used | | | | | | |
| Carbonaceous BOD Decay Rate | .02 - 3.4 | 0.05 | Model Reach | 1-13 | | | 14-18 | | |
| | | | Rate ( / day) | 0.05 | | | 0.025 | | |
| Atmospheric Reaeration Rate | 0 - 100 | Variable | Model Reach | 1-2 | 3-8 | 9-11 | 12 | 13-14 | 15-18 |
| | | | Rate ( / day) | 15 | 3 | 2 | 1.5 | 1 | 0.7 |
| Sediment Oxygen Demand Rate | .001 - .93 | Variable | 0.1 gm / $ft^2$-day | | | | | | |
| **Nitrogen and Phosphorus Coefficients** | | | Generally assigned to calibrate N series, P series, and chl a | | | | | | |
| | Range | Default | Rate Used | | | | | | |
| Organic Nitrogen Hydrolosis Rate** | .02 - .4 | 0.075 | July Data All | 0 | | | | | |
| | | | August Data Model Reach | 1-2 | 3-10 | 11-15 | 16 | 17-18 | |
| | | | Rate ( / day) | 0.1 | 3 | 0.3 | 0.2 | 0.1 | |
| Organic Nitrogen Settling Coefficient | .001 - .10 | 0.03 | .03 / day | | | | | | |
| Nitrification Rate** | .1 - 10 | | July Data Model Reach | 1-10 | | 11-12 | | 13-18 | |
| | | | Rate ( / day) | 4 | | 1 | | .1 | |
| | | | August Data Model Reach | 1-12 | | | 13-18 | | |
| | | | Rate ( / day) | 2 | | | 1 | | |
| Benthic Source NH3-N** | .6 - 61 | | .01 mg / $ft^2$-day | | | | | | |
| Organic Phosphorus Decay | .01 - .7 | 0.22 | .05 / day | | | | | | |
| Organic Phosphorus Settling Coeff. | .001 - .10 | 0.03 | .03 / day | | | | | | |
| Benthic Source Dissolved Phos. | .08 - 8.55 | | .1 mg / $ft^2$-day | | | | | | |

*Primary source of literature rates is Help and Limit Screens for Eutrophication Preprocessor for EPA WASP4/Eutro model, secondary source is QUAL2EU user's manual.

** High ON hydrolosis rates for the August data and high nitrification rates and low ammonia benthic source rates for both data sets were necessary for nitrogen series calibration.

| Table 3 - Power Equation Relationship of Diurnal Dissolved Oxygen to Total Phosphorus | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $DDO = A(TP)^B$ | | | July (6-8) 1999 | | | | Aug (25-27) 1999 | | | |
| | | | Total Phos. (ppb) | | Diurnal D.O. (ppm) | | Total Phos. (ppb) | | Diurnal D.O. (ppm) | |
| Sample Location | Coefficient A | Exponent b | Calculated | Measured | Calculated | Measured Max / Ave | Calculated | Measured | Calculated | Measured Max / Ave |
| S5 | 0.3 | 0.6 | 19 | 19 | 1.76 | 2.3 / 2.2 | 15 | 12 | 1.52 | 1.7 / 1.3 |
| S5a | 0.26 | 0.5 | 29 | 23 | 1.40 | 1.4 / 1.2 | 25 | 19 | 1.30 | 1.4 / 1.2 |
| S6 | 0.28 | 0.5 | 29 | 22 | 1.51 | 1.5 / 1.5 | 25 | 17 | 1.40 | 2.1 / 1.8 |
| S7 | 0.09 | 1 | 29 | 24 | 2.61 | 4.5 / 4.3 | 25 | 18 | 2.25 | 1.0 / 0.6 |
| S8 | 0.04 | 0.9 | 29 | 27 | 0.83 | 2.0 / 0.3 | 25 | 20 | 0.72 | 0.8 / 0.6 |
| S9 | 0.1 | 0.5 | 29 | 32 | 0.54 | 0.9 / 0.1 | 25 | 20 | 0.50 | 0.8 / 0.2 |

The algae formation and growth could be a longer-term phenomena than the assumed two-week period. After the higher spring discharge of phosphorus ceases, the retention of phosphorus in the system could possibly last several weeks.

## Model Prediction Runs

After the water quality model is calibrated to observed data, a prediction run is made at worst case conditions to assure dissolved oxygen criteria will be achieved at all locations. Worse case conditions are defined by:
1. low river flows, when dilution of wastewater inputs is at a minimum;
2. high water temperatures, when the saturation of dissolved oxygen is lower and BOD decay and oxygen demand from the sediment are higher; and
3. maximum inputs (point sources discharging at licensed limits).

Two tests are run with the water quality model to check dissolved oxygen compliance with statutory criteria; one to test compliance of minimum dissolved oxygen criteria and a second to test compliance with the monthly average criteria of 6.5 ppm. The assumptions and inputs used for the prediction runs are summarized in table 4. The area of interest in a prediction run analysis is the location of the lowest dissolved oxygen. River dissolved oxygen typically declines below a large waste input in the downstream direction reaching a minimum several miles downstream, and then recovering after this. A plot of river mile Vs dissolved oxygen reveals a sag at this minimum point (see figures 2, 3, 4) and hence its reference as the "D.O. sag point." The D.O. sag occurs rapidly in the Mousam River at sampling location S7, which is only two miles downstream of Sanford's input. The goal of each model run is to meet the D.O. criteria at the sag point. Compliance with criteria can then be inferred at all other river locations.

A series of model prediction runs were made to investigate causes of impact to river dissolved oxygen and possible solutions to improve river dissolved oxygen to acceptable criteria. Model runs 0 to 4 investigate non-treatment alternatives (figure 2). Assuming that Sanford discharges at its allowable licensed load at a river flow of 10 cfs, model run #1 predicts that river dissolved oxygen could be as low as 1.5 ppm for a daily minimum. This is much lower than the class C minimum dissolved oxygen requirement of 5 ppm. Without Sanford discharging, model run #0 predicts that river minimum dissolved

**Table 4 Prediction Runs Assumptions and Inputs**

**Weekly Average Runs in Consideration of Minimum Dissolved Oxygen Criteria**

| | Organic-N | NH3-N | NO3-N | Total-P | PO4-P | Chl a | BODu | D. O. | Temp | Flow |
|---|---|---|---|---|---|---|---|---|---|---|
| | ppm | ppm | ppm | ppb | ppb | ppb | ppm | ppm | °C | cfs |
| Background | 0.36 | 0.04 | 0.08 | 15 | 1 | 2.5 | 3.04 | 6.5 Ave. | 24.9 - 26.5 | 10 or 20 |
| | | | | | | | | 5.0 Min. | (July 99) | |
| Sanford Inputs | | | | | | | | | | |
| Current | 0.9 | 3.23 | 1.75 | 172 | 43 | 3.2 | 57.4* | 6.03 | 26.7 | 3.48 mgd |
| TMDL | 0.9 | 0.5 | 1.75 | 103 | 26 | 3.2 | 57.4* | 7.5 | 26.7 | |

* Calculated as product of licensed BOD5 weekly average (15 ppm) and the BODu / BOD5 factor (3.83).

**Class C Dissolved Oxygen Criteria** **Minimum D.O. > 5.0 ppm and 60% of Saturation**

**Monthly Average Runs**

| | Organic-N | NH3-N | NO3-N | Total-P | PO4-P | Chl a | BODu | D. O. | Temp | Flow |
|---|---|---|---|---|---|---|---|---|---|---|
| | ppm | ppm | ppm | ppb | ppb | ppb | ppm | ppm | °C | cfs |
| Background | 0.36 | 0.04 | 0.08 | 15 | 1 | 2.5 | 3.04 | 6.65 | 24 | 20 |
| | | | | | | | | Ave of 7/99 and 8/99 data | | |
| Sanford Inputs | | | | | | | | | | |
| Current | 0.9 | 3.23 | 1.75 | 172 | 43 | 3.2 | 38.3** | 6.03 | 26.7 | 3.48 mgd |
| TMDL | 0.9 | 0.5 | 1.75 | 103 | 26 | 3.2 | 38.3** | 7.5 | 26.7 | |

* *Calculated as product of licensed BOD5 monthly average (10 ppm) and the BODu / BOD5 factor (3.83).

**Class C Dissolved Oxygen Criteria** **Monthly Average D.O. > 6.5 ppm**

oxygen is 5.8 ppm. It can be deduced from these two runs that Sanford's impact on dissolved oxygen depletion in the Mousam River can potentially exceed 4 ppm.

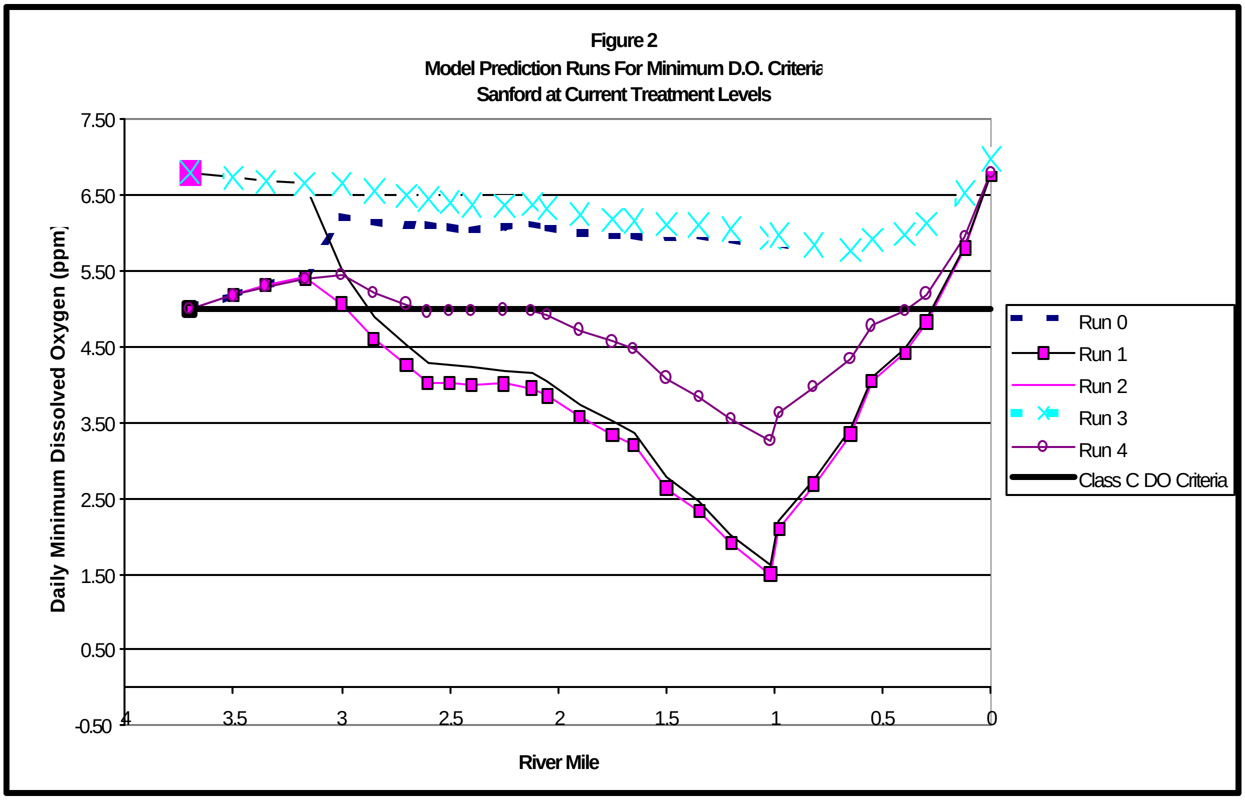
The background minimum dissolved oxygen assigned to the prediction runs (5 ppm) is a low value that was measured in the July data set. Although it is not known whether or not non-point pollution abatement could significantly improve river dissolved oxygen here, this was investigated. If a higher background dissolved oxygen of 6.8 ppm (similar to those measured at lower impacted locations such as Butler Corner, which is above urban areas) is assumed, model runs #2 and #3 show that only 0.1 ppm is gained at the D.O. sag point. Hence non-point source controls are probably not an effective strategy to improve river dissolved oxygen below Sanford's discharge. Finally if the river trigger flow under which Sanford ceases its discharge is increased from 10 to 20 cfs, the model predicts a minimum dissolved oxygen of 3.3 will occur at the sag point, assuming Sanford is discharging at current licensed levels. This represents a significant improvement in dissolved oxygen of 1.8 ppm, but additional measures are still necessary to bring the river into compliance with class C minimum criteria of 5 ppm.

The Mousam River at Sanford does not go under 20 cfs very often and DEP believes this is a reasonable alternative to further investigate. Model runs 5 to 11 investigate additional treatment at Sanford in addition to increasing the river flow from 10 to 20 cfs (figure 3), which collectively could result in attainment of class C dissolved oxygen criteria. First, it must be stated that DEP has observed that the current stage measurement from the Route 4 bridge gaging location could be improved substantially if a permanent staff gage is installed. The measurement currently is from the bridge and the long distance to the water surface could introduce error. Even a small amount of error could be important, since the flow often reported from the gage is 18 to 19 cfs. Significant holding requirements for the effluent discharge could possibly be reduced with more accurate flow determinations. For example, in summer of 1999 there were 32 days when the flow was in-between 18 and 20 cfs.

In model runs #5 and #6, different levels of ammonia treatment (1 and .5 ppm) are investigated. It can be seen that with ammonia levels treated to 0.5, the minimum dissolved oxygen predicted of 4.2 ppm is a significant improvement (0.9 ppm) but still is not enough to meet class C minimum dissolved oxygen criteria of 5 ppm. Next in runs #8 and #10 different phosphorus treatment requirements (3 and 2 lb/day) are investigated (in addition to the 0.5 ppm ammonia requirement). Both are additional reductions from the current 5 lb/day requirement that is currently in place. The model runs indicate that 3 and 2 lb/day total phosphorus requirements result in a minimum dissolved oxygen of 4.8 and 5.2 ppm, respectively. Thus the latter requirement is an acceptable alternative. In run #11, increasing effluent dissolved oxygen from 6 to 7.5 ppm is also investigated. From this run it can be seen that phosphorus would only have to be reduced to 3 lb/day with the additional effluent oxygen requirement.

Carbonaceous BOD (CBOD) reductions were also investigated but were generally not effective. A 50% cut in Sanford's CBOD discharge resulted in an improvement of only 0.1 ppm of the Mousam River dissolved oxygen.

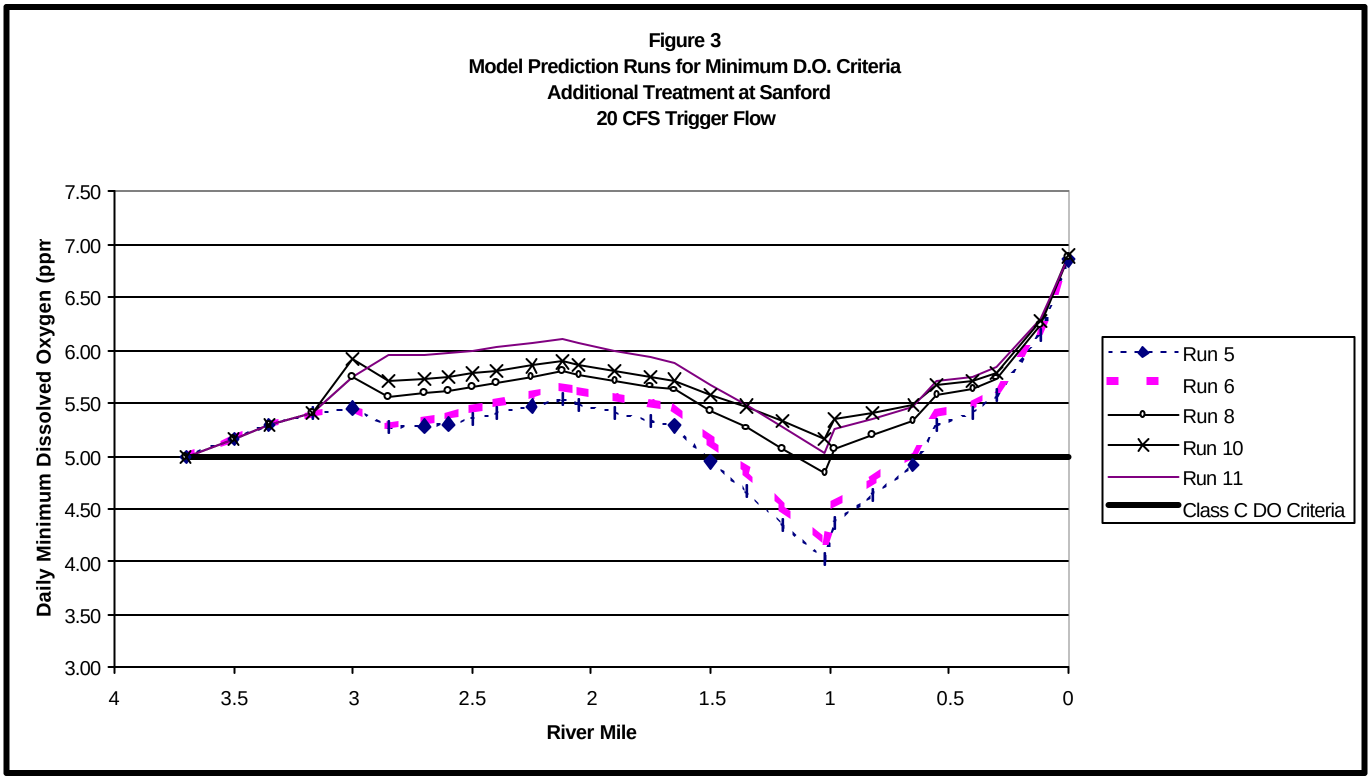
The model run (at 20 cfs) made to check compliance with the class C monthly average requirement of 6.5 ppm (figure 4) predicts a monthly average dissolved oxygen of 6.36 ppm at the sag point with Sanford treated to 0.5 ppm ammonia nitrogen and 3 lb/day total phosphorus. If, in addition to the phosphorus and ammonia removal, Sanford's effluent dissolved oxygen aerated to 7.5 ppm, a monthly average dissolved oxygen of 6.5 ppm is predicted at the sag point which meets criteria.




| | Sanford Treatment Level at 3.48 mgd | | | | River Flow (cfs)** Route 4 | Ambient DO | | | Comment |
|---|---|---|---|---|---|---|---|---|---|
| Run | Description | NH3 (ppm) | BOD5 (ppm) | TP (lb/day) | | Background Minimum DO (ppm) | Model Min DO (ppm) below Sanford Input | Class C D.O. Met? Yes or No | |
| 0 | Zero Discharge | 0 | 0 | 0 | 10 | 5 | 5.8 | Y | Sanford discharged as licensed could potentially cause a 4.3 ppm lowering of D.O. |
| 1 | Current License | 3.93 | 15 | 5 | 10 | 5 | 1.5 | N | |
| 2 | Current License Higher Background. D.O.* | 3.93 | 15 | 5 | 10 | 6.8 | 1.6 | N | Only 0.1 ppm D.O. gained at sag point. NPS controls not an effective strategy |
| 3 | Zero Discharge Higher Background. D.O.* | 0 | 0 | 0 | 10 | 6.8 | 5.9 | Y | |
| 4 | Current License Increase river trigger flow | 3.93 | 15 | 5 | 20 | 5 | 3.3 | N | 1.8 ppm D.O. gain with higher trigger flow. |

* Backgound D.O. similar to Butler Corner assumed. This represents a D.O. level not highly impacted by NPS. It is uncertain if this higher background D.O. could be achieved with NPS controls. The model results predict the higher background D.O.would not be noticed at the D.O. sag point (2 miles below Sanford's outfall).

