

Penobscot River Phosphorus Waste Load Allocation Ambient Monitoring Plan Report - 2012

May 2013

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Goals / Methodology

The primary goal of the Penobscot River Ambient Monitoring Plan (PRAMP) is to measure the effectiveness of the Phosphorus-Waste Load Allocation (P-WLA) in eliminating eutrophication driven Dissolved Oxygen (DO) non-attainment, and to identify potential/particular areas of concern along the river. Eutrophication driven DO non-attainment on the Penobscot primarily occurs in the shallower free flowing reaches of the river where periphyton (bottom attached algae) can flourish. These sections of the river are more prone to large diurnal DO swings than deeper reaches of the river. Diurnal DO swings are produced by algae (and other living plants) that result from net photosynthetic production of oxygen during daylight hours and respirative consumption of oxygen during non-daylight hours. Large diurnal DO swings (> 2 mg/l) are often indicative of nutrient enrichment. Excessive diurnal swings have the tendency to produce early morning DO sags, which are the primary driver of DO non-attainment on the Penobscot River. Longer reaches of free flowing river are considered to be more prone to excessive swings, because the longer travel times equate to longer periphyton contact times.

Water quality sondes can measure the relative algae driven influence along a particular reach of river by placing them upstream and downstream of a particular reach of river being studied. Pairing sondes in this manner allows us to directly assess the relative diurnal DO influence being exerted by the particular reach of river (vs. other non-diurnal influences such as BOD, SOD, and reparation). This diurnal influence is most directly tied to nutrient enrichment.

Project Summary for 2012

This Penobscot River Ambient Monitoring Plan (PRAMP) Report has been developed in accordance with the Penobscot River Phosphorus Waste Load Allocation (P-WLA), dated May 2011. The P-WLA was implemented in conjunction with 2011 MEPDES relicensing for wastewater dischargers on the Penobscot River. The purpose of the P-WLA was to eliminate Dissolved Oxygen (DO) non-attainment, which was being caused by excessive phosphorus point source loadings. The basic rationale behind the P-WLA can be summarized as follows:

- The Department has conducted three water quality surveys (1997, 2001, and 2007) on the Penobscot River that demonstrated DO non-attainment and excessive algae growth.
- The water quality surveys also highlighted excessive ambient phosphorus concentrations attributable to point source loadings.

- Early morning DO sags resulting from large diurnal DO swings were the predominant mechanism causing DO non-attainment.
- Reduced phosphorus loadings are expected to alleviate the DO non-attainment by reducing the amount of algae growth and the corresponding magnitude of large diurnal DO swings.

This past summer (2012) was the second year that ambient monitoring was carried out under the PRAMP, as the majority of MEPDES permit renewals were finalized in May of 2011. The equipment used for this monitoring effort consists of the following;

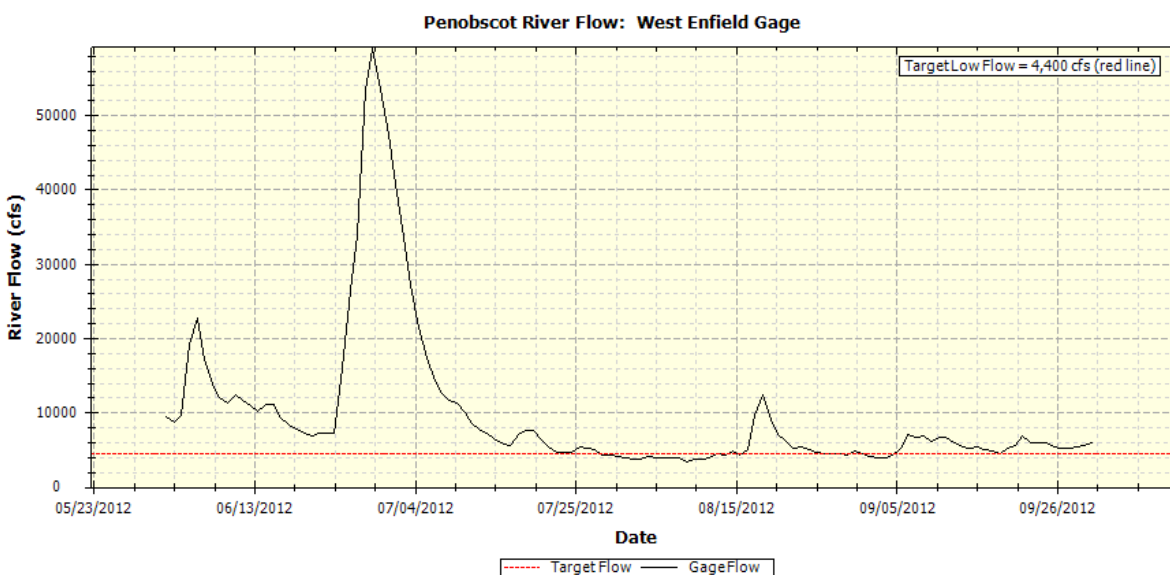
4 Eureka Environmental – Sub2 Manta2 Multiprobes equipped with;

