# Penobscot River
# Phosphorus Waste Load Allocation

# Ambient Monitoring Plan Report – 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 re-aeration). This diurnal influence is most directly tied to nutrient enrichment.

## Project Summary for 2013

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 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 diurnal DO swings.

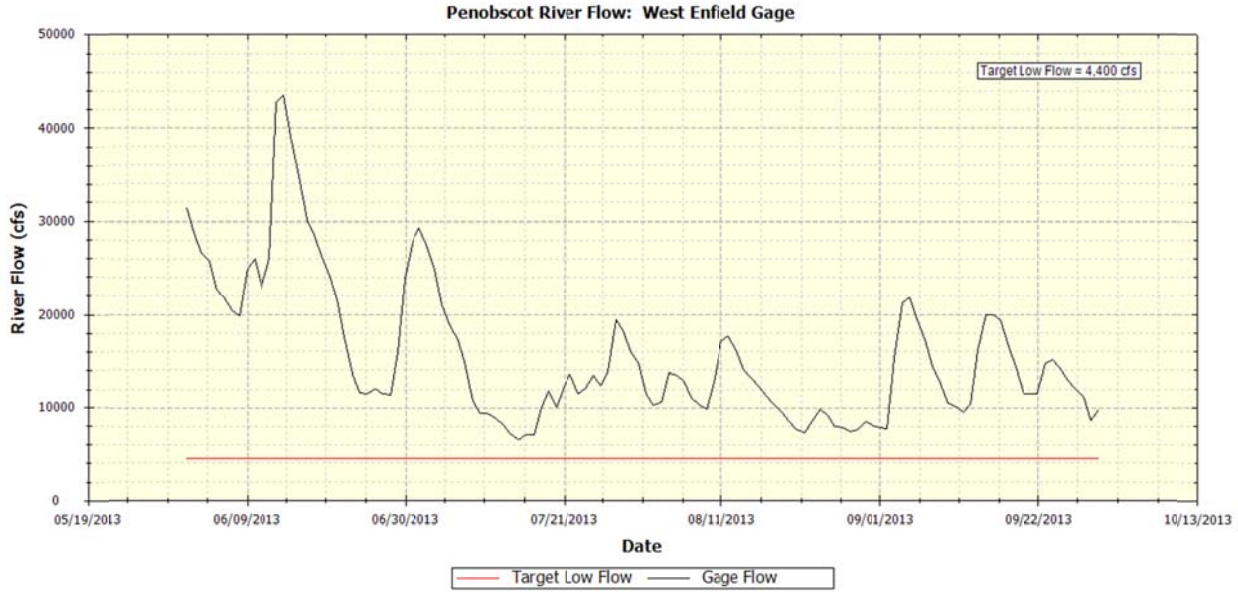
This past summer (2013) was the third year of ambient monitoring under the PRAMP, as the majority of MEPDES permit renewals were finalized in May of 2011. The equipment used for this monitoring effort consists of the following;

***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 to be the most 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 represents the 95th percentile of the flow duration curve. 2013 was a very wet year and the lowest flow recorded for the river was 6,510 cfs (approximately the 65th percentile flow) on July 15 (as shown on the following graph). Due to the high flows, no ambient water quality monitoring was conducted in association with the PRAMP during 2013. Most of the desirable free flowing reaches of the river are relatively inaccessible to routine monitoring under these types of flow conditions.




## Phosphorus Point Source Effluent Monitoring

The 2011 P-WLA includes a provision for routine phosphorus monitoring of the most significant discharges above Bucksport. A summary of these data is provided in the following table. The primary goals of the effluent monitoring program are to demonstrate compliance with P-WLA's and to assess overall phosphorus loadings to the Penobscot River. Table allocations and loadings are expressed in pounds per day (PPD). The table includes data from discharges that occur below head of tide, but the primary focus of the P-WLA was discharges to freshwater. The basic rationale for this is that phosphorus is the limiting nutrient in most freshwater systems, whereas nitrogen is the limiting nutrient for most marine/estuarine systems. Documented

non-attainment on the Penobscot River is believed to be directly related to eutrophication associated with the freshwater portion of the system.