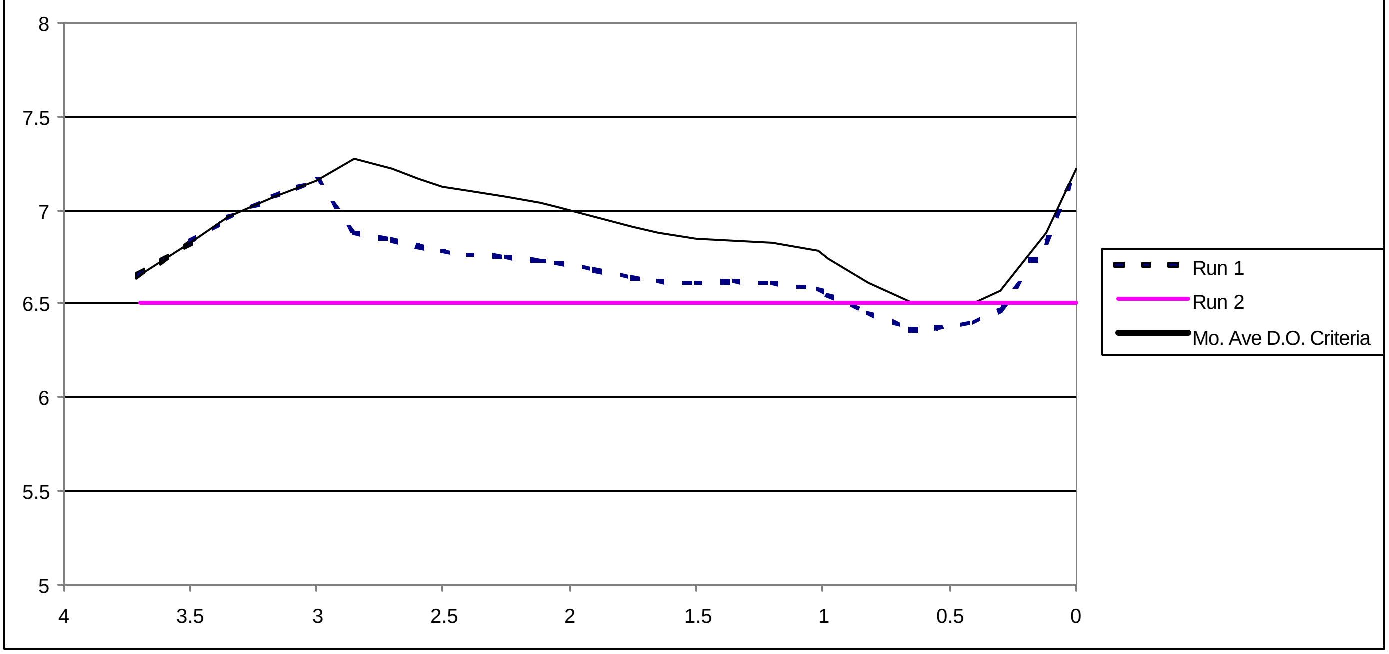
** This flow represents the "trigger" river flow. Sanford is required to cease its effluent discharge under this flow.




| | Additional Sanford Treatment Level at 3.48 mgd | | | | River Flow (cfs)* Route 4 | Ambient DO | | | Comment |
|---|---|---|---|---|---|---|---|---|---|
| Run | Description | NH3 (ppm) | BOD5 (ppm) | TP (lb/day) | | Background Minimum DO (ppm) | Model Min DO (ppm) below Sanford Input | Class C D.O. Met? Y or N | |
| 5 | NH3-N treated to 1 ppm | 1 | 15 | 5 | 20 | 5 | 4.0 | N | 0.9 ppm D.O. gain with Ammonia-N treated to 0.5 ppm |
| 6 | NH3-N treated to 0.5 ppm | 0.5 | 15 | 5 | 20 | 5 | 4.2 | N | |
| 8 | NH3-N to .5 ppm; TP to 3 lb/day | 0.5 | 15 | 3 | 20 | 5 | 4.8 | N | 0.6 ppm gained w / TP treated to 3 lb/day |
| 10 | NH3-N to .5 ppm; TP to 2 lb/day | 0.5 | 15 | 2 | 20 | 5 | 5.2 | Y | Acceptable Alternative |
| 11 | Same as Run 8 with efluent D.O. > 7.5 ppm | 0.5 | 15 | 3 | 20 | 5 | 5.0 | Y | Acceptable Alternative |

* This flow represents the "trigger" river flow. Sanford is required to cease its effluent discharge under this flow.

**Figure 4**
**Model Prediction Run For**
**Monthly Average Dissolved Oxygen Criteria**




| | Sanford Treatment Level at 3.48 mgd | | | | | Ambient DO | | | |
|---|---|---|---|---|---|---|---|---|---|
| Run | Description | NH3 (ppm) | BOD5 (ppm) | TP (lb/day) | River Flow (cfs)** Route 4 | Background DO (ppm) | Model Mo Ave DO (ppm) below Sanford | Class C D.O. Met? Yes or No | Comment |
| 1 | New Treatment Levels | 0.5 | 15 | 3 | 20 | 6.65 | 6.4 | N | Difficult to meet criteria W/O aerated effluent |
| 2 | Same as Run 1 with effluent D.O.≥7.5 ppm | 0.5 | 15 | 3 | 20 | 6.65 | 6.5 | Y | |

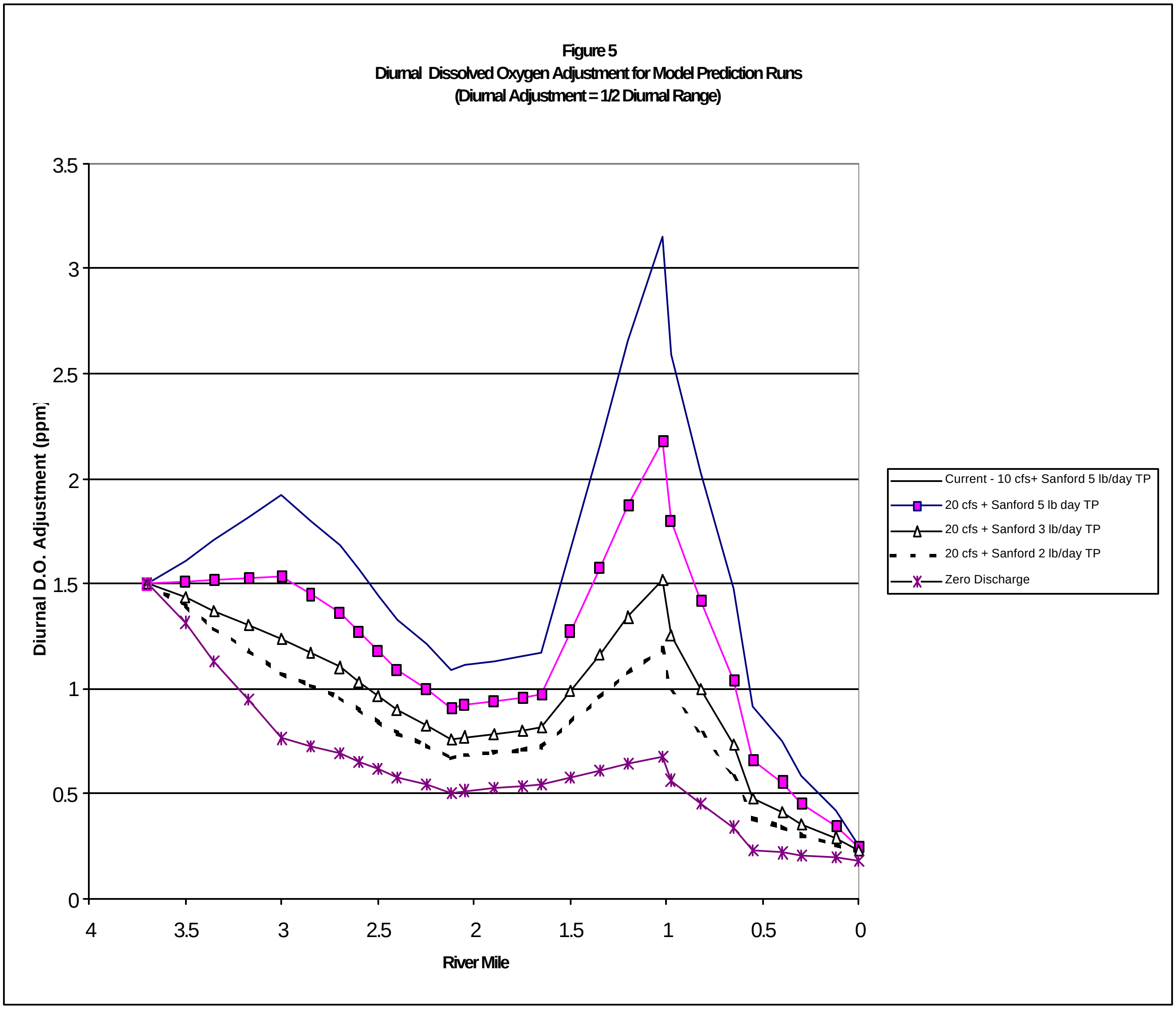


Figure 5
Diurnal Dissolved Oxygen Adjustment for Model Prediction Runs
(Diurnal Adjustment = 1/2 Diurnal Range)
Diurnal D.O. Adjustment (ppm)
River Mile
0
0.5
1
1.5
2
2.5
3
3.5
4
Current - 10 cfs+ Sanford 5 lb/day TP
20 cfs + Sanford 5 lb day TP
20 cfs + Sanford 3 lb/day TP
20 cfs + Sanford 2 lb/day TP
Zero Discharge

## Component Analysis

In a component analysis potential factors to dissolved oxygen depletion are investigated. This is accomplished by individually removing each potential factor from the model input and then observing the difference in the model output of dissolved oxygen. It can then be determined which factors are significant to water quality degradation and where the cleanup efforts should be focused.

The component analysis first focused on categories of pollutants (algae respiration, carbonaceous BOD, nitrogenous BOD, sediment oxygen demand, and initial and tributary dissolved oxygen deficits) and then as source inputs (point source, non-point source, and sediment). The results are displayed in both tabular (table 5) and pie chart (figure 6) format for the D.O. sag point (station S7).

When components are investigated by categories, the modeling analysis shows that algae respiration is currently the most significant impact (48%) followed by nitrogenous BOD decay (26%), and sediment oxygen demand (17%). CBOD decay and initial dissolved oxygen deficits are insignificant impacts (5% and 4%, respectively). Thus cleanup efforts should focus on reducing phosphorus and ammonia inputs.

When components are investigated by sources, it can be seen that if Sanford was discharging its current licensed loads, it is a potential large source of degradation (67%). Most of the impact comes from phosphorus (38%), followed by NBOD (24%), and finally CBOD (4%). Non-point source and natural inputs are comparatively insignificant (16%). Sediment oxygen demand (which represents point, non-point, and natural impacts) is responsible for around 17% of the impact.

The initial dissolved oxygen deficit, although large, (the actual background daily minimum dissolved oxygen of 5.0 ppm is a deficit of 3.2 ppm from saturation) only contributes about 4% of the total deficit at station S7. Hence improving the background dissolved oxygen, will not result in large improvements at the sag point location.

Components were also investigated by sources, after the TMDL is implemented. It can be seen that Sanford's contribution can be reduced from 67% to 30% of the total dissolved oxygen deficit at location S7. As Sanford's impact is reduced, non-point / natural and sediment oxygen demand become more significant (42% and 28%, respectively).

## Table 5 Component Analysis Summary

### Component Analysis - Current Conditions

River Flow = 10 cfs Sanford at Current License

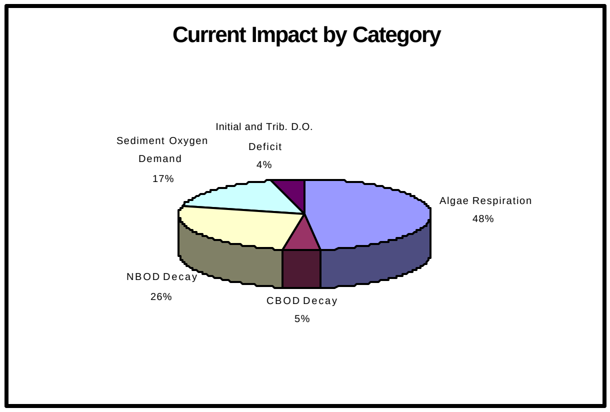
| Description | Daily Min D.O. S7 | Daily Ave D.O. S7 | D.O. Deficit | % of Impact |
|---|---|---|---|---|
| **Impact by Categories** | | | | |
| All Impacts | 1.5 | 4.65 | 6.73 | 100% |
| Algae Respiration | 4.65 | 4.65 | 3.15 | 48% |
| CBOD Decay | 1.81 | 4.96 | 0.31 | 5% |
| NBOD Decay | 3.18 | 6.33 | 1.68 | 26% |
| Sediment Oxygen Demand | 2.61 | 5.76 | 1.11 | 17% |
| Initial and Trib. D.O. Deficit | 1.79 | 4.94 | 0.29 | 4% |
| **Sanford Discharge** | | | | **67%** |
| Sanford at Licensed | 5.82 | 6.5 | 4.32 | 67% |
| Sanford CBOD | 1.78 | 4.93 | 0.28 | 4% |
| Sanford NBOD | 3.1 | 6.25 | 1.6 | 24% |
| Sanford TP | 3.97 | 4.65 | 2.47 | 38% |
| **NonPoint and Natural Impacts** | | | | **16%** |
| NPS/Natural CBOD | 1.54 | 4.69 | 0.04 | 1% |
| NPS/Natural NBOD | 1.54 | 4.69 | 0.04 | 1% |
| NPS/Natural Phosphorus | 3.97 | 4.65 | 0.68 | 10% |
| Initial D.O. Deficit | 1.79 | 4.94 | 0.29 | 4% |
| **Sediment Oxygen Demand** | | | | **17%** |

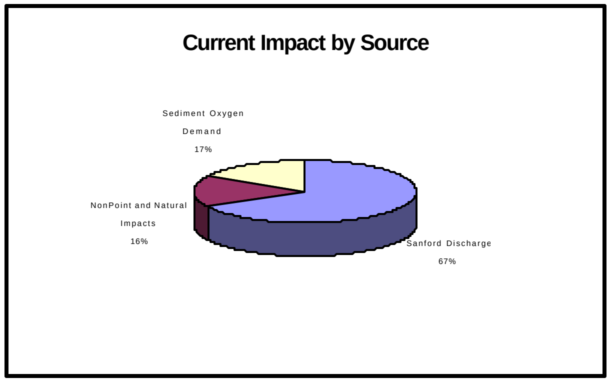
### Component Analysis with TMDL Implemented

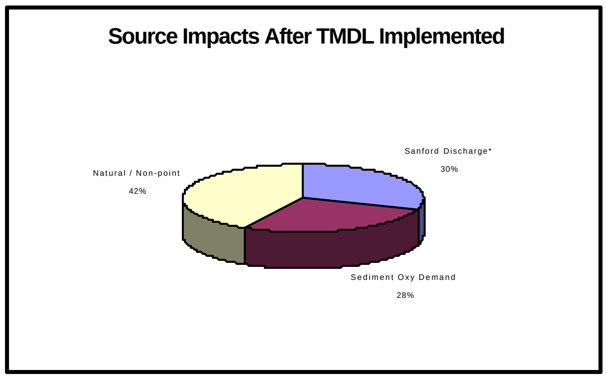
20 cfs - Sanford at 3 lb/day TP and 14.5 lb/day NH3-N

| Description | Daily Min D.O. S7 | Daily Ave D.O. S7 | D.O. Deficit | % of Impact |
|---|---|---|---|---|
| **All Impacts** | 5.03 | 6.55 | 3 | **100%** |
| **Sanford Discharge*** | 6 | 6.68 | 0.97 | **30%** |
| Sanford Phosphorus | 5.87 | 6 | 0.84 | 28% |
| Sanford CBOD + NBOD | 5.33 | 6.85 | 0.3 | 10% |
| **Sediment Oxy Demand** | 5.89 | 7.41 | 0.86 | **28%** |
| **Natural / Non-point** | 6.2 | 7.04 | 1.17 | **42%** |

## Figure 6 Component Analysis Pie Charts

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*Aerating effluent dissolved oxygen to 7.5 ppm contributes 0.17 ppm at station S7.

## Discussion of Alternatives

### Ocean Outfall

Re-location of Sanford's outfall to the ocean about 3000 feet off shore from Kennebunk beach is Sanford's preferred alternative (Phase 2 Wastewater Facilities Study, The Sanford Sewer District, Wright Pierce Engineers, Feb. 2000). The total length of the outfall from their treatment plant to the ocean is would be about 15 miles. This would have the advantage of increasing Sanford's dilution from 2.8:1 to 400:1. As a result many of the potential water quality impacts due to Sanford's discharge would go away. The Facilities Plan has estimated that the total capital cost of this alternative is $22 million.

This alternative is not feasible due to three considerations.

1. The state water quality classification law (465-B (2)(C) ) prohibits the Department from issuing licenses for new discharges to class SB waters if the discharge results in the closure of an open shellfishing area by DMR. The proposed outfall location is an open shellfish area, and DMR's policy for treatment plant outfalls dictates an automatic closure as a margin of safety for possible disinfection failures. Hence the law appears to preclude the ocean outfall.
2. Antidegradation provisions of the state water quality classification law states that existing uses and the level of water quality necessary to protect those existing uses must be maintained and protected. Shellfishing is an existing use that must be protected. The DEP could only issue a waste discharge license if a finding is made that the discharge does not have a significant impact on existing uses.
3. There appears to be significant public opposition to the outfall in the town of Kennebunk. Since right-of-way and Kennebunk's approval of an outfall going through their town are necessary, this, in itself, could make this option not doable.

### Outfall Re-Located below Estes Lake

To investigate the Mousam River below Estes Lake as a possible outfall location, the DEP undertook some dissolved oxygen and temperature sampling in the summer of 2000. The summer of 2000 was generally a wet and cool summer and not very conducive to worse case conditions of low flow and high water temperature. DEP was able to sample two days (6/29 and 7/13) before flow conditions became too high. The data reveals that class B dissolved oxygen standards are currently not being met in many river locations from the Old Falls dam to Route 1 (see figure 7). The low dissolved oxygen readings in the first impoundment below the Old Falls dam may be due to a deep-water release from the Old Falls dam.

Even assuming this problem could be fixed, the lower Mousam is impounded by dams throughout most of its length and is not well suited to assimilate waste from a large discharge. It was evident from docks, boats observed, and occasional rope swings that

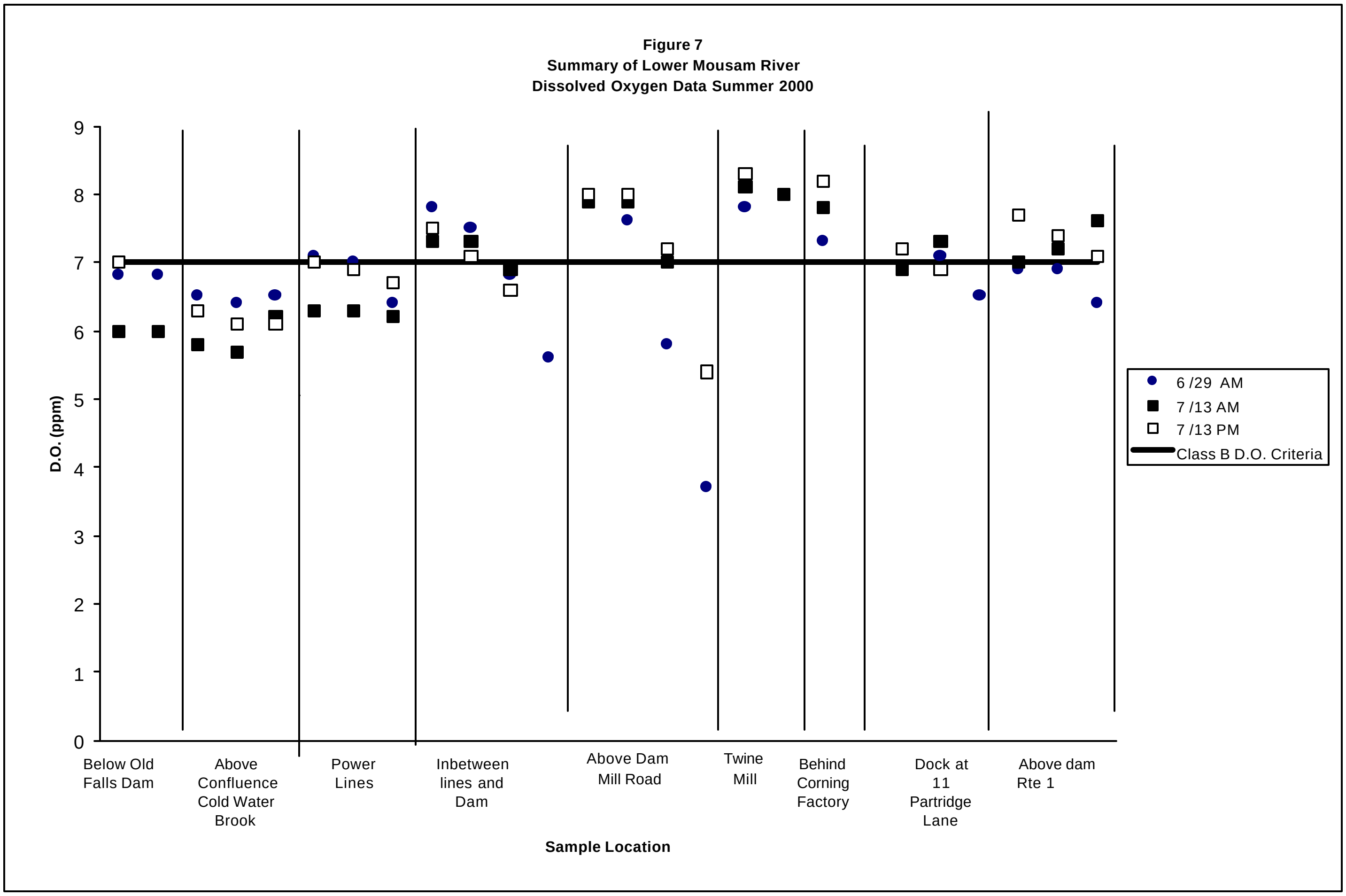


Figure 7
Summary of Lower Mousam River
Dissolved Oxygen Data Summer 2000
D.O. (ppm)
0
1
2
3
4
5
6
7
8
9
Below Old Falls Dam
Above Confluence Cold Water Brook
Power Lines
Inbetween lines and Dam
Above Dam Mill Road
Twine Mill
Behind Corning Factory
Dock at 11 Partridge Lane
Above dam Rte 1
Sample Location
6 /29 AM
7 /13 AM
7 /13 PM
Class B D.O. Criteria

this area receives much recreational use in Kennebunk.  The option does not appear to hold much promise as a feasible option.