- Optical Dissolved Oxygen Sensor – primary parameter of interest with regard to non-attainment.
- Temperature Sensor – Temperature data is necessary to calculate DO % saturation. Temperature data also helps to decipher potential climatic influences on water quality.
- Conductivity Sensor – Conductivity data are helpful in assessing the relative level of impact from pollutant sources (point and non-point).
- pH Sensor – pH data are measured to assess compliance with the pH criterion in Maine’s Water Quality Standards and as an indicator of excessive plant growth.
- Depth Sensor – Depth information is helpful when collecting profile data, and also helps to assess changes in river flow (stage) for remote deployments.

1 Handheld Communication Device to be used to communicate with all 4 multiprobes.



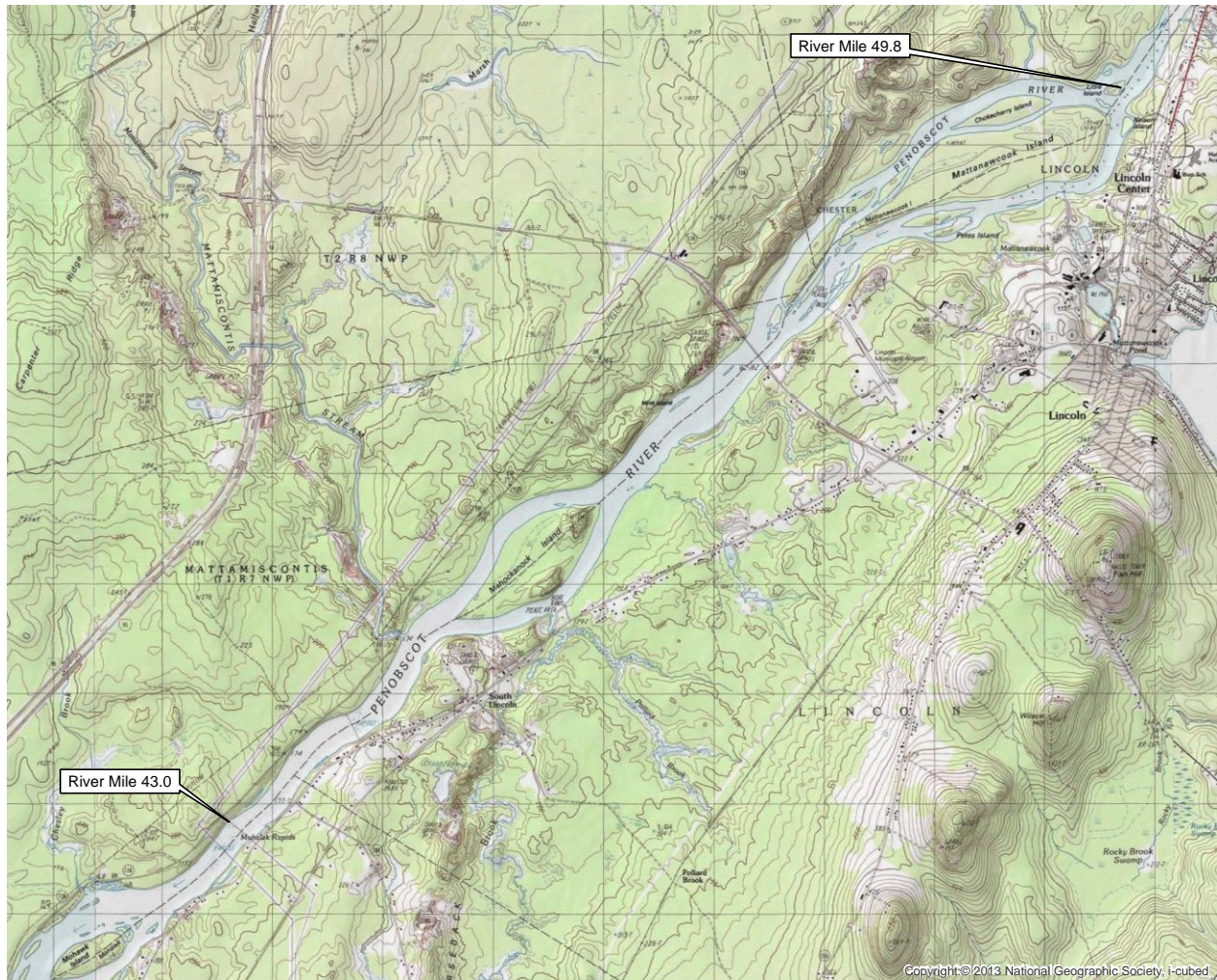
The PRAMP targets periods of low river flow during summer months. These periods are considered critical conditions and represent worst case scenarios with respect to water quality. The Department uses a target flow of 4,400 cfs (as measured at the West Enfield gage) as representative of low flow conditions for the Penobscot River. This target flow is based on the 95th percentile on a flow duration curve. These target flows were reached during two periods in 2012 as shown on the following figure. The Department managed to conduct two sets of sonde deployments during 2012, one during each of these low flow periods.