Penobscot River - Millinocket to Bucksport
Total Phosphorus Loading Summary Table

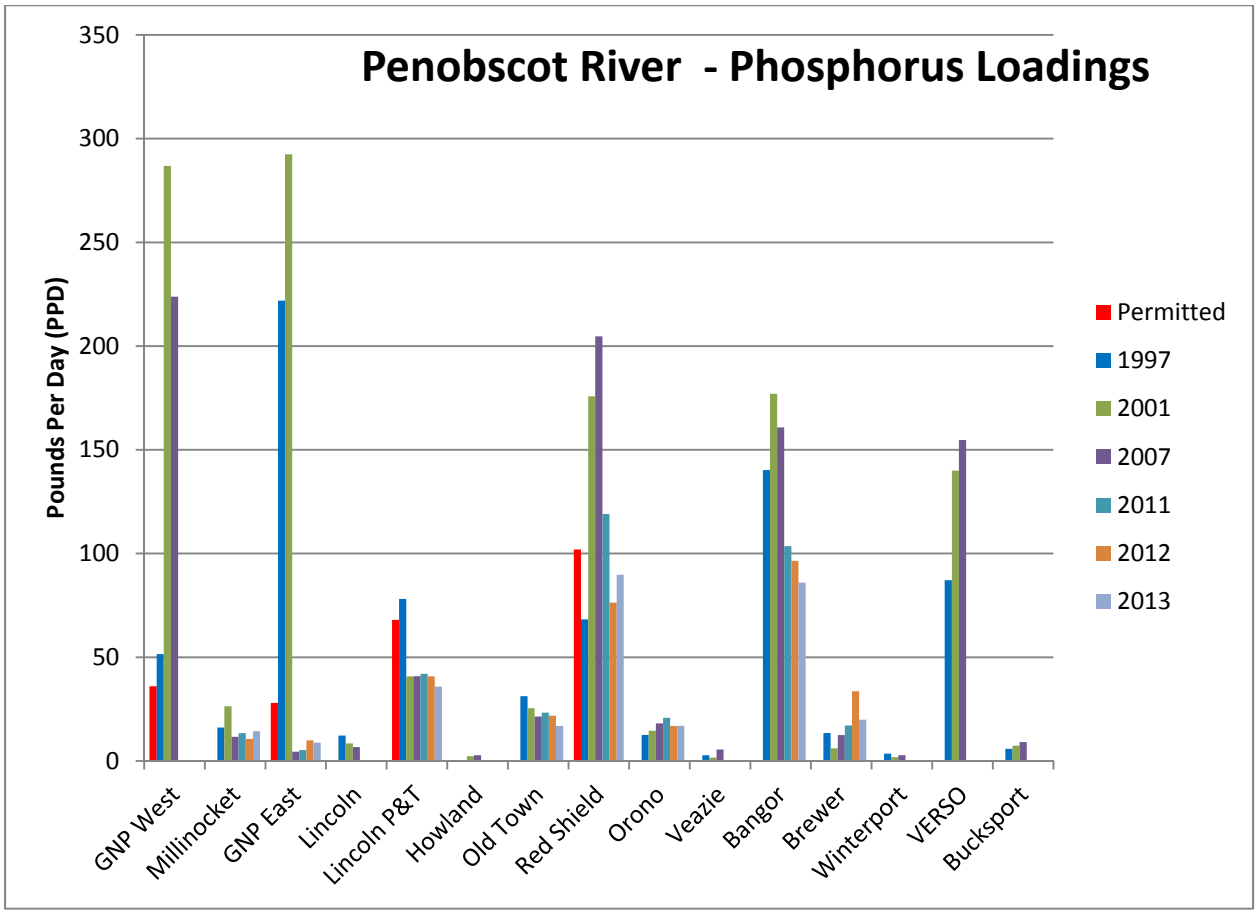
| Discharger Name | Type | Flow (MGD) | River Mile Postion | Permitted Allocation (PPD) | 1997 (PPD) | 2001 (PPD) | 2007 (PPD) | 2011 (PPD) | 2012 (PPD) | 2013 (PPD) |
|---|---|---|---|---|---|---|---|---|---|---|
| GNP West | Papermill | 43 | 83.3 | 36 | 52 | 287 | 224 | 0 | 0 | 0 |
| Millinocket | POTW | 2.33 | 81.6 | - | 16 | 26 | 12 | 13 | 11 | 14 |
| GNP East | Papermill | 33 | 75.7 | 28 | 222 | 292 | 4 | 5 | 10 | 9 |
| Lincoln | POTW | 1.07 | 49.4 | - | 12 | 8 | 7 | *9* | *9* | *9* |
| Lincoln P&T | Papermill | 16.3 | 49.3 | 68 | 78 | 41 | 41 | 42 | 41 | 36 |
| Howland | POTW | 0.03 | 35.1 | - | *3* | 2 | 3 | *3* | *3* | *3* |
| Old Town | POTW | 1.7 | 11.2 | - | 31 | 25 | 21 | 23 | 22 | 17 |
| Red Shield | Papermill | 24.4 | 9.9 | 102 | 68 | 176 | 205 | 119 | 76 | 90 |
| Orono | POTW | 1.84 | 6.9 | - | 13 | 15 | 18 | 21 | 17 | 17 |
| Veazie | POTW | 0.35 | 1.6 | - | 3 | 2 | 6 | *3* | *3* | *3* |
| **Sub-Totals Above Head of Tide** | | | | **234** | **497** | **875** | **540** | **239** | **191** | **197** |
| Bangor | POTW | 18 | -3 | - | 140 | 177 | 161 | 104 | 96 | 86 |
| Brewer | POTW | 5.19 | -3.3 | - | 13 | 6 | 13 | 17 | 34 | 20 |
| Winterport | POTW | 11 | -15.6 | - | 4 | 2 | 3 | *3* | *3* | *3* |
| VERSO | Papermill | 18 | -20.6 | - | 87 | 140 | 155 | *127* | *127* | *127* |
| Bucksport | POTW | 0.46 | -22.2 | - | 6 | 7 | 9 | *8* | *8* | *8* |
| **Totals Down to Bucksport** | | | | | **748** | **1207** | **880** | **497** | **459** | **441** |