### Outfall In Current Location

Possible treatment options for keeping the outfall in its current location were discussion previously in the Model Prediction Runs section.  The following actions were needed by Sanford to meet class C dissolved oxygen criteria:

1. Ammonia Nitrogen treated to 14.5 lb /day ( 0.5 ppm at 3.48 mgd)
2. Total Phosphorus treated to 3 lb/day
3. Effluent dissolved oxygen maintained at 7.5 ppm
4. Cease discharge whenever river flow at the Route 4 gage is under 20 cfs.

The first of these options should be implemented seasonally from May 15 to Sept. 30.  #2 and #3 should be implemented seasonally from May 1 to Sept 30.  #4 should be implemented year round due also to toxic criteria concerns.  A May startup date is necessary (rather than the current June 1 startup).  The bottom-attached plants can become established in May, and the overall goal is to prevent their buildup and growth. A mid May rather than an early May startup is used for initiating the summer ammonia limits.  This is due to the fact that ammonia removal works best in warmer weather and it may be difficult to achieve the more stringent criteria in early May.

This option may not be as favorable to Sanford due to the still relatively low dilution (4.7:1 summer, 4:1 non-summer).  If a plant expansion is needed in the future, limits would have to be maintained at this current mass.  While these license limits are very restrictive, they are still within the range of what is technically achievable.

A possible add-on option to this could be for Sanford to consider building either additional holding capacity and/or land applying a portion of their effluent.  Pollutant parameters could be licensed as a mass and this would leave open the option for Sanford to decide how much flow they could discharge (based upon expected treatment) to meet license mass limits.

Another necessary ingredient will be for DEP to follow up with river sampling after all the necessary actions are implemented to determine their effectiveness.

## Discussion of Background Data

The DEP undertook sampling on the upper Mousam River in the summer of 2000 on four occasions.   The purpose of this sampling was to determine the cause of the degraded background conditions above Sanford.  Dissolved oxygen levels recorded above the Sanford outfall in the 1999 sampling at route 4 were low.  The early morning dissolved oxygen ranged from 4.8 to 5.1 ppm in the July data and 5.4 to 5.8 ppm in the August data.  Dissolved oxygen values greater than 7 ppm are more typical of lowly impacted areas.

The Butler corner sampling location is above the urban areas in Sanford and Springvale and more representative of a lower impacted area. At the upper most sampling point, Butler corner, early morning dissolved oxygen ranged from 6.6 to 6.8 in the July data and 7.2 to 7.5 in the August data. The river is class B here, requiring 7 ppm and 75% of saturation. The July data did not meet class B criteria. It is presumed most of the dissolved oxygen depletion here is due to natural causes, although some of the depletion may not be natural. Hence it is evident that some of the depletion at the Route 4 sampling site is natural, but a larger portion may not be due to natural causes.

The Sanford treatment plant and outfall are located about four river miles below the Sanford urban area. The Route 4 bridge is about halfway in-between theses two locations. Just above the Route 4 bridge there is a long stretch of river that is relatively shallow with slow sluggish currents. There are large populations of macrophytes and bottom-attached algae here. Most of the dissolved oxygen deficit observed at the Route 4 location is probably due to algae respiration from the bottom-attached plants.

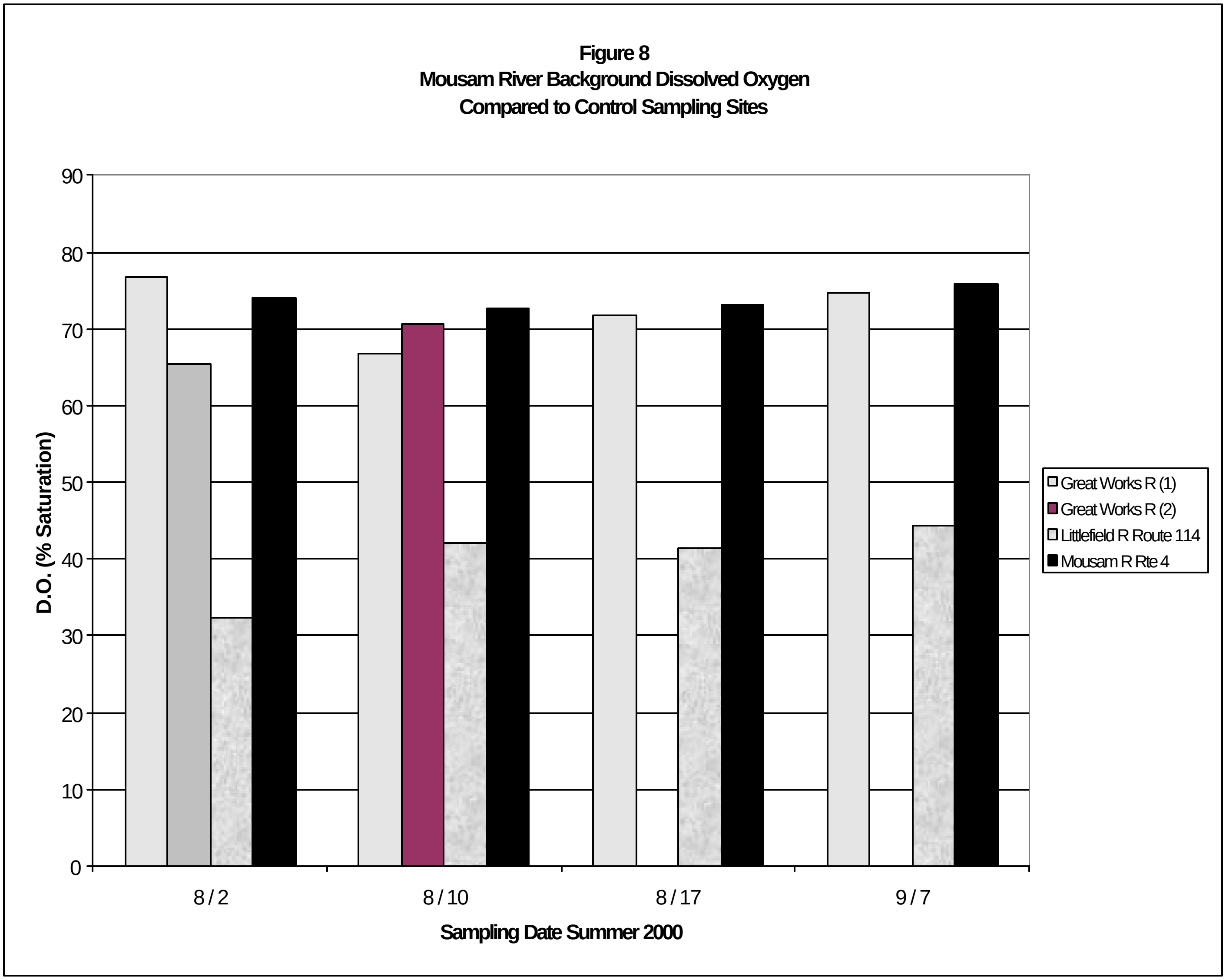
The sampling in the summer of 2000 attempted to compare sampling locations on the upper Mousam to control points in other watersheds. The Great Works was sampled at two locations and the Littlefield River (upper tributary to Estes Lake) was also sampled. The Mousam River was sampled at five locations from the inlet of #1 Pond to Route 4.

After collecting some of this data, it was evident that these locations may not represent lowly impacted areas. For example, the dissolved oxygen recorded (3.0 to 4.4 ppm range) for a class B segment, the Littlefield River did not even meet class C criteria. The Great Works River locations did not always meet class B criteria with observed dissolved oxygen levels of 6.3 and 6.4 ppm. The Great Works watershed was recommended for non-point source cleanup in the Salmon Falls River TMDL (MDEP, May 1999). The water is highly colored here so probably much of the dissolved oxygen depletion is due to natural conditions. (Color typically has high BOD associated with it from wetland drainage).

Similarly, non-point source cleanup is targeted for the Mousam Lake watershed in a TMDL to be undertaken there. Limited data exists to suggest why dissolved oxygen levels are so low on the Littlefield River. One possibility could be poor water quality in Shaker Pond, which is above the Littlefield sampling point on route 111. Shaker Pond has only been sampled twice by DEP in the last ten years, but this limited data indicates elevated algae as chlorophyll a.

The Mousam River Route 4 location typically had the lowest dissolved oxygen of all the Mousam River sites (lowest 6.2 ppm), but due to the lack of low flow conditions in the summer of 2000, did not reach the lower levels of 1999. When the summer 2000 dissolved oxygen data from the Mousam River Route 4 sampling location is compared to the other control sites (figure 8), dissolved oxygen as percent of saturation typically slightly exceeded the other sites.

Phosphorus data was collected at four Mousam River locations and one site each on the Great Works and Littlefield. The Mousam River phosphorus was typically lower than the other sampling locations (figure 9). The Mousam River phosphorus was typically in-between 10 to 20 ppb, which is not particularly high. The growth of bottom attached



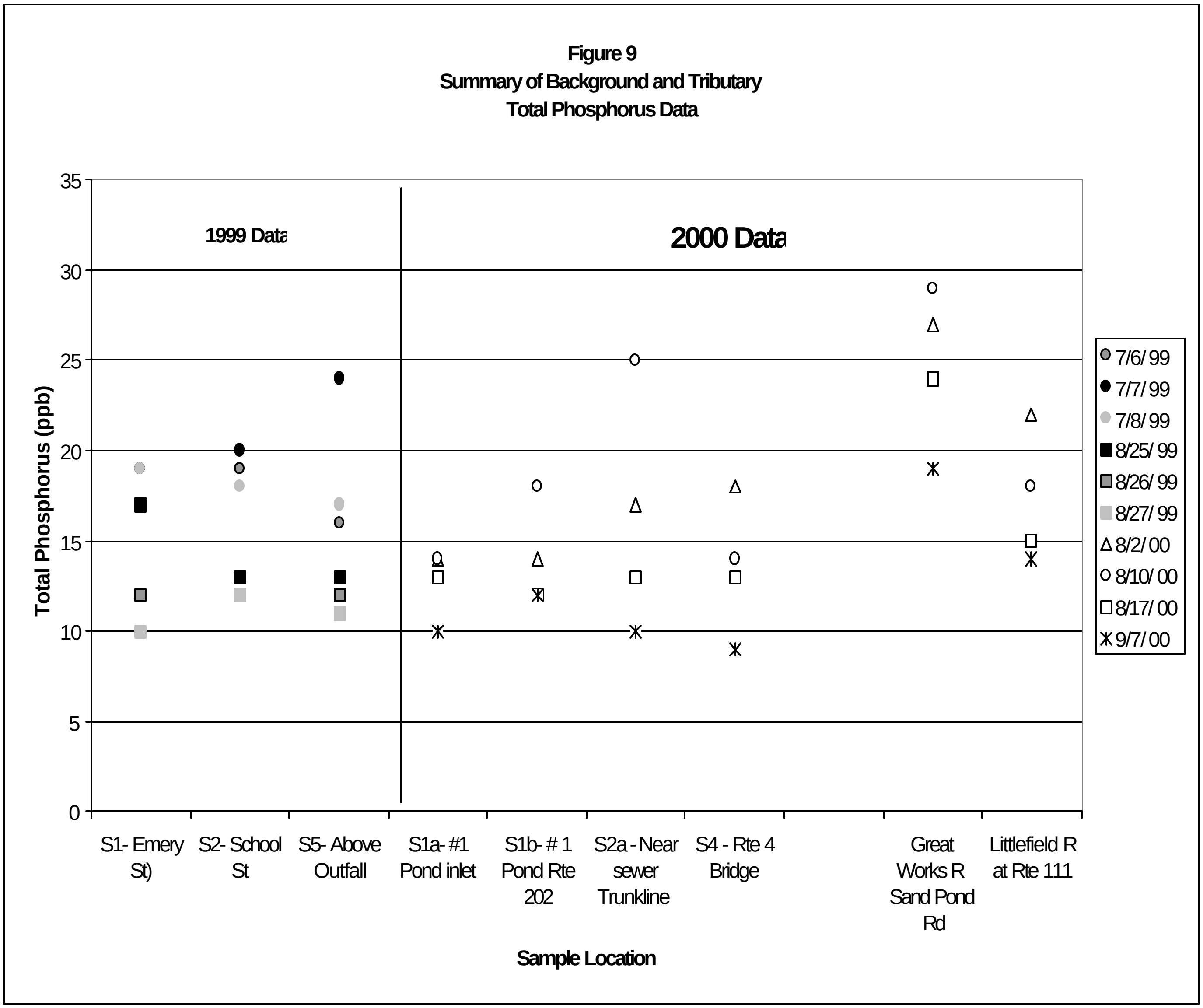


Figure 9
Summary of Background and Tributary
Total Phosphorus Data
1999 Data
2000 Data
Total Phosphorus (ppb)
35
30
25
20
15
10
5
0
S1- Emery St)
S2- School St
S5- Above Outfall
S1a- #1 Pond inlet
S1b- # 1 Pond Rte 202
S2a - Near sewer Trunkline
S4 - Rte 4 Bridge
Great Works R Sand Pond Rd
Littlefield R at Rte 111
Sample Location
7/6/99
7/7/99
7/8/99
8/25/99
8/26/99
8/27/99
8/2/00
8/10/00
8/17/00
9/7/00

plants in the river may be due to rapid uptake of water column phosphorus during storm events and/or nutrients deposited in the sediment. There is often a very high uptake rate of phosphorus when significant plant populations are established and this could explain why water column phosphorus here was never very high.

It is difficult to conclude anything concrete from this analysis, other than the Mousam is probably not impacted any more than the other sites. When one considers the higher urban land use in the Mousam River watershed when compared to the control sites, this is a surprising finding. It can probably be inferred that at least some of the dissolved oxygen depletion observed at the Route 4 sampling location is due to natural sources.

## TMDL for the Mousam River at Sanford

### BOD, Ammonia Nitrogen and Total Phosphorus

Increasing the river flow which trigger's Sanford's requirement to cease their effluent discharge from 10 to 20 cfs is an essential part of the TMDL. This action was the most effective strategy for improving the Mousam River dissolved oxygen. Both the model prediction runs and the component analysis indicate that algae respiration and nitrogenous BOD decay are the most significant impacts. The Sanford discharge is the major source of phosphorus and ammonia to the Mousam River at Sanford. Decreases to phosphorus and ammonia from Sanford's input are an essential part of the TMDL

The summer TMDL's for BOD5, ammonia, and phosphorus limit Sanford SD to 392, 14.5, and 3 lb/day, respectively (table 5a). The non-summer TMDL for ammonia limits them to 276 lb/day. A non-summer (October 1 to May 14) limit for ammonia is also necessary due to toxic requirements. A non-summer limit of 276 lb/day ammonia (table 5b) nitrogen is needed to meet chronic AWQC for ammonia of 2.6 ppm (2.1 ppm ammonia-N) at 15 $^{o}$C and pH 7). An explicit margin of safety equal to 10% of Sanford's allocation was provided for summer BOD and non-summer ammonia.

Although non-point source controls minimizing impact from urban runoff are not an essential part for meeting dissolved oxygen criteria, it is still recommended that stormwater best management practices be implemented in the Sanford and Springvale area. This could add greater assurance of meeting class C criteria, and non-point sources, if not abated, could continue to lower water quality from existing conditions. The improvement in water quality from Sanford's reduced discharges could go for naught if non-point sources are allowed to continue unchecked.

Sanford SD requests that a higher tier flow be allowed to facilitate emptying the wastewater lagoons in the spring. This would allow for more summer storage of effluent, which is essential with the increased minimum trigger flow from 10 to 20 cfs (under which Sanford SD is required to cease discharge). A double of effluent flow from 4.4 to 8.8 mgd is allowed from February 15 to April 15, provided river flows exceed 100 cfs at Route 4. The mass of ammonia allocated to Sanford at this higher tier is 612 lb/day. A large margin of safety (53% of total TMDL) is provided to assure that ammonia levels in the river will not approach the AWQC.

## Table 6a Summer TMDL for BOD, Ammonia-N, Phosphorus

Sanford's TMDL for all pollutants is zero when river flow < 20 cfs at Route 4 Gage

**BOD, Phosphorus Limits Apply May 1 to Sept 30**

**Ammonia Limits Apply May 15 to Sept 30**

| | | Concentration (ppm) | | | TMDL Load (lb/day) | | |
|---|---|---|---|---|---|---|---|
| **BODu, NH3-N, TP** | Flow (mgd) | Ultimate BOD* | NH3-N | Total Phosphorus | Ultimate BOD* | NH3-N | Total Phosphorus |
| Natural and Non-Point Backgr | 13.3 | 3.04 | 0.04 | 0.015 | 337 | 4.4 | 1.66 |
| Incremental Groundwater Loa | 2 | 3 | 0.04 | 0.015 | 50 | 0.7 | 0.25 |
| Sanford Sanitary District | 3.48 | 57.4 | 0.5 | 0.10 | 1500 | 14.5 | 3 |
| | Maintain effluent dissolved oxygen > 7.5 ppm | | | | | | |
| Cyro Industries | | | | | 0 | 0 | 0 |
| Margin of Safety | | | | | 166 | 0 | 0 |
| | | | | **Total** | **2053** | **20** | **5** |

* The BODu / BOD5 ratio for Sanford is 3.83. This results in a BOD5 TMDL of 392 lb/day for Sanford.

## Table 6b Non-Summer TMDL for Ammonia-N

Sanford's TMDL for ammonia is zero when river flow < 20 cfs at Route 4 Gage

**Applies Oct 1 to May 14.**

| | | Concentration (ppm) | | | TMDL Load (lb/day) | | |
|---|---|---|---|---|---|---|---|
| | Flow (mgd) | Ultimate BOD | NH3-N* | Total Phosphorus** | Ultimate BOD | NH3-N* | Total Phosphorus** |
| Natural and Non-Point Source | 13.3 | None | 0.04 | None** | None | 4.4 | None** |
| Sanford Sanitary District | 4.4 | | 7.51 | | | 276 | |
| Cyro Industries | | | | | | 0 | |
| Margin of Safety | | | | | | 30 | |
| | | | | **Total** | **None** | **310** | **None**** |

*Based upon ammonia CCC criteria of 2.6 ppm (NH3-N = 2.1 ppm) at a river temperature of 15°C, pH 7.

** Non-Summer TP limits of 23 and 46 lb/day, respectively for a monthly average and daily maximum have historically been in Sanford license. These limits are still needed due to water quality considerations in Estes Lake.

## Table 6c Non-Summer TMDL for Ammonia-N at Higher Tier Flow

**Applies from Feb 15 to April 15 and whenever flow exceeds 100 cfs at Route 4 Gage.**

| | | Concentration (ppm) | | | TMDL Load (lb/day) | | |
|---|---|---|---|---|---|---|---|
| | Flow (mgd) | Ultimate BOD | NH3-N* | Total Phosphor.** | Ultimate BOD | NH3-N* | Total Phosphor.** |
| Natural and Non-Point Source | 65 | None | 0.04 | None** | None** | 21.7 | None** |
| Sanford Sanitary District | 8.8 | | 7.52 | | | 552 | |
| Cyro Industries | | | | | | 0 | |
| Margin of Safety | | | | | | 780 | |
| | | | | **Total** | **None** | **1354** | **None**** |

*Based upon ammonia CCC criteria of 2.7 ppm (NH3-N = 2.2 ppm) at a river temperature of 10°C, pH 7.

** Non-Summer TP limits of 23 and 46 lb/day, respectively for a monthly average and daily maximum have historically been in Sanford license. These limits are still needed due to water quality considerations in Estes Lake.