Results

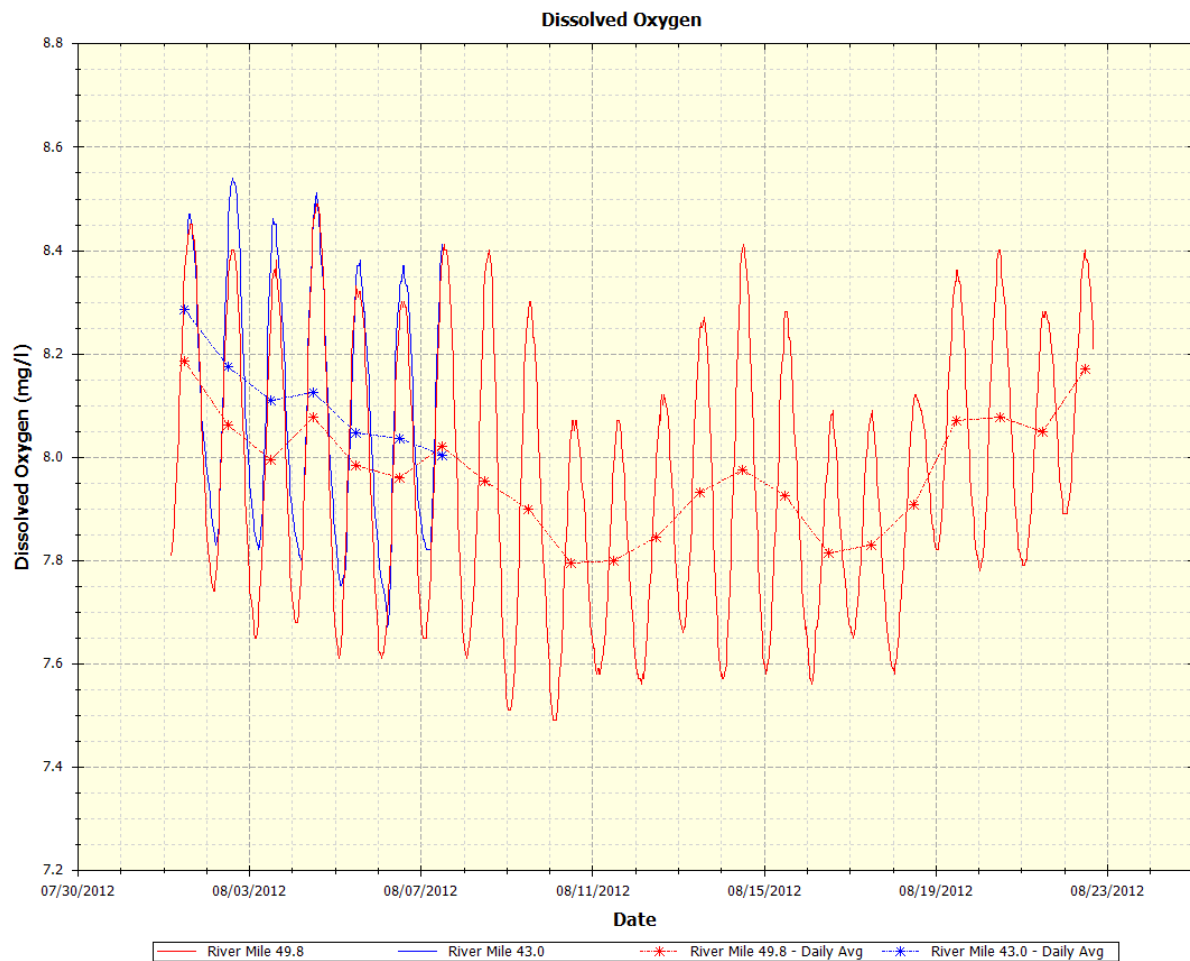
2012 was the second year of a multi-year monitoring effort. The Department is still trying to assess the general effectiveness of phosphorus waste load reductions and to identify potential areas of concern with regard to DO non-attainment. Two specific reaches of river were monitored during 2012. Each reach addressed priority concerns and helped to provide valuable insights for further sampling in the upcoming 2013 sampling season. Specific details are provided as follows;