*NOTE: Shaded areas are not based on actual data. These data represent facility averages from years when data was collected. It was necessary to fill in these gaps to estimate total loadings to the river.*

This table highlights the following:

1. Post P-WLA (2011) loadings to the Penobscot River are substantially less than historic loadings. Freshwater loadings are approximately 67% less than historic loadings, and loadings to the entire river are approximately 50% less. It should be noted that the GNP mills are presently operating at significantly reduced capacity, but that these mills have demonstrated the ability operate well within their defined allocations during operational periods.
2. The most significant municipal discharges have not fluctuated significantly since the P-WLA was implemented.

This same data are presented in the following chart, which highlights the relative improvement and influence of each discharge from a historical perspective. All of the most significant discharges (historically greater than 50 PPD) have demonstrated significant phosphorus loading reductions since the P-WLA has been implemented.




## Conclusions

No ambient monitoring was conducted in 2013, but the documented high river flows suggest that the Penobscot River attained designated classification criteria in 2013. The supplemental evaluation of phosphorus loadings provide good reason to be optimistic about continued DO attainment in future years. Continued monitoring is recommended based on the following reasons:

1. The removal of the Great Works Dam (2012) and the Veazie Dam (2013) in association with the Penobscot River Restoration work has resulted in significant changes to hydraulic conditions in the lower freshwater portion of the river. The changes are expected to result in additional improvements in water quality, but there is no significant data yet that documents the relative impact on water quality.
2. To date, the PRAMP work has not experienced flows at or near 7Q10 conditions. Continued efforts are necessary to better assess lower flow conditions should they occur.

## 2014 Work Plan

Past PRAMP work provides good insights to prioritize monitoring efforts for the 2014 season. Additionally, the Penobscot River Restoration work provides impetus for future monitoring work. The dam removal efforts are expected to improve downstream water quality, but monitoring is necessary to document the actual influence. 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 2014 is detailed as follows;

1. The lower freshwater portion of the river is presently experiencing the most significant diurnal DO swings and dam removal efforts are expected to influence this particular dynamic. The Department expects to focus a majority of its efforts on this particular section of river (Old Town to Bangor).
2. The uppermost portion of the river (Millinocket to Old Town) appears to be in pretty good condition, but the Department will continue to consider sonde deployments along this stretch of river. The Penobscot Indian Nation (PIN) is presently focusing a good deal of monitoring in Dolby Pond. The Department expects to leverage PIN's monitoring efforts to inform potential future deployments. Future upstream deployments may consist of only one sonde (i.e., not paired sondes) such that the Departments limited resources can be better utilized in the lower portion of the river.