### Toxic Criteria TMDL

The data collected by Sanford over a 14-month period utilizing clean techniques was used as a basis for calculating the TMDL for seven different toxic substances. A spreadsheet analysis (Table 6) using the median data collected at Butler Corner and directly above Sanford's outfall was used to calculate the toxic criteria TMDL. In this analysis it was presumed that data collected at Butler Corner represents natural conditions.

Below Butler Corner, there are possible pollution sources such as urban runoff and the Sanford landfill. Increases observed in the data concentration from Butler Corner to Sanford's outfall location were presumed to be from non-point source pollution. The TMDL was calculated based upon toxic ambient water quality criteria (AWQC).

The TMDL involves setting all concentration inputs to natural conditions or the values measured at Butler Corner (.57 ppb). Although the ambient concentration (.57 ppb) exceeds the AWQC (.018 ppb), there is a provision in Maine law which exempts natural conditions as a cause of non-attainment. The natural background arsenic (.57 ppb) was also assigned to Sanford's effluent. A 64% reduction in non-point sources of arsenic is needed to meet this TMDL and maintain the river arsenic at .56 ppb.

The AWQC for lead are not met above Sanford's outfall so it is evident that non-point source reductions are necessary. The TMDL for lead requires a 25% reduction in non-point sources and maintain the river lead concentration at 0.41 ppb. Sanford was assigned an effluent concentration equivalent to the lead criteria (0.41 ppb).

## Summary of Recommendations

A number of options were investigated that allows Sanford to keep its outfall in its current location and still maintain water quality standards. The following actions are recommended.

1. Implement stormwater best management practices on urban Sanford and Springvale.
2. Reduce non-point mass discharges of lead by 24% and arsenic by 64% through #1.
3. To facilitate compliance with stringent license requirements and address growth and possible future treatment plant expansions, Sanford should consider investigating additional holding capacity and / or partial land application of effluent.
4. The Sanford WWTP should be licensed as follows (see table 7).

## Table 7 Mousam River (Sanford) TMDL for Toxic Substances

Sanford's TMDL for all toxic substances = 0 when river flow < 20 cfs at Route 4 Gage

A TMDL of zero is assigned to Cyro Industries for all toxic substances

### Applies All Year

**Chronic Dilution = 4.00**

| | 7Q10 Flow (cfs) | | | | Concentration (ppb) | | TMDL (lb/day) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Butler Corner | Above SSD Outfall | WQC | WQC Basis | Butler Corner | Above Outfall | Natural | NPS | Sanford Allocation | Total TMDL | Sanford TMDL Conc (ppb)* |
| Arsenic** | 14 | 20.7 | 0.018 | HH | 0.565 | 0.88 | 0.043 | 0.020 | 0.02 | 0.084 | 0.57 |
| Selenium | 14 | 20.7 | 5 | CCC | 0.17 | 0.16 | 0.013 | 0.005 | 0.72 | 0.74 | 19.7 |
| Copper | 14 | 20.7 | 2.99 | CCC | 0.35 | 0.91 | 0.026 | 0.075 | 0.34 | 0.44 | 9.3 |
| Lead*** | 14 | 20.7 | 0.41 | CCC | 0.095 | 0.525 | 0.007 | 0.039 | 0.015 | 0.061 | 0.41 |
| Zinc | 14 | 20.7 | 27.1 | CCC | 0.97 | 2.4 | 0.073 | 0.194 | 3.74 | 4.01 | 102 |
| Aluminum | 14 | 20.7 | 87 | CCC | 24.7 | 31.4 | 1.86 | 1.64 | 9.39 | 12.89 | 256 |

* Concentration needed to meet TMDL mass allocation at the annual design flow of 4.4 mgd

** The natural arsenic value (.565 ppb) is used to derive the TMDL. Both Sanford's effluent and NPS were assigned the natural background arsenic. Maine law has a provision which exempts natural conditions as a cause of non-attainment. The arsenic TMDL

***The TMDL for lead requires a 24% reduction in NPS. The measured NPS load for lead is .051 lb/day. Sanford's effluent was assigned the WQC (.41 ppb).

**Acute Dilution = 4.00**

| | | | | | Concentration (ppb) | | TMDL (lb/day) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1Q10 Butler | 1Q10 Above SSD | WQC (ppb) | WQC Basis | Butler Corner | Above Outfall | Natural | NPS | Sanford Allocation | Total TMDL | Sanford TMDL Conc (ppb)* |
| Copper | 14 | 20.7 | 3.89 | CMC | 0.35 | 0.91 | 0.026 | 0.075 | 0.47 | 0.57 | 12.9 |
| Silver | 14 | 20.7 | 0.25 | CMC | 0.006 | 0.006 | 0.0005 | 0.0002 | 0.036 | 0.037 | 1.0 |

## Mousam River (Sanford) TMDL for Toxic Substances at Higher Tier Flow

TMDL applies from Feb 15 to April 15, whenever river flow at Route 4 > 100 cfs

A TMDL of zero is assigned to Cyro Industries for all toxic substances

**Chronic Dilution = 4.00**

| | 7Q10 Flow (cfs) | | | | Concentration (ppb) | | TMDL (lb/day) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Butler Corner | Above SSD Outfall | WQC | WQC Basis | Butler Corner | Above Outfall | Natural | NPS | Sanford Allocation | Total TMDL | Margin of Safety |
| Arsenic** | 70 | 100 | 0.018 | HH | 0.565 | 0.88 | 0.213 | 0.091 | 0.04 | 0.345 | 0.000 |
| Selenium | 70 | 100 | 5 | CCC | 0.17 | 0.16 | 0.06 | 0.02 | 1.45 | 3.06 | 1.53 |
| Copper | 70 | 100 | 2.99 | CCC | 0.35 | 0.91 | 0.13 | 0.36 | 0.68 | 1.83 | 0.66 |
| Lead*** | 70 | 100 | 0.41 | CCC | 0.095 | 0.525 | 0.036 | 0.185 | 0.03 | 0.25 | 0.00 |
| Zinc | 70 | 100 | 27.1 | CCC | 0.97 | 2.4 | 0.365 | 0.926 | 7.49 | 16.57 | 7.79 |
| Aluminum | 70 | 100 | 87 | CCC | 24.7 | 31.4 | 9.30 | 7.59 | 18.77 | 53.21 | 17.54 |

* Concentration needed to meet TMDL mass allocation at the annual design flow of 8.8 mgd

** The natural arsenic value (.565 ppb) is used to derive the TMDL. Both Sanford's effluent and NPS were assigned the natural background arsenic. Maine law has a provision which exempts natural conditions as a cause of non-attainment. The arsenic TMDL

***The TMDL for lead requires a 24% reduction in NPS. The measured NPS load for lead is .246 lb/day. Sanford's effluent was assigned the WQC (.41 ppb).

**Acute Dilution = 4.00**

| | | | | | Concentration (ppb) | | TMDL (lb/day) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1Q10 Butler | 1Q10 Above SSD | WQC (ppb) | WQC Basis | Butler Corner | Above Outfall | Natural | NPS | Sanford Allocation | Total TMDL | Margin of Safety |
| Copper | 70 | 100 | 3.89 | CMC | 0.35 | 0.91 | 0.132 | 0.358 | 0.95 | 2.38 | 0.94 |

# Table 8 Sanford S. D. Waste Discharge License Effluent Limits

## Summer

| Flow 3.48 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppm) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | Daily Max. | Mo.Ave. | Weekly Ave | Daily Max. | | |
| BOD5 | 261 | 392 | 522 | 10 | 15 | 20 | 5/1 to 9/30 | 3 / week |
| NH3-N | | 14.5 | | | | | 5/15 to 9/30 | 3 / week |
| Total Phos. | 3 | | | | | | 5/1 to 9/30 | 3 / week |
| TSS | 290 | 435 | 580 | 10 | 15 | 20 | 5/1 to 9/30 | 3 / week |
| Dissolved Oxygen | Maintain at > 7.5 ppm | | | | | | 5/1 to 9/30 | Daily |

## NonSummer

| Flow 4.4 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppm) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | Daily Max. | Mo.Ave. | Weekly Ave | Daily Max. | | |
| BOD5 | 1101 | 1651 | 1835 | 30 | 45 | 50 | 10/1 to 4/30 | 3 / week |
| NH3-N | 276 | | | 11.3 | | | 10/1 to 5/14 | 3 / week |
| Total Phos. | 23 | | 46 | | | | 10/1 to 4/30 | 1 / week |
| TSS | 1101 | 1651 | 1835 | 30 | 45 | 50 | 10/1 to 4/30 | 3 / week |

## Toxic Substances

| Flow 4.4 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppb) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | | Mo.Ave. | Weekly Ave | Daily Max. | | |
| Arsenic | 0.02 | | | 0.8 | | | All Year | 1 / week |
| Silver | | | 0.036 | | | 1.5 | All Year | 1 / week |
| Selenium | 0.72 | | | 29 | | | All Year | 1 / week |
| Copper | 0.34 | | 0.47 | 14 | | 19 | All Year | 1 / week |
| Lead | 0.015 | | | 0.6 | | | All Year | 1 / week |
| Zinc | 3.74 | | | 153 | | | All Year | 1 / week |
| Aluminum | 9.39 | | | 384 | | | All Year | 1 / week |

## High Flow Tier Limits

In order to facilate emptying of wastewater lagoons which increases their summer storage capacity, SSD is allowed to discharge the following limits from Feb 15 to April 15, whenever flow as measured at Route 4 > 100 cfs.

| Flow 8.8 mgd | Mass Limits (lb/day) | | | Concentration Limits (ppb) | | | Time Period | Monitoring Frequency |
|---|---|---|---|---|---|---|---|---|
| | Mo.Ave. | Weekly Ave | Daily Max. | Mo.Ave. | Weekly Ave | Daily Max. | | |
| BOD5 | 2202 | 3303 | 3670 | 30 | 45 | 50 | 2/15 to 4/15 | 3 / week |
| NH3-N | 612 | | | 12.5 | | | 2/15 to 4/15 | 1 / week |
| Total Phos. | 23 | | 46 | | | | 2/15 to 4/15 | 1 / week |
| TSS | 2202 | 3303 | 3670 | 30 | 45 | 50 | 2/15 to 4/15 | 3 / week |
| Arsenic | 0.04 | | | 0.8 | | | 2/15 to 4/15 | 1 / week |
| Silver | | | 0.07 | | | 1.5 | 2/15 to 4/15 | 1 / week |
| Selenium | 1.45 | | | 30 | | | 2/15 to 4/15 | 1 / week |
| Copper | 0.68 | | 0.95 | 14 | | 19 | 2/15 to 4/15 | 1 / week |
| Lead | 0.03 | | | 0.6 | | | 2/15 to 4/15 | 1 / week |
| Zinc | 7.49 | | | 153 | | | 2/15 to 4/15 | 1 / week |
| Aluminum | 18.77 | | | 384 | | | 2/15 to 4/15 | 1 / week |

**License Conditions**

1. Sanford is required to cease discharge whenever river flow as measured at Route 4 < 20 cfs
2. Install permanent staff gage at Route 4
3. The gage at Route 4 should be calibrated yearly by USGS or a qualified hydrologist
4. River flow should be reported daily year round.

# Appendix
# Calibration / Verification of Water Quality Model

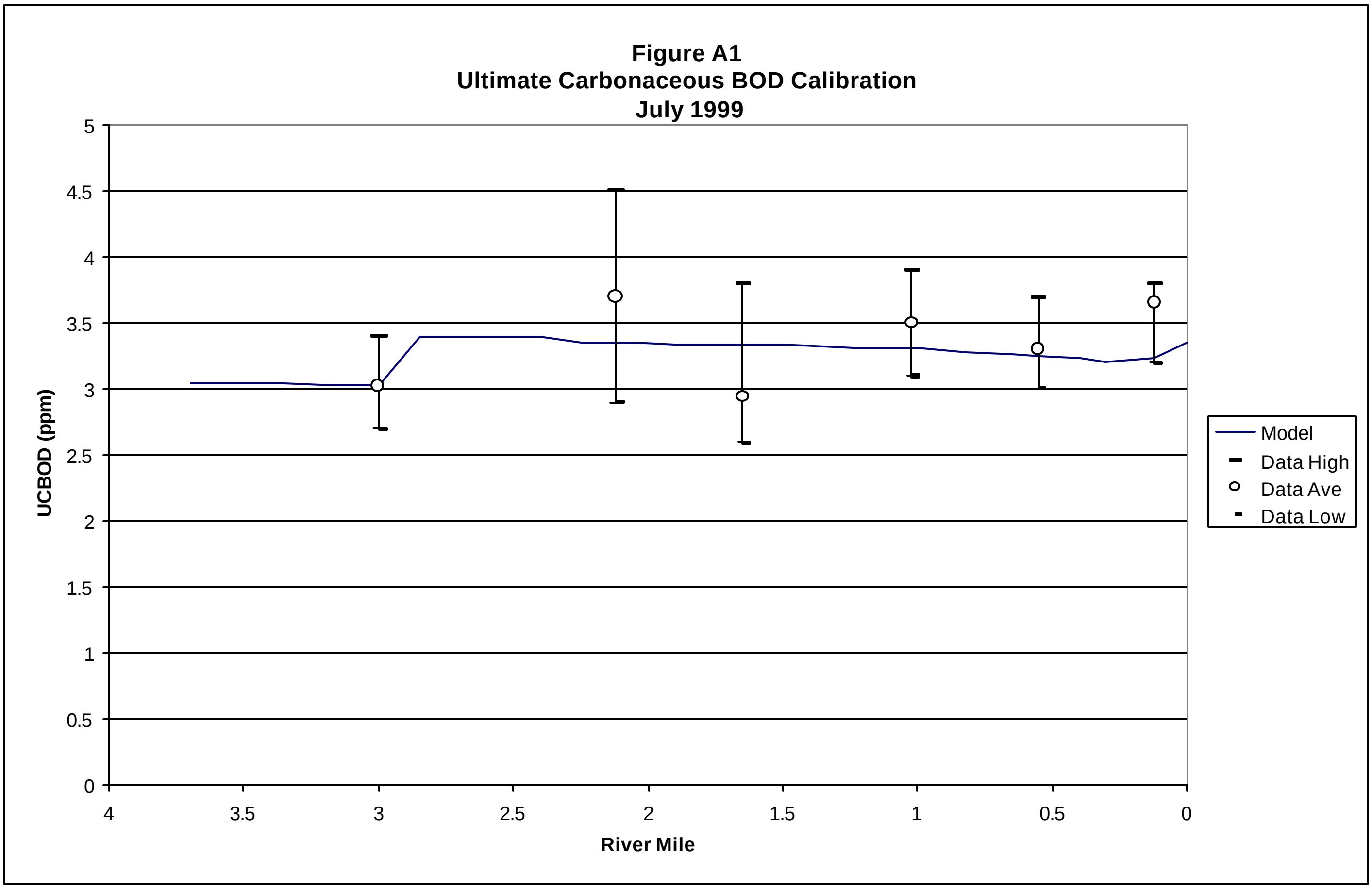


Figure A1
Ultimate Carbonaceous BOD Calibration
July 1999
UCBOD (ppm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model
Data High
Data Ave
Data Low

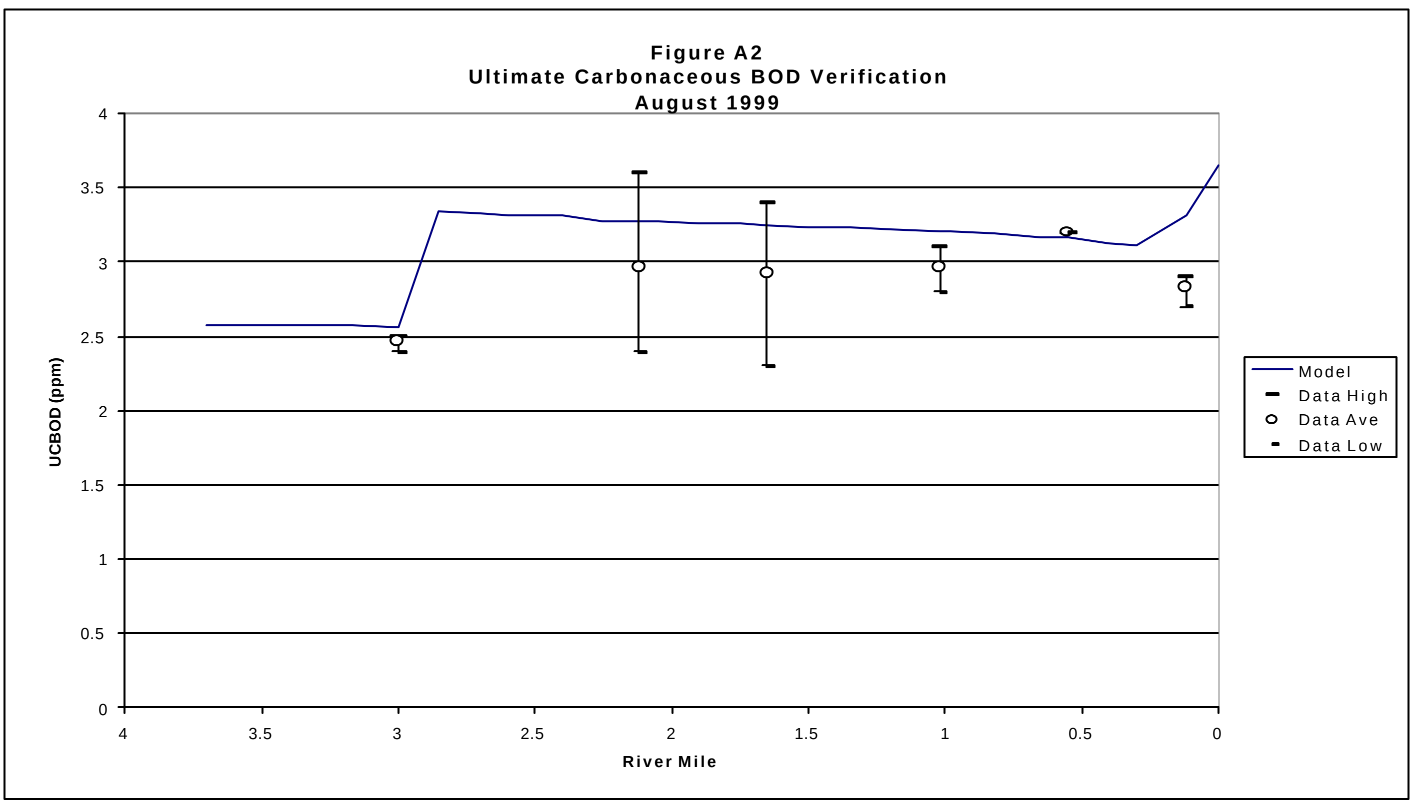


Figure A2
Ultimate Carbonaceous BOD Verification
August 1999
UCBOD (ppm)
4
3.5
3
2.5
2
1.5
1
0.5
0
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model
Data High
Data Ave
Data Low

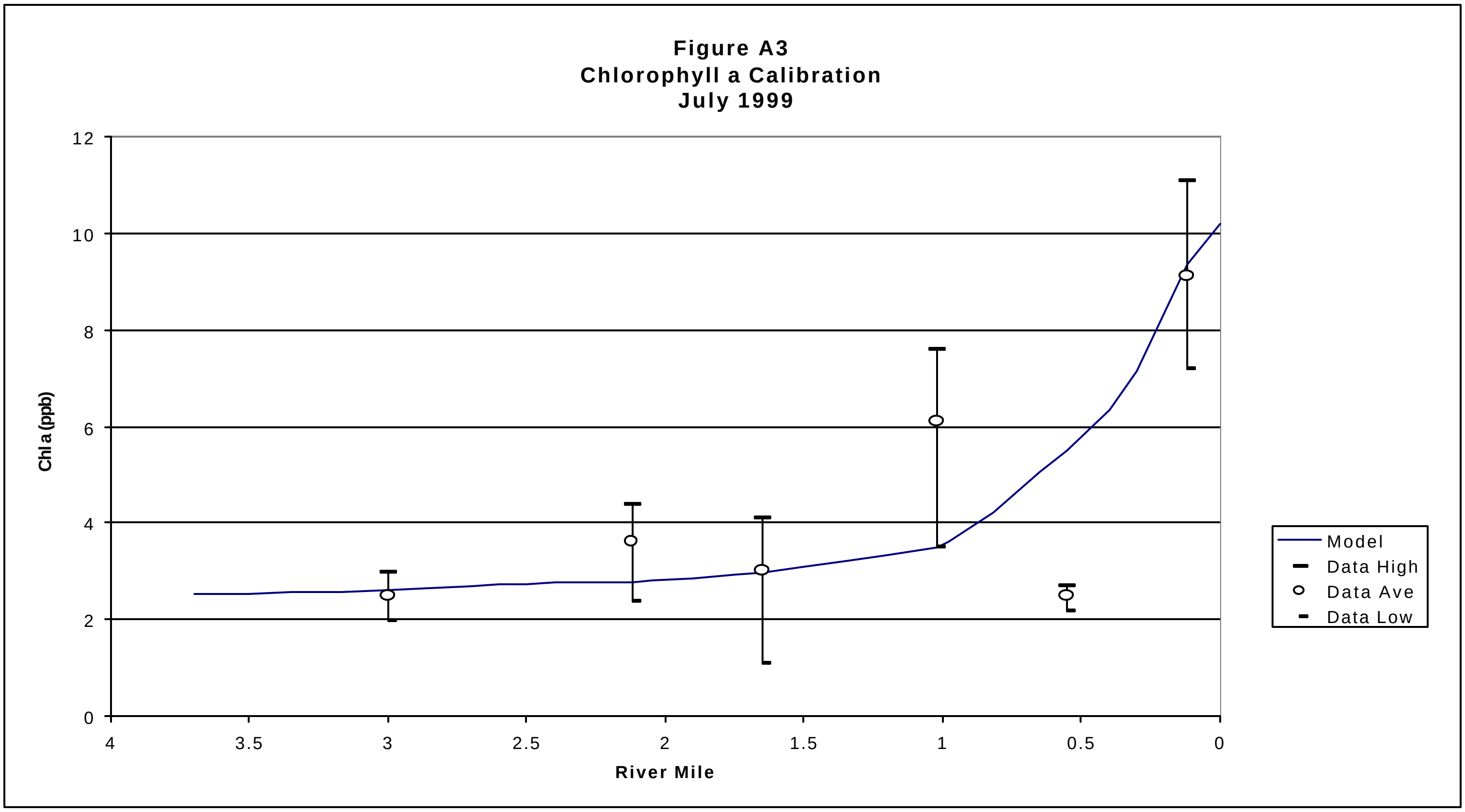


Figure A3
Chlorophyll a Calibration
July 1999
Chl a (ppb)
River Mile
Model
Data High
Data Ave
Data Low