REACH 1 – Mattanawcook Island to Mohawk Rapids (River Mile 49.8 to River Mile 43.0)



This nearly seven mile reach brackets a free flowing section of river immediately below the Lincoln Paper & Tissue (RM 49.3) and Lincoln POTW (RM 49.5) outfalls. The river becomes impounded a short distance below this section. This particular section of river would be expected to be the most sensitive to eutrophication related responses resulting from the two Lincoln outfalls. This section of river is Class B and past DO non-attainment has consisted of early morning readings, which are indicative of a eutrophication related response. New phosphorus discharge limits instituted in the spring of 2011 are expected to bring this reach into attainment for DO.

The 2012 DO data for this reach of river are summarized in the following figure.



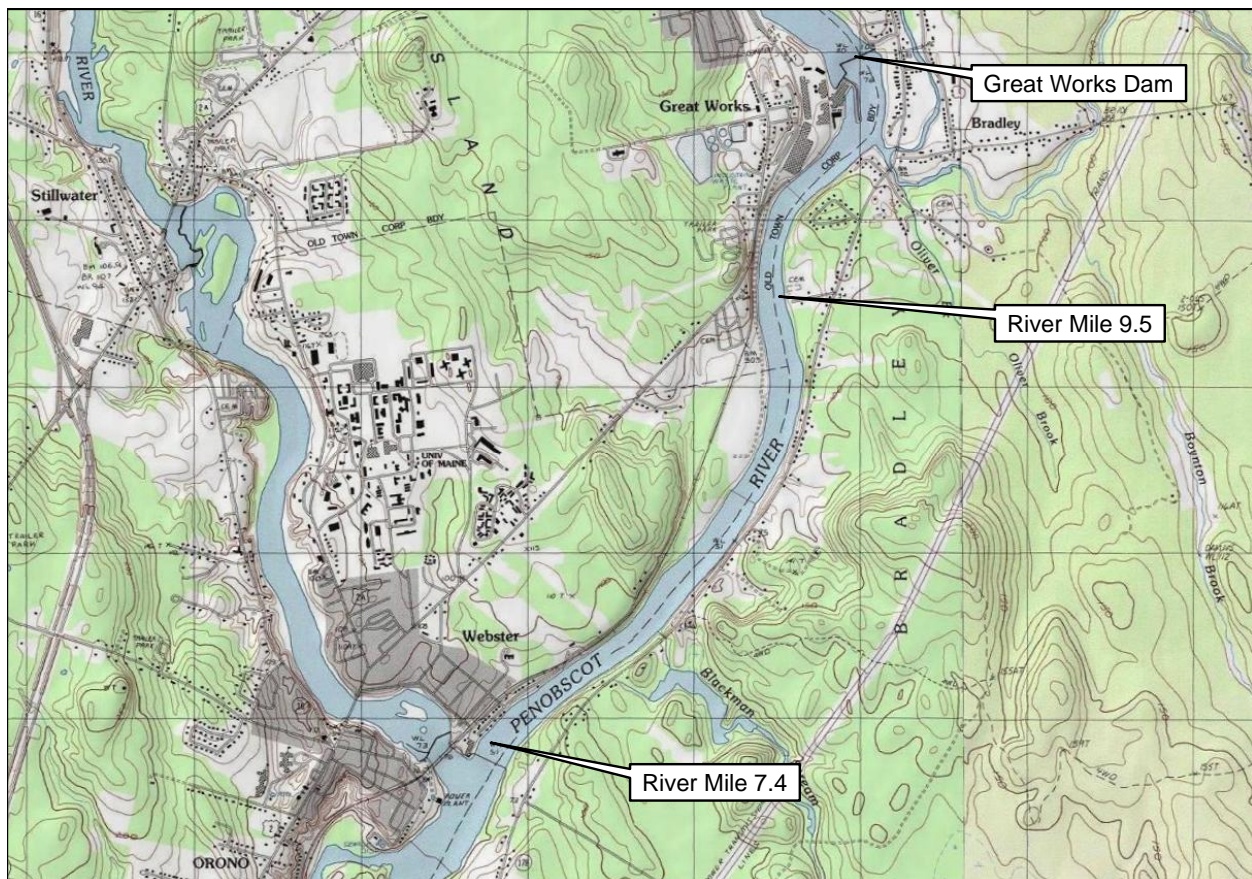
These data highlight the following;