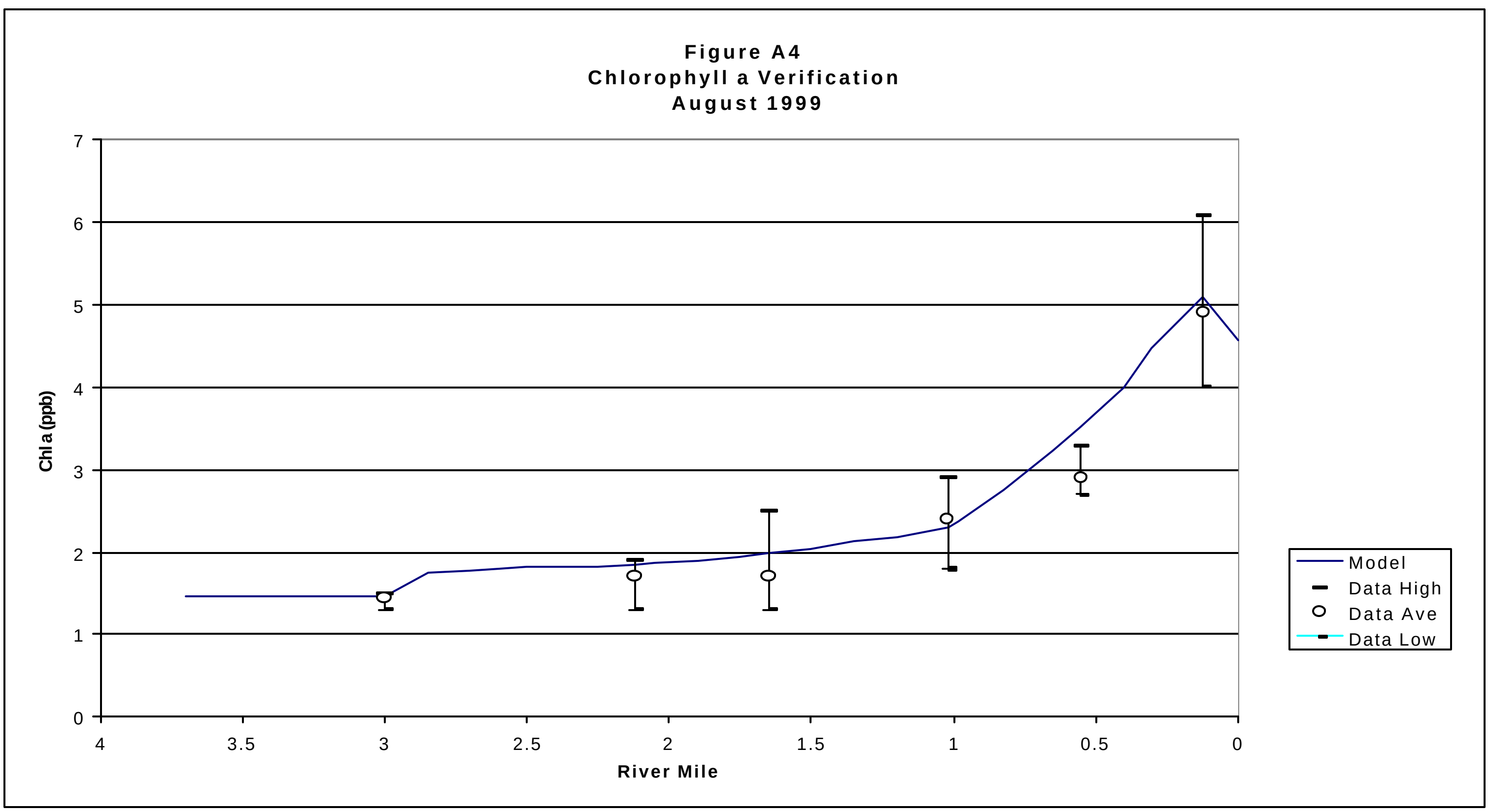



Figure A4
Chlorophyll a Verification
August 1999
Chl a (ppb)
River Mile
Model
Data High
Data Ave
Data Low

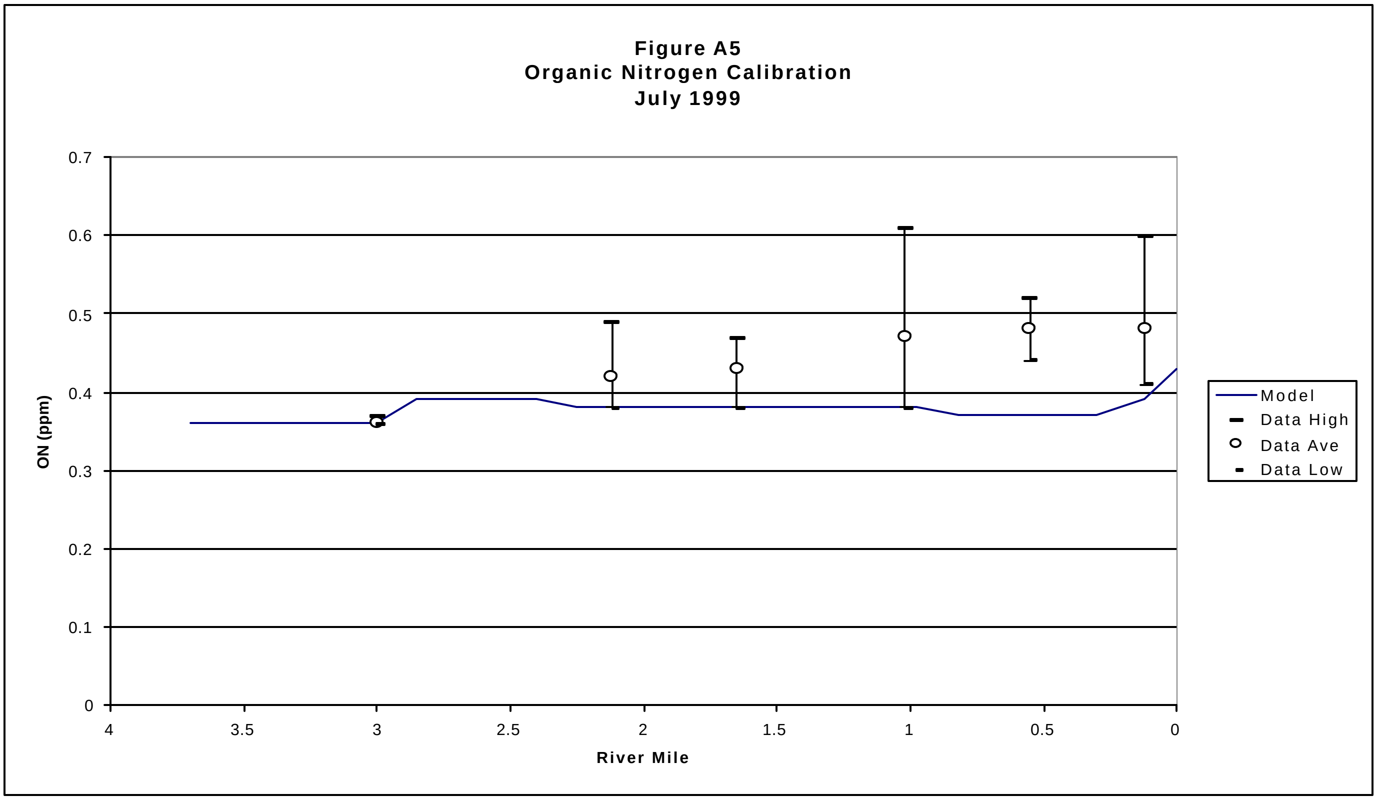


Figure A5
Organic Nitrogen Calibration
July 1999
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ON (ppm)
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model
Data High
Data Ave
Data Low

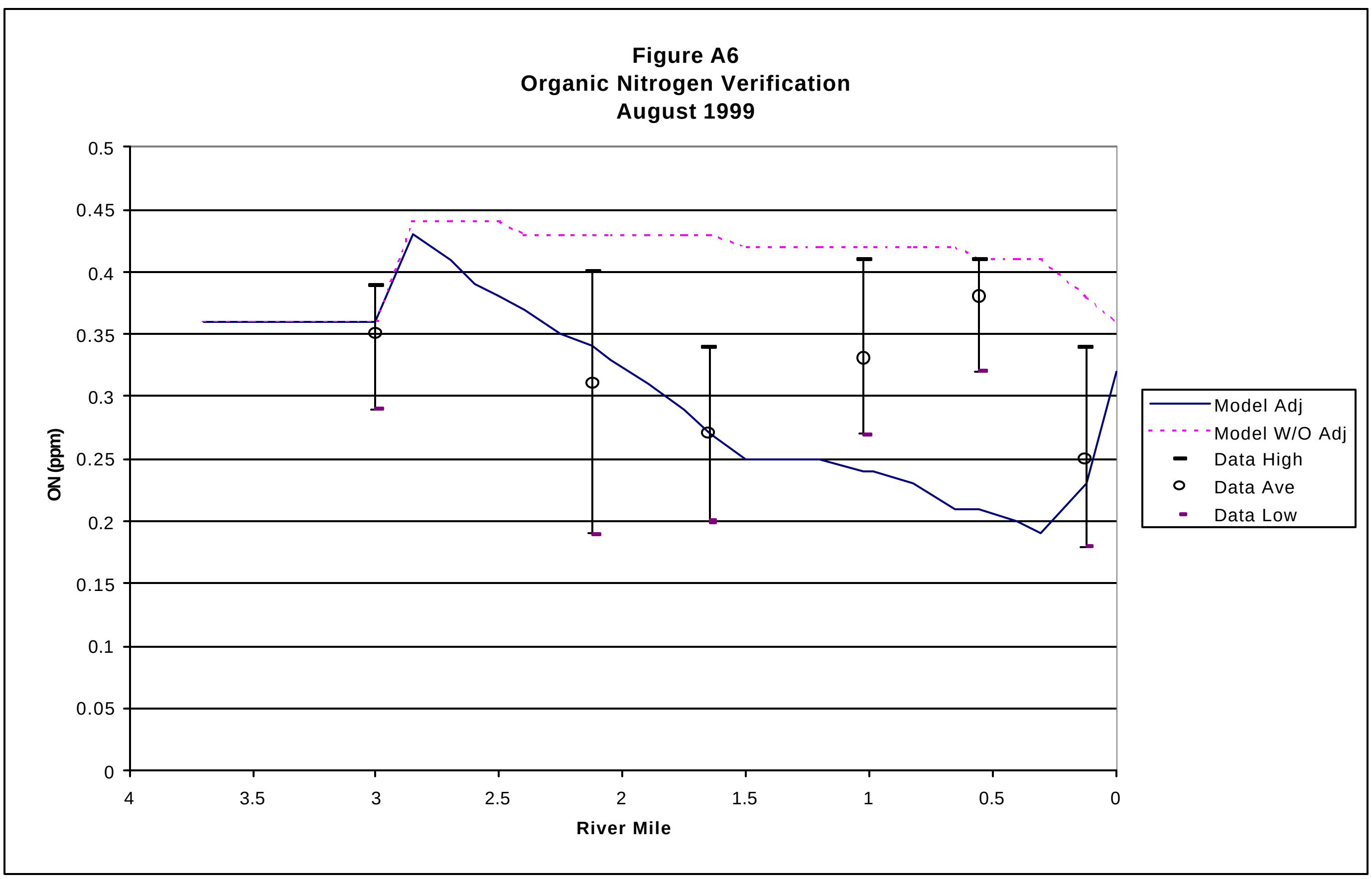


Figure A6
Organic Nitrogen Verification
August 1999
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ON (ppm)
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model Adj
Model W/O Adj
Data High
Data Ave
Data Low

Figure A7
Ammonia Nitrogen Calibration
July 99

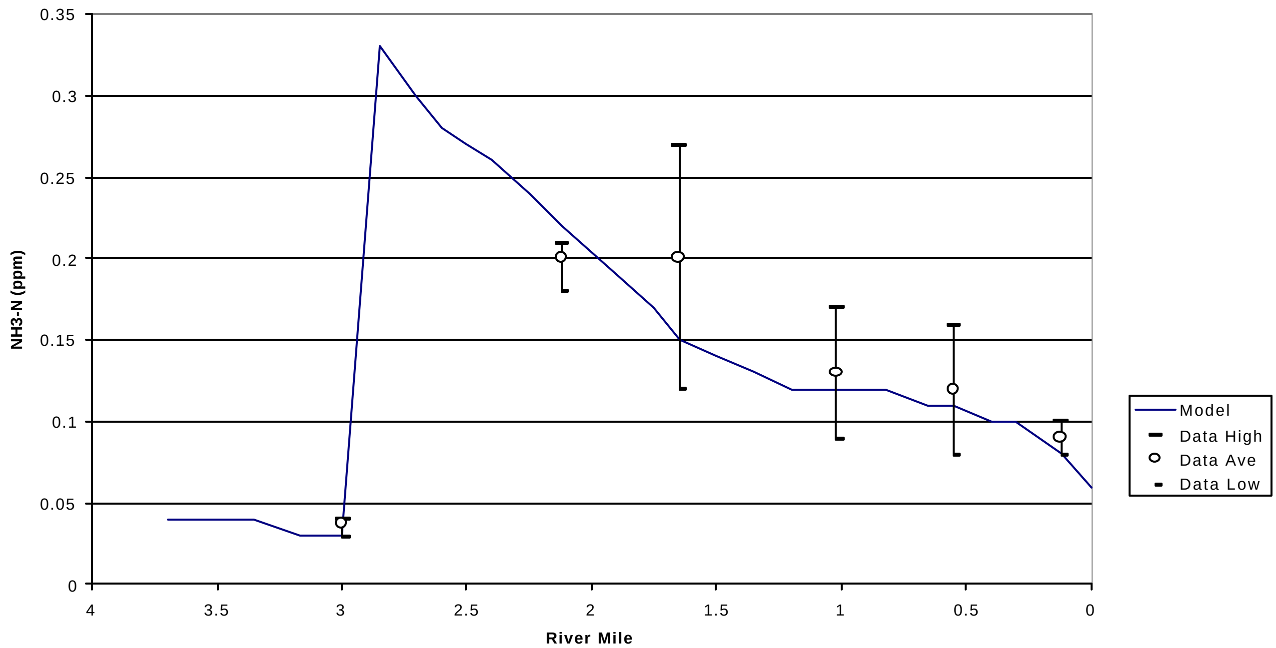
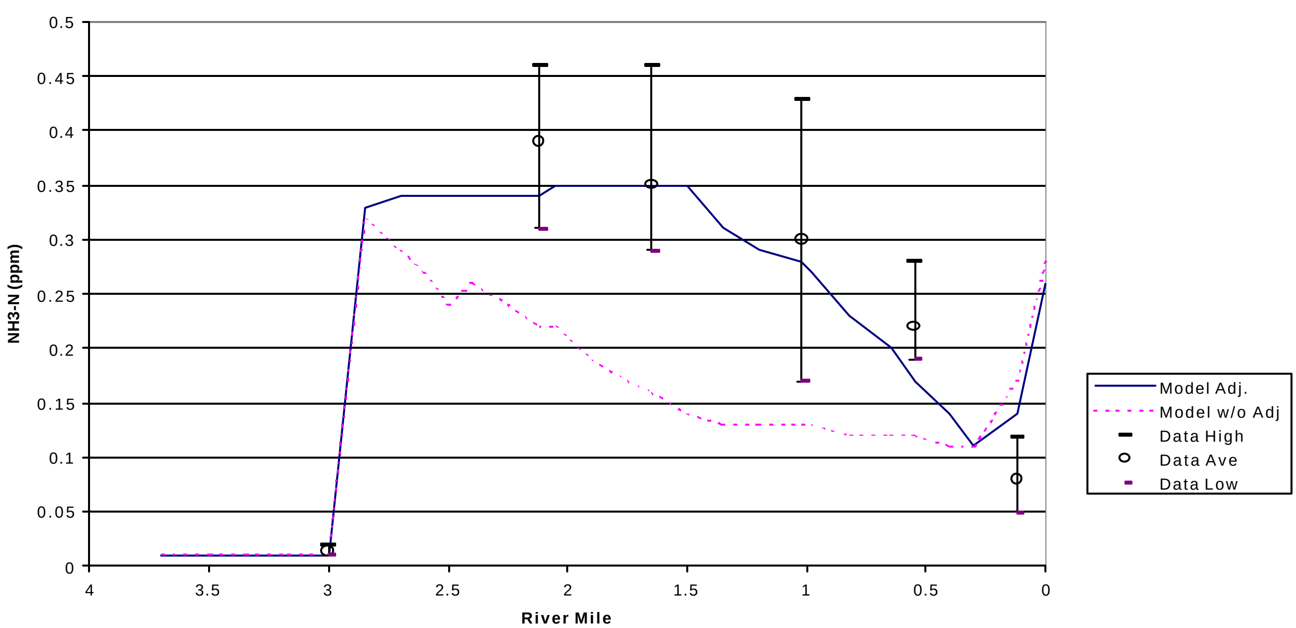



Figure A8
Ammonia Nitrogen Verification
August 1999



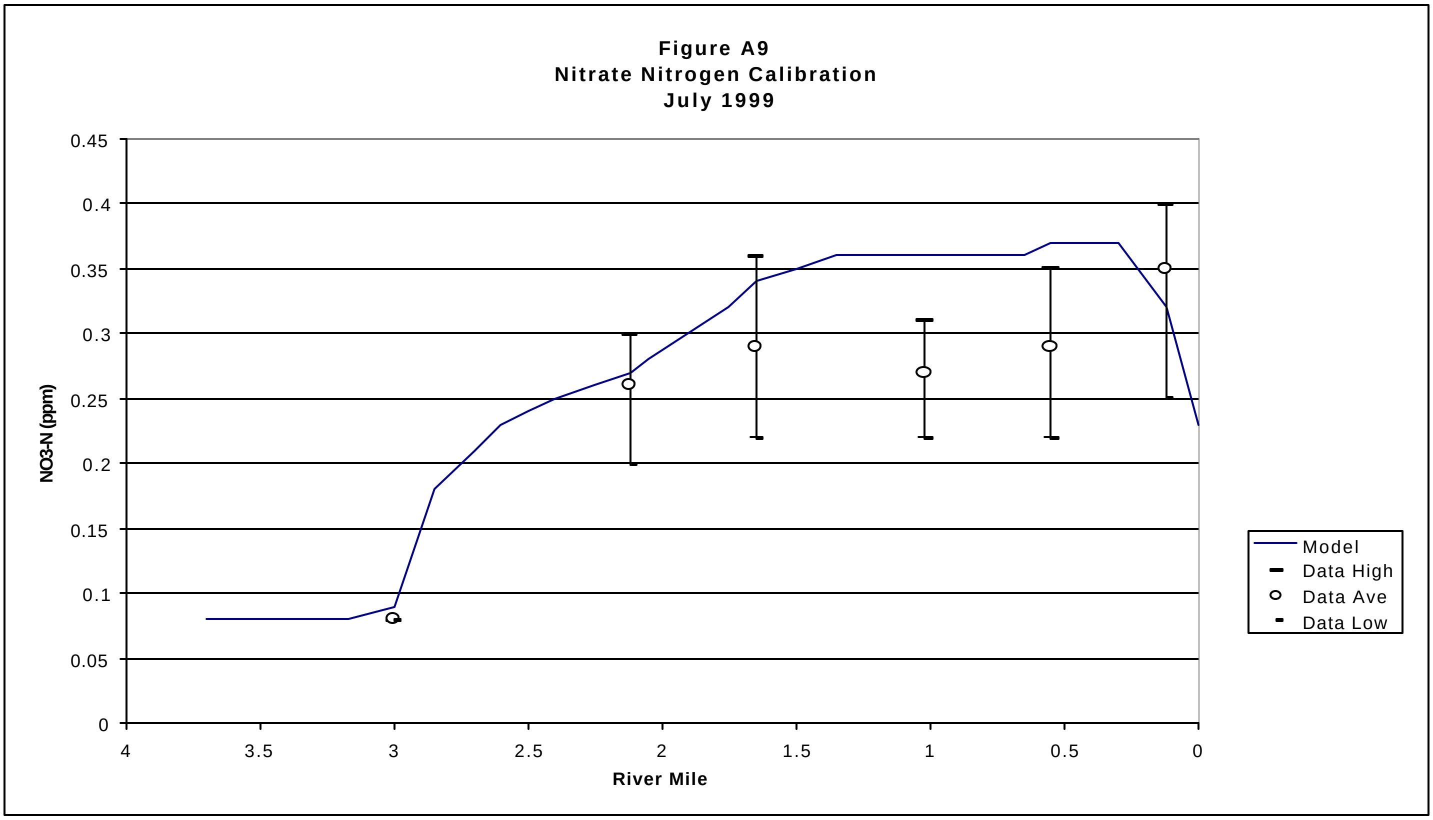


Figure A9
Nitrate Nitrogen Calibration
July 1999
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
NO3-N (ppm)
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model
Data High
Data Ave
Data Low

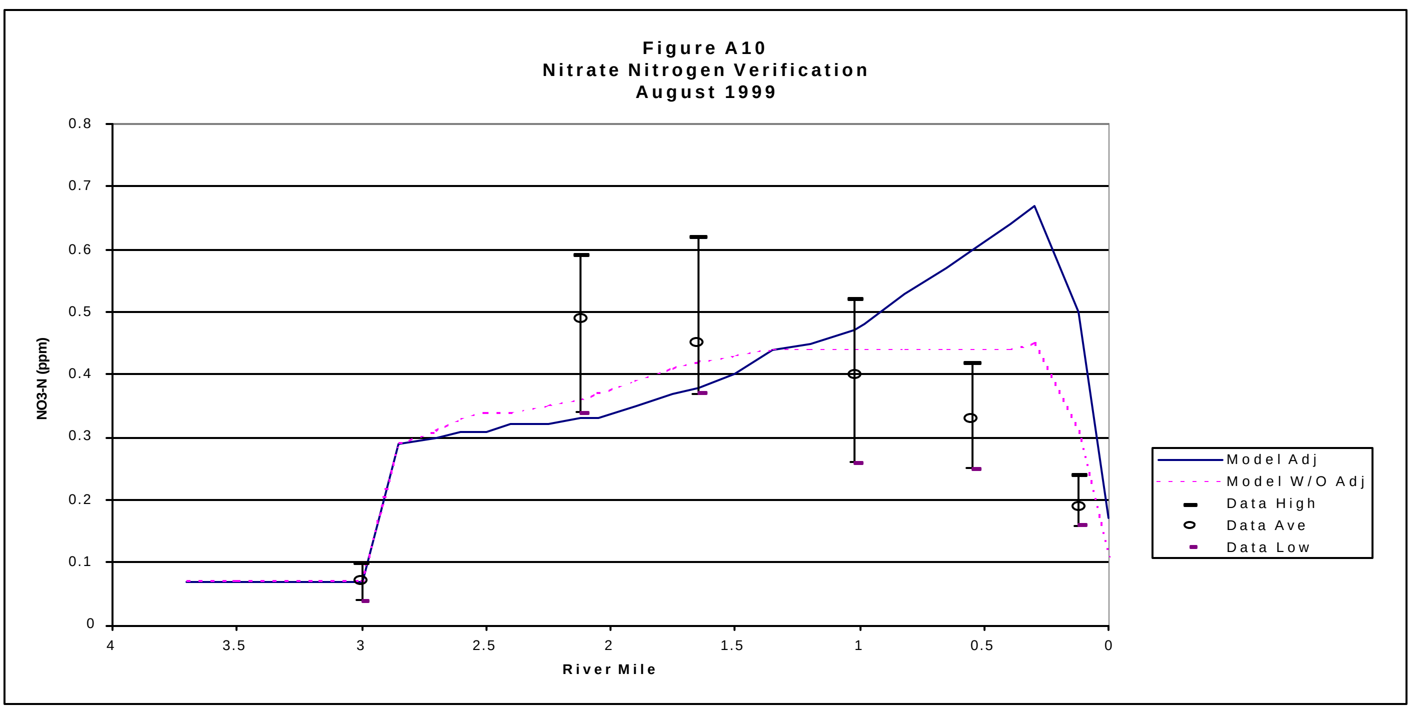


Figure A10
Nitrate Nitrogen Verification
August 1999
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
NO3-N (ppm)
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model Adj
Model W/O Adj
Data High
Data Ave
Data Low

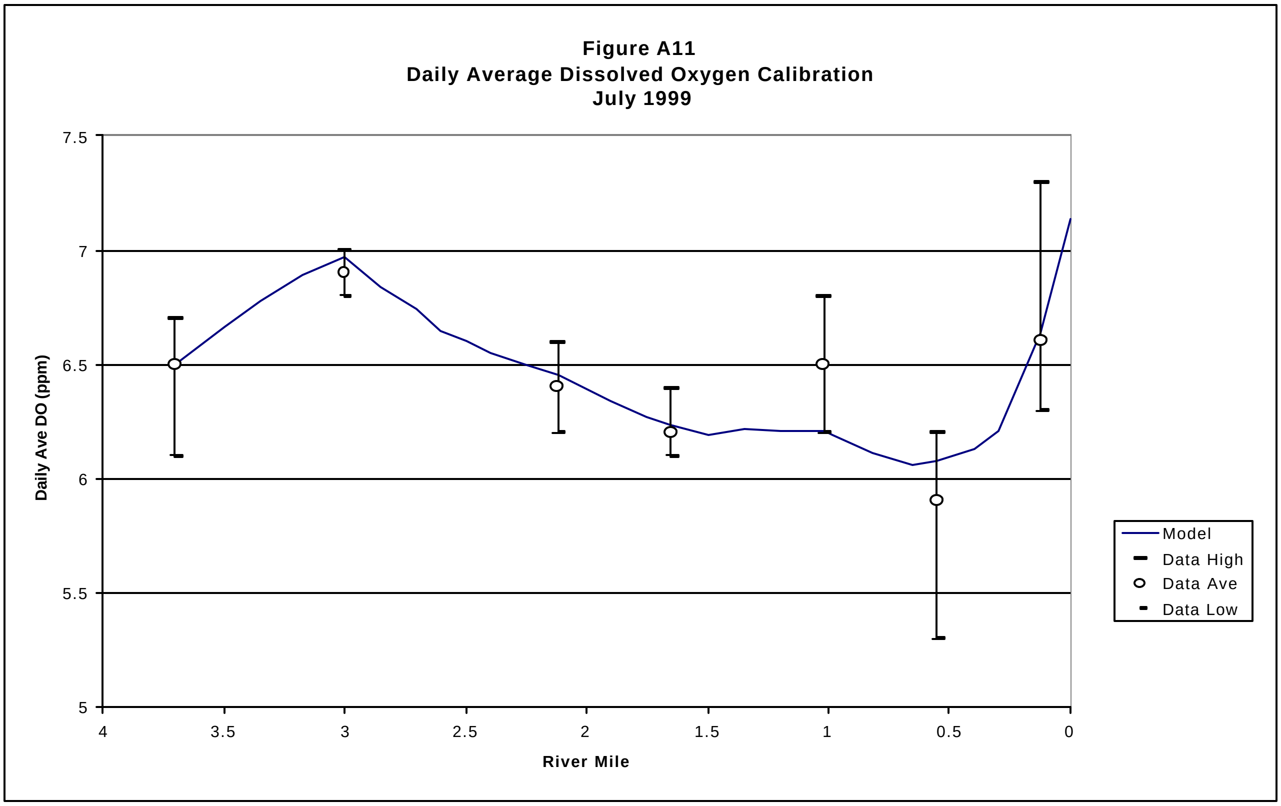


Figure A11
Daily Average Dissolved Oxygen Calibration
July 1999
Daily Ave DO (ppm)
River Mile
Model
Data High
Data Ave
Data Low

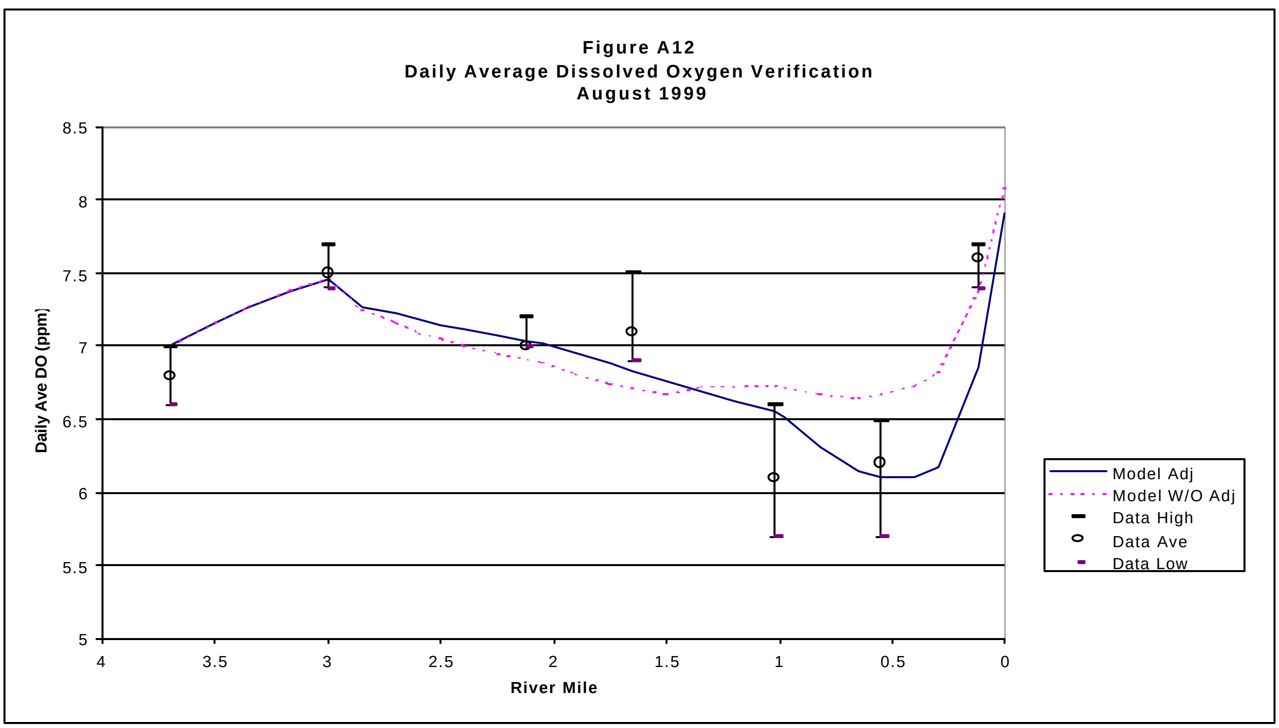


Figure A12
Daily Average Dissolved Oxygen Verification
August 1999
Daily Ave DO (ppm)
River Mile
Model Adj
Model W/O Adj
Data High
Data Ave
Data Low

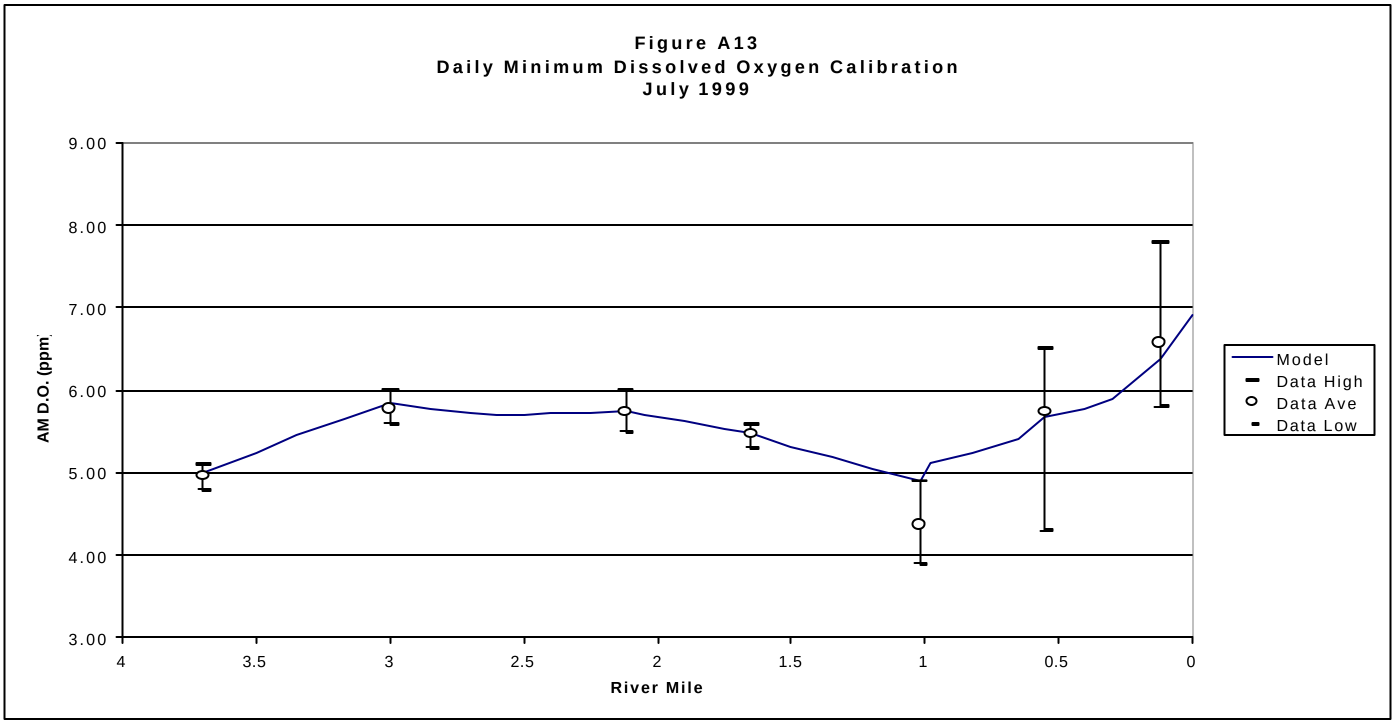


Figure A13
Daily Minimum Dissolved Oxygen Calibration
July 1999
AM D.O. (ppm)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model
Data High
Data Ave
Data Low

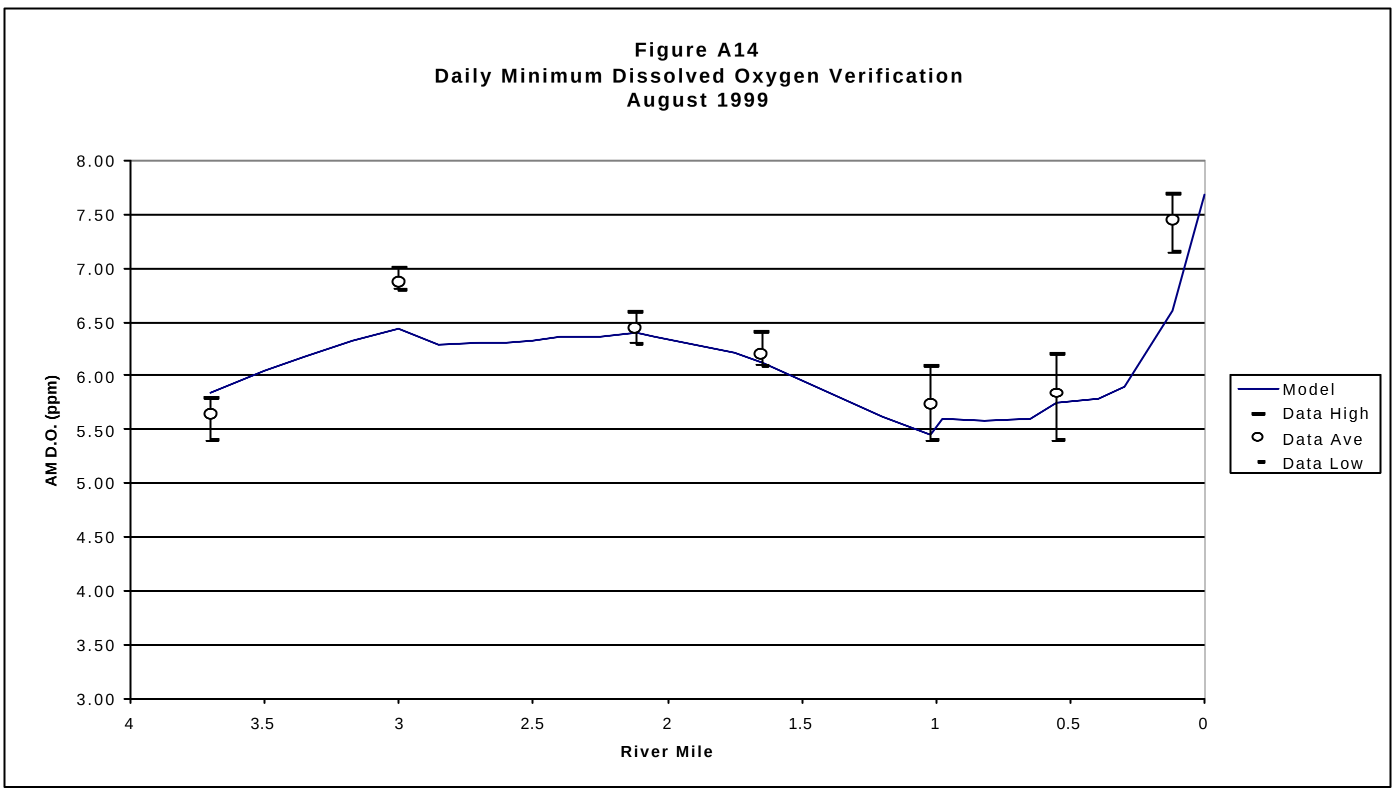


Figure A14
Daily Minimum Dissolved Oxygen Verification
August 1999
AM D.O. (ppm)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
4
3.5
3
2.5
2
1.5
1
0.5
0
River Mile
Model
Data High
Data Ave
Data Low