- The data indicate DO attainment during this critical period of 2012. These data are representative of some of the lowest flows experienced in 2012 and all data are well above associated classification criteria of 7 mg/l.
- The average diurnal DO swing for both of these locations is approximately 0.8 mg/l, which is less than the DO swings of 1.4 mg/l measured in previous years under comparable conditions. The data suggests that phosphorus loading reductions are having a positive effect. DO swings less than 1.0 mg/l are generally considered to be in a normal range and are not suggestive of highly enriched conditions.
- There is a slight net increase in DO from upstream to downstream, which is best demonstrated by comparing the relative daily average values. This demonstrates that DO is recovering along this particular stretch of river, which is what would be hoped for along a free flowing reach as a result of

atmospheric reoxygenation. DO percent saturation ranges between 89% and 109%, which limits the potential for any dramatic DO recovery

- Specific conductivity, DO % saturation, pH, temperature and depth data were also collected in conjunction with these DO data. A graphical summary of this supplemental data is provided as an attachment to this report. These data will also be made available electronically upon request.

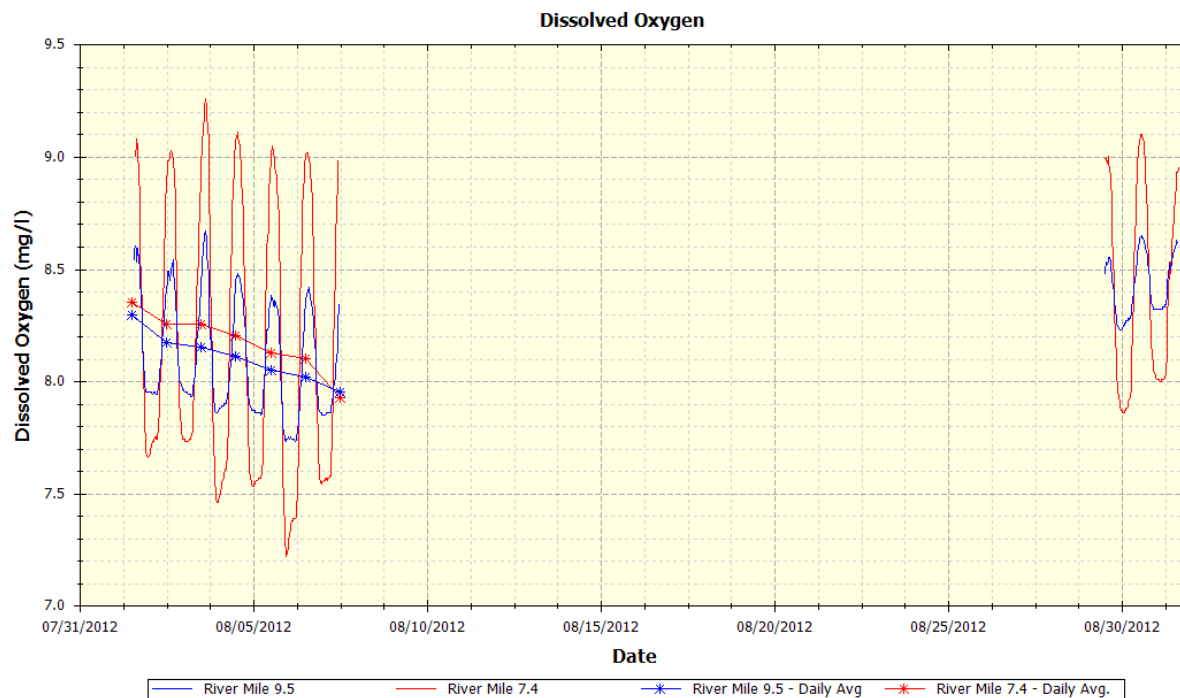
REACH 2 - Below Great Works Dam (River Mile 9.5 to River Mile 7.4)