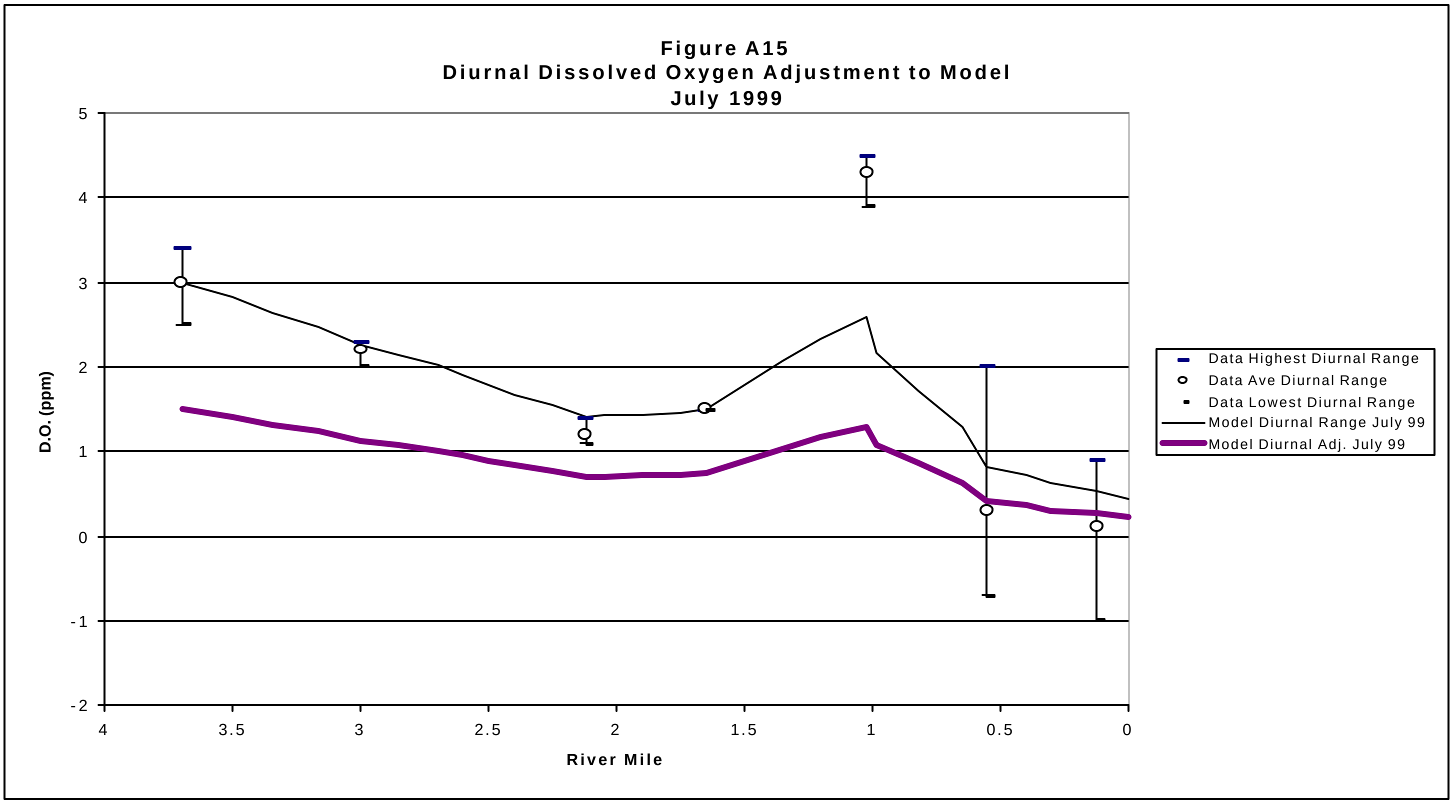


Figure A15
Diurnal Dissolved Oxygen Adjustment to Model
July 1999
D.O. (ppm)
River Mile
Data Highest Diurnal Range
Data Ave Diurnal Range
Data Lowest Diurnal Range
Model Diurnal Range July 99
Model Diurnal Adj. July 99

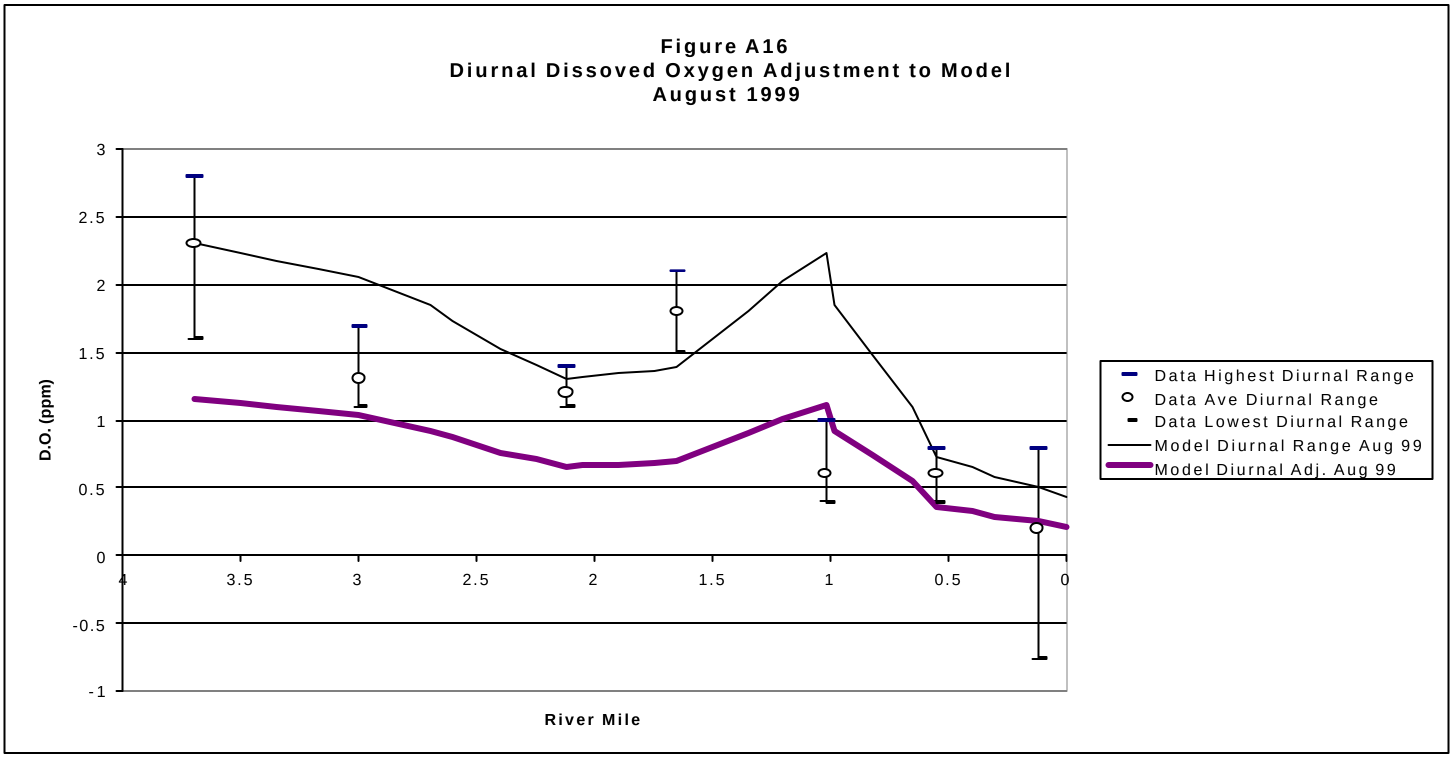



Figure A16
Diurnal Dissoved Oxygen Adjustment to Model
August 1999
D.O. (ppm)
River Mile
Data Highest Diurnal Range
Data Ave Diurnal Range
Data Lowest Diurnal Range
Model Diurnal Range Aug 99
Model Diurnal Adj. Aug 99

# Town of Sanford Clean Techniques Toxic Data

## Mousam River Metals Data -Sanford S D

| Ambient Data ppb | Silver | | | Arsenic | | | Selenium | | | Copper | | | Lead | | | Zinc | | | Aluminum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Butler Corner | School St | Above Outfall | Butler Corner | School St | Above Outfall | Butler Corner | School St | Above Outfall | Butler Corner | School St | Above Outfall | Butler Corner | School St | Above Outfall | Butler Corner | School St | Above Outfall | Butler Corner | School St | Above Outfall |
| **1999** | | | | | | | | | | | | | | | | | | | | | |
| 2-Feb | | | | 0.38 | 0.55 | 0.6 | 0.05 | 0.07 | 0.06 | 2.08 | 4.82 | 2.15 | 2.77 | 2.14 | 2.7 | 1.85 | 5.3 | 5.85 | 66.2 | 80.4 | 86.1 |
| 2-Mar | | | | 0.36 | 0.42 | 0.49 | 0.05 | 0.06 | 0.13 | 6.73 | 2.92 | 2.97 | 3.75 | 3.21 | 3.76 | 11.2 | 9.63 | 9.28 | 105 | 142 | 137 |
| 10-Mar | | | | | | | | | | | | | | | | | | | | | |
| 30-Mar | | | | 0.33 | 0.38 | 0.5 | 0.08 | 0.15 | 0.05 | 3.23 | 3.44 | 2.48 | 2.14 | 2.68 | 2.2 | 2.9 | 4.85 | 5.85 | 74.7 | 99.7 | 102 |
| 31-Mar | | | | | | | | | | | | | | | | | | | | | |
| 27-Apr | | | | 0.162 | 0.359 | 0.378 | 0.04 | 0.068 | 0.048 | 0.28 | 0.63 | 0.66 | 0.07 | 0.39 | 0.43 | 1.23 | 2.74 | 2.94 | 29 | 64 | 58 |
| 25-May | 0.006 | 0.006 | 0.013 | 0.48 | 0.88 | 1.19 | 0.2 | 0.2 | 0.2 | 0.36 | 0.75 | 1.07 | 0.3 | 0.71 | 0.8 | 1.4 | 4.2 | 3.94 | 25 | 51.3 | 117 |
| 26-May | | | | | | | | | | | | | | | | | | | | | |
| 22-Jun | 0.02 | 0.02 | 0.02 | 0.59 | 1.34 | 1.04 | 0.2 | 0.2 | 0.2 | 0.3 | 0.71 | 0.72 | 0.05 | 0.62 | 0.42 | 0.91 | 1.98 | 1.53 | 10 | 28 | 16 |
| 23-Jun | | | | | | | | | | | | | | | | | | | | | |
| 6-Jul | 0.002 | 0.003 | 0.004 | 0.68 | 1.35 | 1.23 | 0.1 | 0.1 | 0.1 | 0.37 | 0.91 | 0.9 | 0.09 | 0.64 | 0.53 | 0.1 | 0.71 | 0.11 | 11.9 | 24.1 | 18.8 |
| 7-Jul | 0.002 | 0.01 | 0.007 | 0.65 | 1.45 | 1.29 | 0.1 | 0.1 | 0.1 | 0.68 | 1.3 | 1.5 | 0.15 | 0.87 | 0.86 | 0.04 | 1.16 | 0.52 | 24.4 | 39.1 | 34.5 |
| 8-Jul | 0.002 | 0.005 | 0.002 | 0.64 | 1.38 | 1.29 | 0.1 | 0.1 | 0.2 | 0.75 | 1.19 | 1.2 | 0.14 | 0.68 | 0.63 | 0.04 | 0.98 | 0.41 | 21.7 | 32 | 28.2 |
| 20-Jul | 0.018 | 0.007 | 0.01 | 0.79 | 1.26 | 1.08 | 0.1 | 0.1 | 0.1 | 0.84 | 1.19 | 1.26 | 0.37 | 0.59 | 0.56 | 1.03 | 2.39 | 1.77 | 40 | 32 | 27 |
| 21-Jul | | | | | | | | | | | | | | | | | | | | | |
| 25-Aug | 0.003 | 0.006 | 0.006 | 0.57 | 0.79 | 0.87 | 0.2 | 0.14 | 0.14 | 0.25 | 0.67 | 0.66 | 0.02 | 0.52 | 0.43 | 0.48 | 1.91 | 1.85 | 7.1 | 24.7 | 14.6 |
| 26-Aug | 0.008 | 0.009 | 0.005 | 0.52 | 1.19 | 0.87 | 0.14 | 0.14 | 0.14 | 0.34 | 0.77 | 0.72 | 0.051 | 0.458 | 0.38 | 0.6 | 3.4 | 1.37 | 6.59 | 16.2 | 11.5 |
| 27-Aug | 0.001 | 0.001 | 0.006 | 0.56 | 0.77 | 0.85 | 0.16 | 0.16 | 0.16 | 0.33 | 0.75 | 0.71 | 0.047 | 0.52 | 0.52 | 0.46 | 1.51 | 1.61 | 6.31 | 20.8 | 13.5 |
| 21-Sep | 0.006 | 0.005 | 0.005 | 0.637 | 0.7 | 0.89 | 0.2 | 0.2 | 0.2 | 0.34 | 0.71 | 0.92 | 0.112 | 0.329 | 0.457 | 1.25 | 3.83 | 4.76 | 27.2 | 38.1 | 46.2 |
| 19-Oct | 0.007 | 0.018 | 0.003 | 0.59 | 0.88 | 1.41 | 0.2 | 0.1 | 0.1 | 0.32 | 0.58 | 0.62 | 0.068 | 0.383 | 0.381 | 0.88 | 2.8 | 3.52 | 12.8 | 19.9 | 24.3 |
| 16-Nov | 0.009 | 0.02 | 0.009 | 0.49 | 0.66 | 0.66 | 0.2 | 0.2 | 0.2 | 0.32 | 0.66 | 0.71 | 0.1 | 0.405 | 0.452 | 1.09 | 3.7 | 3.88 | 36.6 | 57.7 | 56.7 |
| 8-Dec | 0.003 | 0.003 | 0.003 | 0.37 | 0.46 | 0.45 | 0.26 | 0.26 | 0.26 | 1.38 | 1.81 | 1.79 | 0.292 | 0.51 | 0.538 | 1.11 | 3.14 | 3.39 | 40 | 61.4 | 62.8 |
| **2000** | | | | | | | | | | | | | | | | | | | | | |
| 24-Feb | 0.002 | 0.002 | 0.003 | 0.35 | 0.45 | 0.52 | 0.18 | 0.23 | 0.16 | 0.36 | 0.67 | 0.92 | 0.073 | 0.318 | 0.602 | 1.54 | 4.72 | 5.48 | 26.7 | 63.1 | 78 |
| 5-Apr | 0.029 | 0.029 | 0.029 | 0.36 | 0.52 | 0.74 | 0.128 | 0.186 | 0.189 | 2.31 | 2.57 | 2.71 | 0.419 | 0.815 | 0.913 | 2.08 | 5.02 | 5.21 | 75.4 | 115 | 106 |
| Median All | 0.006 | 0.006 | 0.006 | 0.52 | 0.77 | 0.87 | 0.14 | 0.14 | 0.14 | 0.36 | 0.77 | 0.92 | 0.112 | 0.59 | 0.538 | 1.09 | 3.14 | 3.39 | 26.7 | 39.1 | 46.2 |
| Median >4/99 | 0.006 | 0.006 | 0.006 | 0.565 | 0.835 | 0.88 | 0.17 | 0.15 | 0.16 | 0.35 | 0.75 | 0.91 | 0.095 | 0.52 | 0.525 | 0.97 | 2.77 | 2.395 | 24.7 | 35.05 | 31.35 |

| Effluent Data ppb | 1999 | | | | | | | 2000 | | Median | Maximum |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10-Mar | 31-Mar | 26-May | 23-Jun | 21-Jul | 26-Aug | 21-Sep | 24-Feb | 5-Apr | | |
| Silver | | | 0.028 | 0.02 | 0.011 | 0.008 | 0.005 | 0.043 | 0.052 | 0.02 | 0.052 |
| Arsenic | 0.35 | 0.42 | 0.87 | 0.8 | 0.94 | 0.82 | 0.42 | 1.3 | 0.45 | 0.8 | 1.3 |
| Selenium | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.14 | 0.2 | 0.45 | 0.526 | 0.2 | 0.526 |
| Copper | 2.11 | 6.49 | 1.2 | 1.18 | 1.07 | 0.73 | 1.42 | 1.95 | 5.47 | 1.42 | 6.49 |
| Lead | 0.166 | 1.51 | 0.11 | 0.02 | 0.12 | 0.02 | 0.046 | 0.222 | 0.412 | 0.12 | 1.51 |
| Zinc | 5.95 | 4.7 | 1.4 | 0.71 | 0.84 | 0.65 | 1.36 | 5.13 | 4.13 | 1.4 | 5.95 |
| Aluminum | 62.1 | 159 | 879 | 52 | 98 | 52.7 | 26.4 | 231 | 66.4 | 66.4 | 879 |

# Summer 2000 Water Quality Data

**Lower Mousam River**
**MDEP**

Date 6/29/00
Weather: Cloudy

| Sta Code | Location | Depth m | Time AM | DO ppm | DO % Sat. | Temp $^{o}C$ |
|---|---|---|---|---|---|---|
| S12 | Below Old Falls Dam | 0 | 9:20 | 6.8 | 78.7% | 22.6 |
| | | 1 | | 6.8 | 78.7% | 22.6 |
| S13 | Above Confluence Cold Water Brook (brown camp left side) | 0 | 8:35 | 6.5 | 74.3% | 22.0 |
| | | 1 | | 6.4 | 73.1% | 21.9 |
| | | 1.7 | | 6.5 | 73.9% | 21.7 |
| S14 | Power Lines | 0 | 8:10 | 7.1 | 82.5% | 22.8 |
| | | 1 | | 7.0 | 80.5% | 22.3 |
| | | 2 | | 6.4 | 72.4% | 21.4 |
| S15 | (broken dead tree right) | 0 | 7:45 | 7.8 | 91.1% | 23.1 |
| | | 1 | | 7.5 | 87.6% | 23.1 |
| | | 2 | | 6.8 | 77.5% | 21.8 |
| | | 3 | | 5.6 | 62.9% | 21.1 |
| S16 | Above Dam at Mill Rd, West Kennebunk | 0 | 6:42 | 7.9 | 91.4% | 22.6 |
| | | 1 | | 7.6 | 88.1% | 22.7 |
| | | 2 | | 5.8 | 66.6% | 22.2 |
| | | 3 | | 3.7 | 41.3% | 20.7 |
| S17 | Near Dam at Twine Mill | 0 | 7:05 | 7.8 | 91.1% | 23.1 |
| | | 1 | | | | |
| S18 | Behind Corning Factory | 0 | 7:20 | 7.3 | 82.0% | 21.1 |
| | | 1 | | | | |
| S19 | Off dock at Donovan residence (11 Partridge Lane) | 0 | 8:35 | 7.2 | 83.5% | 22.7 |
| | | 1 | | 7.1 | 82.3% | 22.7 |
| | | 2 | | 6.5 | 75.1% | 22.5 |
| S20 | Above dam at Rte 1 bridge (east bank off railing) | 0 | 7:45 | 6.9 | 79.5% | 22.4 |
| | | 1 | | 6.9 | 79.5% | 22.4 |
| | | 2 | | 6.4 | 73.8% | 22.4 |

**Lower Mousam River**
**MDEP**

Date 7/13/00
Weather Clear

| Sta Code | Location | Depth m | AM Time AM | DO ppm | DO % Sat. | Temp °C | PM Time PM | DO ppm | DO % Sat. | Temp °C |
|---|---|---|---|---|---|---|---|---|---|---|
| S12a | Above Old Falls Dam | 0 | 8:50 | 8.1 | 95.9% | 23.8 | | | | |
| | | 1 | | 7.9 | 92.8% | 23.4 | | | | |
| | | 2 | | 8.1 | 95.1% | 23.4 | | | | |
| | | 3 | | 6 | 68.9% | 22.2 | | | | |
| | | 4 | | 1.3 | 14.3% | 20.1 | | | | |
| S12 | Below Old Falls Dam | 0 | 7:20 | 6.0 | 68.6% | 22.0 | 12:47 | 7.0 | 82.2% | 23.4 |
| | | 1 | | 6.0 | 68.6% | 22.0 | | | | |
| S13 | Above Confluence Cold Water Brook (brown camp left side) | 0 | 7:11 | 5.8 | 66.1% | 21.8 | 13:00 | 6.3 | 74.7% | 23.9 |
| | | 1 | | 5.7 | 65.1% | 21.9 | | 6.1 | 70.0% | 22.2 |
| | | 2 | | 6.2 | 69.1% | 20.7 | | 6.1 | 69.6% | 21.9 |
| S14 | Power Lines | 0 | 7:00 | 6.3 | 71.8% | 21.8 | 13:15 | 7.0 | 84.6% | 24.9 |
| | | 1 | | 6.3 | 71.8% | 21.8 | | 6.9 | 79.8% | 22.6 |
| | | 2 | | 6.2 | 70.6% | 21.8 | | 6.7 | 76.2% | 21.7 |
| S15 | (broken dead tree right) | 0 | 6:48 | 7.3 | 84.6% | 22.7 | 13:30 | 7.5 | 91.3% | 25.3 |
| | | 1 | | 7.3 | 84.6% | 22.7 | | 7.1 | 82.5% | 22.8 |
| | | 2 | | 6.9 | 79.8% | 22.6 | | 6.6 | 75.6% | 22.1 |
| S16 | Above Dam at Mill Rd, West Kennebunk | 0 | 6:35 | 7.9 | 91.7% | 22.8 | 13:37 | 8.0 | 98.1% | 25.7 |
| | | 1 | | 7.9 | 91.7% | 22.8 | | 8.0 | 94.1% | 23.5 |
| | | 2 | | 7.0 | 80.5% | 22.3 | | 7.2 | 83.3% | 22.6 |
| | | 3 | | | | | | 5.4 | 61.2% | 21.5 |
| S17 | Near Dam at Twine Mill | 0 | 6:55 | 8.1 | 93.7% | 22.6 | 13:15 | 8.3 | 101% | 25.2 |
| | | 1 | | 8.0 | 92.6% | 22.6 | | | | |
| S18 | Behind Corning Factory | 0 | 7:15 | 7.8 | 89.0% | 21.9 | 13:00 | 8.2 | 96.0% | 23.2 |
| | | 1 | | | | | | | | |
| S19 | Off dock at Donovan residence (11 Partridge Lane) | 0 | 7:35 | 6.9 | 78.6% | 21.8 | 12:45 | 7.2 | 83.5% | 22.7 |
| | | 1 | | 7.3 | 83.2% | 21.8 | | 6.9 | 79.7% | 22.5 |
| S20 | Above dam at Rte 1 bridge (east bank off railing) | 0 | 7:50 | 7.0 | 80.4% | 22.2 | 12:30 | 7.7 | 88.6% | 22.3 |
| | | 1 | | 7.2 | 82.7% | 22.2 | | 7.4 | 84.8% | 22.1 |
| | | 2 | | 7.6 | 87.8% | 22.5 | | 7.1 | 81.8% | 22.4 |

**Upper Mousam River Summer 2000 Data**

| Sta Code | Location | Date | Time | Depth | DO (ppm) | DO(% sat) | Temp (oC) | TP (ppb) | Flow (cfs) |
|---|---|---|---|---|---|---|---|---|---|
| S1a | #1 Pond Inlet (River St) | 2-Aug | 7:45 | < 1 meter | 8.8 | 96.8% | 20 | 14 | |
| | | 10-Aug | 8:07 | | 8.1 | 94.4% | 23 | 14 | |
| | | 17-Aug | 7:45 | | 8.2 | 90.7% | 20.3 | 13 | |
| | | 7-Sep | 8:25 | | 8.6 | 90.8% | 18 | 10 | |
| S1b | #1 Pond (River St lower) | 2-Aug | 7:35 | 1M | 8.4 | 92.4% | 20 | No TP Data | |
| | | 10-Aug | 8:00 | | 7.5 | 87.1% | 22.8 | | |
| | | 17-Aug | 7:35 | | 7.3 | 80.3% | 20 | | |
| | | 7-Sep | 8:20 | | 7.4 | 76.7% | 17.1 | | |
| S1c | #1 Pond above Dam (Rte 202) | 2-Aug | 7:25 | 2 M depth. Readings uniform in vertical | 7.5 | 82.2% | 19.8 | 14 | |
| | | 10-Aug | 7:50 | | 7.8 | 92.3% | 23.8 | 18 | |
| | | 17-Aug | 7:30 | | 7.3 | 81.6% | 20.8 | 12 | |
| | | 7-Sep | 8:10 | | 7.6 | 80.8% | 18.3 | 12 | |
| S2a | Near sewer trunkline below wetland | 2-Aug | | < 1 meter | | | | 17 | |
| | | 10-Aug | 7:15 | | 6.4 | 74.9% | 23.2 | 25 | |
| | | 17-Aug | 7:05 | | 6.8 | 74.3% | 19.7 | 13 | |
| | | 7-Sep | 7:45 | | 6.9 | 69.9% | 16.0 | 10 | |
| S4 | Rte 4 Bridge | 2-Aug | 6:40 | < 1 meter | 6.8 | 73.9% | 19.4 | 18 | 208 |
| | | 10-Aug | 6:55 | | 6.2 | 72.6% | 23.2 | 14 | 72 |
| | | 17-Aug | 6:40 | | 6.7 | 73.1% | 19.6 | 13 | 48 |
| | | 7-Sep | 7:30 | | 7.4 | 75.8% | 16.5 | 9 | 20 |
| GW1-t | Great Works R at Old Mill Rd | 2-Aug | 7:10 | < 1 meter | 7.6 | 76.8% | 15.9 | | |
| | | 10-Aug | 8:25 | | 6.3 | 66.7% | 18.1 | | |
| | | 17-Aug | 8:00 | | 7.1 | 71.8% | 15.9 | | |
| | | 7-Sep | 8:40 | | 8.2 | 74.7% | 11.2 | | |
| GW2-t | Great Works R at Sand Pond Rd | 2-Aug | 7:00 | < 1 meter | 6.4 | 65.5% | 16.5 | 27 | |
| | | 10-Aug | 8:40 | | 6.4 | 70.7% | 20.2 | 29 | |
| | | 17-Aug | | | | | | 24 | |
| | | 7-Sep | 8:57 | | 8.1 | | 14.2 | 19 | |
| LR-t | Littlefield River at Route 111 | 2-Aug | 6:20 | 1 m, Reading uniform in vertical | 3.0 | 32.3% | 19.0 | 22 | |
| | | 10-Aug | 6:25 | | 3.6 | 42.0% | 23.1 | 18 | |
| | | 17-Aug | 6:40 | | 3.8 | 41.4% | 19.5 | 15 | |
| | | 7-Sep | 7:05 | | 4.4 | 44.3% | 15.7 | 14 | |

# Responses to Public Comment

## USEPA Comments

1. Comment: Please verify that the TMDL river segment is class C and the 303d listing is for WBS#628R.
Response: MDEP agrees.

2. Comment: Please consider including a map of the watershed with the non-attainment segment identified.
Response: A map will be included.

3. Comment: Please reconsider the silver TMDL at this time. The listed CCC (0.12 ppb) does not have standing with EPA as criteria guidance.
Response: MDEP will drop the chronic silver TMDL. However the acute criteria for silver is 0.25 ppb and an acute silver TMDL will be included in the final report.

4. Comment: Please reconsider the arsenic TMDL, both the target for the total and the non-point source (NPS) allocation.
Response: Maine law has a provision, which exempts natural causes as a cause of non-attainment. The total TMDL will be based upon maintaining the natural arsenic level of 0.56 ppb in the TMDL segment. This results in a total TMDL of 0.084 lb/day. Sanford's TMDL for arsenic remains unchanged (0.02 lb/day). The arsenic TMDL for natural and NPS is .043 and.02 lb/day, respectively.

4a. An error has been discovered in the toxic substance TMDL (table 7). The same river flow was assigned for Butler Corner and above Sanford's outfall. Field observations verify that the flow at Butler Corner is less. The table has been changed using flows of 14 and 20.7 cfs at Butler Corner and above Sanford's outfall, respectively (based upon a proportion of drainage areas). The changes do not affect the total TMDL and Sanford's allocation, but result in a lower allocation for natural sources and a higher allocation for NPS. Table 7 will be redone in the final report with the mentioned changes and those in in #3 and #4.

5. Comment: What is the basis for assuming that the data collected at Butler Corner represents natural background conditions, especially with respect to arsenic in surface water? Have you information on the range of natural background levels for arsenic in surface water in Maine?
Response: Butler corner is above the urban areas of Sanford and Springvale and just below Mousam Lake and can be expected to have relatively clean water quality conditions for toxic substances. MDEP undertook toxic sampling in 1998 at 61 unimpacted sites for seven toxic substances including arsenic. The goal of this study was to determine natural background levels for the seven toxic substances statewide. The arsenic detection limit utilized for this study was 0.8 ppb, much higher than the Sanford

study in which values as low as .16 ppb were recorded. In the 1998 study, 24% of the samples (total 109) were above the detection level of 0.8 ppb. Values as high as 2.7 ppb were recorded. It is reasonable to assume that about 1/3 of these samples were higher than the 0.56 ppb recorded at Butler Corner (the higher detection level makes a more precise estimate impossible). Had Butler Corner been included in this study, it too would have tested below the detection limit of 0.8 ppb. Another consideration is the fact that a compilation of statewide data indicates that groundwater in Sanford has high arsenic values (Arsenic in Maine Groundwater, An Example from Buxton, Maine, Marvinney, Loiselle, Hopeck, Braley, Krueger). Hence natural conditions for toxic substances at Butler Corner appears to be a reasonable assumption.

6. Comment: In the executive summary, please resolve the apparent contradiction between items #4 and #5.
Response: In #4 the statement "Non-point source pollution does not appear to be a significant contributor" is directed toward the non-attainment segment where point source pollution is the major source of impact to dissolved oxygen depletion. In #5, the statement "Degraded background conditions in the Mousam is probably due to stormwater runoff from the urban areas of Sanford and Springvale is directed at dissolved oxygen depletion above the non-attainment segment.

The NPS inputs of nutrients which are probably from urban runoff appear to be partly responsible for dissolved oxygen depletion in the river from the Sanford urban area to the Rte 4 bridge. The Mousam is considered to be marginally attaining class C dissolved oxygen criteria upstream of Sanford's outfall. Downstream of Rte 4, dissolved oxygen appears to be recovering from NPS impacts and by the time the Sanford discharge starts impacting dissolved oxygen in the river, NPS impacts are nearly gone. NPS appear to be a significant contributor of some toxic substances, lead and copper in particular. This will be better explained in the final TMDL report.

7. Comment: Please clarify whether or not you have considered future NPS in the load allocation. If there is no statement of intent or allocation in the TMDL for future NPS, there is an implicit assumption that there will be no future growth, etc. in the area, and raises the question of how load reductions will be handled for future NPS loadings, if they occur.
Response: Trying to quantify future NPS loads is difficult and picking a future time period on which to apply the projected loads is equally difficult. It is hoped that future efforts will decrease NPS pollution rather than presuming it will increase . The phase II NPDES stormwater permitting efforts should result in a reduction of future NPS loading to the Mousam River. In addition, the TMDL report has recommended that stormwater best management practices be implemented on urban Springvale and Sanford. Allocation to future NPS at this time is premature, but DEP agrees this should be watched closely.

8. Comment: Please clarify whether stream conditions or lake conditions are the more critical influence on setting the summer TMDL for TP in the non-attainment segment upstream of Estes Lake.

Response: The stream conditions are the more critical factor requiring a TP limit of 3 lb/day. The lake TP restrictions require a TP limit of 5 lb/day. The current water quality trends at Estes Lake appear to indicate a slight improvement (personal communication Judy Potvin, Lakes Section, MDEP). Historic data indicates that algae blooms can be avoided at Estes Lakes as long as the operation of the Sanford WWTP for phosphorus removal is good. The recent improvements at the SSD treatment plant for removing phosphorus and the newly required lower TP limits should result in even more improvement in both the river and lake.

9. Comment: Please consider clarifying MDEP's apparent intention to set a WLA of zero for Sanford at flows less than 20 cfs by translating the narrative assumption (now stated in the TMDL tables 5a, 5B, and 6 into the framework of the TMDL tables.
Response: The narrative wording "Assumes Sanford does not discharge when river flow < 20 cfs at Route 4 gage" that is included at the top of tables 5a, 5b, and 6 will be reworded as follows. "Sanford's TMDL for all pollutant parameters is zero, whenever river flow as measured at the Rte 4 bridge < 20 cfs." In addition, MDEP plans to include this as a licensed condition in Sanford's waste discharge permit.

10. Comment: Please clarify the status of Cyro Industries in the TMDL
Response: The exclusion of Cyro Industries in the TMDL table, together with the total defined TMDL for each parameter automatically implies a TMDL of zero for Cyro (or any future discharge) for each pollutant parameter. The tables will be changed to better clarify this.

11. Comment: How has a margin of safety (MOS) been included in the TMDL's?
Response: MDEP concurs that a MOS is being provided at flows under 20 cfs, since the model predicts a minimum dissolved oxygen of 5.8 ppm will occur which is 0.8 ppm over minimum criteria. In addition, a 10% reduction of BOD is being provided as an explicit margin of safety when river flow is greater than 20 cfs. The fact that the plant performs at BOD levels well under license requirements provides some additional margin of safety. An explicit margin of safety of 10% is also being provided for the non-summer ammonia TMDL. The large explicit margin of safety for toxic substances that varies from 30% to 50% is provided for the higher tier flow TMDL (except for lead and arsenic, which need NPS reductions to meet the TMDL).

12. Comment: How have seasonal variations been considered in the TMDL?
Response: Seasonal variations have been considered due to the fact that BOD, TP, and ammonia TMDL's are different for the summer and non-summer. A section will be added to the final TMDL report that explains this in more detail.

13. Comment: Describe the details of the process by which ME DEP gave the public an opportunity to participate in the TMDL process.
Response: The availability of the TMDL for public comment was advertised in the legal notices section of two newspapers in southern Maine. The TMDL has also been available in electronic form on the web in DEP's homepage. In addition, DEP has had

many meetings with the Sanford Sanitary District personnel and their consultant (Wright Pierce Engineers) throughout the development and public comment period of the TMDL.

14. Comment; In the submittal letter, please state that TMDL is final submitted under section 303(d) of the Clean Water Act and include the following:
-Name and location of the waterbody
-The pollutants of concern
-The priority ranking of the waterbody
Response: Ok.

15. Comment: Include more background information on NPS. Include allowances for future point and NPS. Encourage Sanford to explore growth management.
Response: More background information can be included. A recommendation was included in the report (page 27) that addressed future growth. "To facilitate compliance with stringent license requirements and address growth and possible future treatment plant expansions, Sanford should consider investigating additional holding capacity and / or partial land application of effluent." Growth management is another possible way of complying with the TMDL in the future. However each licensee has the flexibility to determine its own method for complying with the TMDL in the future.

16. Comment: Please consider revising the section on "Discussion of Background Data." The Great Works and Littlefield Rivers appear to be a poor choice for reference unimpacted streams. The data appears to support that NPS is affecting all three rivers presented.
Response: MDEP agrees with the statement that York County is impacted by NPS pollution. However, care should be exercised on determining the blame on the dissolved oxygen depletion of these three rivers. This section is an important part of the TMDL, since it suggests that the upper Mousam (above the SSD outfall) may be affected less by natural and NPS oxygen depletion than the two other rivers. This is a particularly surprising finding when the land uses are considered. The upper Mousam River drainage includes a large urban area and the other rivers presented are more rural in nature.

The dissolved oxygen depletion in the upper Great Works watershed is probably not due to NPS pollution. The water of the Great Works was visibly highly colored. The presence of color indicates high natural BOD from the wetland drainage in the vicinity of the sampling points. Hence probably most of the dissolved oxygen depletion here is due to natural causes. The upper Mousam similarly drains wetlands and some of its dissolved oxygen depletion can be due to natural causes. While it is true the Great Works was included as a priority for cleanup in the Salmon Falls TMDL, the sample locations for this study include only about 10% to 15% of the total Great Works drainage.

MDEP agrees that this should be better explained in the final TMDL report.

# Sanford Sanitary District Comments

1. Comment: The Sanford Sanitary District (SSD) states that they have little control over stormwater and non-point source discharges to the river because they are an independent entity separate from the town of Sanford. As such, they have little control over recommendations #1 and #2 on page 2 of the Executive Summary.
Response: There will be no requirement for the SSD to implement NPS reductions. However, the SSD should understand the implications of not controlling NPS pollution to the Mousam River. For example, if phosphorus NPS pollution is allowed to continue unchecked, the NPS phosphorus load to the river could increase in the future. This could result in even more stringent TP limits for the SSD in the future.

The TMDL's for lead and arsenic require immediate reductions in NPS loads. Once again, the SSD will not be required to implement the NPS reductions. This could possibly be achieved through NPDES stormwater permitting.

In either case, the SSD is encouraged to communicate with the appropriate town officials to insure an effort will be forthcoming to reduce NPS pollution.

2. Comment: SSD requests that a second tier of river loading conditions be established for a WWTP flow of 8.8 mgd that would be in effect whenever the river trigger flow exceeds100 cfs.
Response: This issue was discussed often at meetings between MDEP and the SSD. MDEP understands that the SSD needs this higher flow tier to decrease the lagoon volume as low as possible in the spring to facilitate the summer storage capacity of the plant. From MDEP's point of view there was the issue of margin of safety, i.e. not being near or at AWQC in the river for toxic substances for long periods of time. To address this concern, the river trigger flow for the upper tier was increased by a factor of five from the lower river tier (20 cfs) and the WWTP flow only by a factor of two (rather than five). This effectively allows for a MOS factor of between 30% and 50%.

MDEP would allow a higher tier discharge for a limited time period in late winter to early spring. More specifically we would propose to allow the higher tier discharge from Feb 15 to April 15. The mass limits for non-summer BOD and ammonia could be doubled and the mass limits for toxic substances could also be doubled. The non-summer mass limit for TP should remain the same. For ammonia and the other toxic substances, a non-summer TMDL at flows over 100 cfs will have to be established for the time period of mid February to mid April.

3. Comment: SSD requests that their allocation in the TMDL be revised to allow more ammonia and less BOD. More specifically they are requesting that their BOD5 allocation in the TMDL be reduced by 1/3 (from 435 to 290 lb/day) to allow for a 38% increase of their ammonia allocation in the TMDL (from 14.5 to 20 lb/day).

Response: DEP modeling shows that the minimum river dissolved oxygen predicted by the model under this new allocation is 5 ppm, which still meets class C criteria. However, the fact that Sanford has historically discharged well under its license requirements for BOD was a major consideration for the margin of safety (MOS) proposed for the TMDL. Summer concentration limits for ammonia and / or phosphorus may be necessary as a new margin of safety.
Note: Subsequent correspondence with Wright Pierce Engineers (Mitnik to Leonard telephone conversation 1/24/01) indicates that Sanford is no longer pursuing this option, due to their preference not to include summer ammonia concentration limits in their waste discharge license.

4. Comment: SSD requests that summer concentration limits not be included for ammonia based upon the mass limits that were derived from dissolved oxygen consumption. SSD request that if summer concentration limits for ammonia be put on the license, they be based upon toxic concerns (8.67 ppm).
Response: Logistically it does not make sense to include concentration limits that are more than 17 times the required concentration limit at design flow (0.5 ppm). There is no water quality basis for summer ammonia concentration limits. DEP recognizes that a treatment system utilizing lagoons offers more flexibility than a typical flow through system. DEP proposes to license the summer ammonia as a mass limit (14.5 lb/day) with no concentration limit included.

5. Comment: The SSD requests that the summer period for initiating the more stringent ammonia limits be changed from May 1 to May 15. The limits can be recalculated based upon a non-summer temperature of 15 $^{o}$C.
Response: This request is acceptable to DEP and will be incorporated into the final report.

6. Comment: SSD requests that the license TSS and non-summer BOD limits be revisited. Advanced treatment limitations for BOD and TSS are currently required year round. There does not appear to be a water quality basis for the non-summer limits of both and the summer TSS limits. Process changes in the plant could make non-summer compliance with advanced treatment requirements difficult.
Response: DEP agrees that the non-summer limits for BOD and TSS are not necessary and proposes to change them to conventional secondary limits. However, we feel that the advanced summer limits for TSS are needed to meet class C aquatic life water quality criteria. Given that earlier data here marginally met class C, DEP is concerned that a summer increase in TSS could lead to aquatic life non-compliance due to a smothering of habitat. (The 1999 data has shown improved aquatic life conditions from earlier data and class C is now met in the TMDL segment.)

7. Comment: SSD is concerned that the requirement to maintain their effluent dissolved oxygen to 8 ppm will be difficult to meet at high water temperatures and are requesting this requirement be reduced to 7.5 ppm. Preliminary calculations show that 50% less energy is needed for the 7.5 ppm requirement as compared to 8 ppm.

Response: This request is acceptable to DEP, since the model predicts that river dissolved oxygen should still meet class C criteria with SSD's effluent aerated to 7.5 ppm.

## **Kennebunk Sewer District Comments**:

1.Comment: Kennebunk Sewer District (KSD) states a better understanding of the causes of the non-attainment of class B dissolved oxygen criteria of the lower Mousam River is needed.
Response: DEP believes a major cause of the non-attainment of the lower Mousam River is a bottom release of river water from the Old Falls dam. Data has shown that low dissolved oxygen often occurs in the deeper portions of the Old Falls impoundment . If this problem were corrected, most of the lower Mousam could probably attain class B dissolved oxygen criteria.

2. Comment: KSD states that more evidence is needed to support DEP's statement that water quality from segments upstream of Estes Lake do not effect water quality in Kennebunk.
Response: The data taken directly above KSD's outfall in the Mousam River estuary study has generally shown that good dissolved oxygen levels occur here and low pollutant levels also are evident here. Estes Lake and the many impoundments located down to Kennebunk result in a long residence time where pollutants can be assimilated before they reach Kennebunk. In addition, there is a long stretch of rapids at the head of the estuary which aerates the dissolved oxygen to conditions approaching saturation at Kennebunk.

3. Comment: KSD is concerned that the approach taken by MDEP to manage the Mousam watershed is piecemeal and a more complete analysis that considers the entire watershed is needed.
Response: MDEP agrees with the approach suggested by KSD in principle, but logistically watershed approaches are difficult. The scope of field work needed to sample a watershed the size of the Mousam does not fit within DEP's budget and staffing constraints, considering the Mousam is only one of several TMDL's (160) that need to be undertaken in the next ten years. In addition, deadlines such as the one dictated by the Sanford situation (end of 2000) make a watershed approach difficult due to the much longer time period needed for a whole watershed study. The long residence time of the Mousam and Estes Lake of several weeks makes a piecemeal approach possible. This approach suggested by KSD could still be done in the future, to reduce NPS pollution within the Mousam watershed. The DEP would need a lot of outside help to make something like this possible.