This 3.1 mile stretch of river below Great Works Dam has historically exhibited significant diurnal DO swings during past surveys of the river. The entire reach is Class B. The 4 mile reach of river immediately upstream of this reach is also Class B and is characterized by one paper mill discharge, one municipal POTW discharge and a series of two dams. Past DO non-attainment in the lower portion of the river has primarily been in this general vicinity. The Department suspects that past DO non-attainment has been driven by excessive nutrient loadings from the upstream discharges. New phosphorus discharge limits instituted in the spring of 2011 are

expected to bring this reach into attainment for DO. Of additional interest in 2012 was the removal of Great Works Dam, which is immediately upstream of this reach. The dam removal is expected to provide water quality improvement.

The 2012 DO data for this reach of river are summarized in the following figure. The gap in the dataset represents a period when the sondes were pulled out of the river due to concerns associated with storm flows.



These data highlight the following;

- The data indicate DO attainment during this critical period of 2012. These data are representative of some of the lowest flows experienced in 2012 and all data are well above associated classification criteria of 7 mg/l.
- Associated diurnal influences corroborate the assumption that the primary driver of diurnal DO swings is attributable to a periphyton response in shallower/free-flowing reaches of the river. The swings are significantly greater at the downstream location, which is subjected to significantly longer periphyton contact times.
- The average diurnal DO swing for the downstream location ranges between 1.4 and 1.8 mg/l, which is slightly lower than last years data. This suggests some

slight improvement, but still demonstrates a need for continued monitoring in this particular section of the river.

- There is very little net gain or loss of DO occurring in this particular reach of river, which is not too surprising considering that the daily average values are at or near saturation.
- The upstream location (River Mile 9.5) has a slightly broader DO range than last year, which might be related to the Great Works Dam removal. Removal of the dam created a longer stretch of free flowing river upstream of this monitoring location. Continued monitoring will be necessary to determine the actual impact of the dam removal on water quality.
- Specific conductivity, DO % saturation, pH, temperature and depth data were also collected in conjunction with this DO data. A graphical summary of this supplemental data is provided as an attachment to this report. These data will also be made available electronically upon request.

Conclusions

No DO non-attainment was measured in association with the PRAMP during 2012. All data were well above appropriate classification criteria. There were no measured diurnal DO swings that would suggest excessive nutrient enrichment (i.e., > 2.0 mg/l). The 2012 results provide good reason to be optimistic about continued DO attainment, but continued monitoring is recommended based on the following reasons:

1. The 2012 data were collected during reasonably low flow conditions, but flows were significantly higher than what would be considered a critical 7Q10 condition. The 7Q10 for the Penobscot River is considered to be 3,070 cfs (as measured at the West Enfield Gage), whereas the 2012 water quality data is representative of flows only as low as 3,800 cfs. Flows in this range are comparable to flows where past DO non-attainment had been measured.
2. Water quality data from the upper portion of the river look particularly good, but discharges were well below licensed loadings. Further scrutiny will be warranted should nutrient loadings start to ramp up. The Penobscot Indian Nation (PIN) is continuing regular monitoring of the upstream Dolby Impoundment, which will help the Department to target further monitoring efforts in this reach of river.
3. Water quality data from the lower portion of the river are still somewhat concerning due to the significant diurnal DO range exhibited at river mile 7.4

as well as the changes that have occurred in the river as a result of the dam removal.

2013 Work Plan

The 2012 PRAMP provides good insights to prioritize monitoring efforts for the 2013 season. Additionally, the Great Works Dam removal provides impetus for continued monitoring. Additionally, Veazie Dam is presently scheduled for removal in 2013. These dam removal efforts are expected to improve downstream water quality, and will be a particular focus of continued PRAMP efforts. The Department will continue with its adaptive management style approach, and intends to move monitoring stations around the river system if unanticipated conditions arise. The anticipated focus for 2013 is detailed as follows;

1. The upstream portion of the river appears to be in pretty good condition, but the Department will continue to plan for deployments along this stretch of river. Future deployments may consist of only one sonde (i.e., not paired sondes) such that resources can be better utilized in the lower portion of the river.
2. The lower portion of the river is still experiencing significant diurnal DO swings and dam removal efforts are ongoing. The Department expects to focus a majority of its efforts on this particular section of river (river mile 12 to river mile 0).

Supplemental Water Quality Data - (Graphical Representation)

