Presumpscot River Dye Study

Below Cumberland Dam, Westbrook to Old Smelt Hill Dam, Falmouth

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Note to reader:

The United States Environmental Protection Agency's role in this project was to provide Maine Department of Environmental Protection a dye study of the Lower Presumpscot River. The Maine Department of Environmental Protection, provided water quality sampling, sample locations, advice and comments. Interpretations of the data relating to measured flows will be made by the Maine Department of Environmental Protection in a separate document.

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INTRODUCTION

Maine Department of Environmental Protection (MEDEP) requested EPA Region 1, Office of Environmental Measurement and Evaluation's (OEME) assistance in conducting a dye study on the Lower Presumpscot River from Westbrook to Falmouth. The data collected during this dye study will be used to determine the dispersion and time of travel of the Presumpscot River during low flow conditions and for future development of a TMDL model which will aid in better understanding of river hydrodynamics during low flow conditions. Additional water quality measurements were provided by MEDEP. Additional flow measurements were provided by USGS to aid MEDEP in modeling the river.

A fluorescent dye marker tracer system (Rhodamine WT) was used to provide accurate on-site measurements. Intensive measurements were taken, utilizing a discrete cell Turner Designs Fluorometer and ISCO discrete samplers.

Presumpscot River Study Area

The Presumpscot River flows from its origin at the outlet of Sebago Lake on the east side of the lake, running 25 miles to Martin Point in Portland where it enters into Casco Bay. The watershed encompasses 648 square miles. There is a 270 foot drop in elevation over the same distance which makes many sections of the river high gradient, with pooling occurring behind the impoundments. The study encompassed an area from downstream of the South African Pulp and Paper Industries (SAPPI) Cumberland Mill at the mill bridge to the area where the old Smelt Hill Dam in Falmouth was located prior to October 2002. The Presumpscot River was examined through monitoring at 4 fixed stations as seen in Table 1. The Presumpscot River in the study vicinity is listed in the MEDEP 2008, Impaired Waters List (303(d)) for waters not attaining water quality standards.

EQUIPMENT AND METHODS

A list of equipment can be found in the Quality Assurance Plan in Appendix B. Methods used in the field are also described in Appendix B. Key method components to the study are identified below, which included dye, sampling train and fluorometer.

Rhodamine WT Dye

Rhodamine WT was the dye selected for this study because it has several properties that make it an ideal tracer. It is water soluble, highly fluorescent, essentially harmless to aquatic life yet still detectable at low concentrations, and reasonably stable in normal aquatic conditions (Wilson et al., 1986). Additionally, it has the unique ability to absorb green light and emit red light. Because few compounds have these properties, interference from other substances is rare.

Sampling Train

The sampling train consisted of an ISCO Model 3700 sampler, intake hose and a discrete base. The intake hose was new Tygon tubing. The sampler was set up to collect 400 milliliters of effluent at one hour intervals. ISCO samplers were serviced by field personnel and samples were analyzed in the discrete cell fluorometer.

Fluorometer

A Turner Designs model 10-AU-005 fluorometer was configured as a discrete cell holder to accept 25 mm cuvettes. The unit was calibrated to measure concentrations of Rhodamine WT dye between 0.01 PPB (parts per billion) and 8 PPB. When concentrations of Rhodamine WT dye exceeded 8 PPB, discrete grab samples were collected, diluted, and analyzed in the laboratory. Calibration was conducted before the initial run each day, then checked after every 10-20 samples and post calibration checked at the end of each day.

RESULTS

All analytical results were included with the examination of all fluorometry at each station. The data will be compared at each station showing time of travel for leading edge, peak flow and 20% of peak trailing edge where it was practical. Dispersion and dilution patterns for each station were charted in Appendix C. Raw data can also be found in Appendix C. Results indicate a fast moving high gradient river reach under low flow conditions with a minimal amount of dispersion and dilution over time.

During the study, SAPPI controlled the flows of the river at the outlet from Lake Sebago to produce a constant low flow over a 7 day period. Crews diluted 1000ml of concentrated dye with river water. At 10:15 AM, Crews then distributed the diluted dye in a 1-gallon glass jar over a 30 second period at USGS flow gaging station 01064118, downstream of Cumberland Mill at SAPPI Paper. This was an ideal location for mixing and to verify low flows along the lower section of the Presumpscot River. At the time of the dye study, MEDEP contracted USGS to conduct flow measurements at four locations in the lower basin to determine the volume during low flow as well as compare results to this dye study.

The dye results show a very fast moving river from downstream of Cumberland Mill dam to the old Smelt Hill Dam. This is indicated by the roughly speed of ½ mile per hour at the two stations that were successfully sampled.

Sample locations were taken with a Trimble GeoXT GPS unit. Accuracy is within 2 meters.

Table I: Study I Station Locations

Latitude decdeg	Longitude decdeg	Station
43.686992	-70.347043	PR3 dye injection @ USGS discharge measurement

43.687977	-70.337577	Downstream SAPPI Outfall, LEW
43.702995	70.324787	PR4 RT 302 Bridge, @ canoe launch, REW
43.724444	-70.302572	PR6 Blackstrap Road, @ old USGS Gage Station REW
43.717074	-70.264498	PR10 Allen Ave Extension, @ end of rock jetty LEW

Locations are based on NAD83 Datum. LEW=left edge of water, REW=right edge of water looking downstream

Dye Plume Progression

The station downstream of the SAPPI WWTP outfall was used to determine initial concentration of the dye slug injection and may be used for initial dilution purposes. Due to the depth of the river and the majority of flow was on the other side of the river, the peak concentrations may have been on the other side of the river from SAPPI paper. Considering this station is downstream of the Sappi WWTP Outfall, there is extensive mixing with the outfall at this point.

Table 2: Downstream SAPPI WWTP outfall @ end of access road, LEW

	Hours after injection	Concentration (ppb)
Leading Edge	0.7	0.5
Peak	0.8	1.6

At Station PR4, Route 302 Bridge, upstream of bridge by canoe launch the sampling tubing intake was pull out of water and no samples were collected in the ISCO 24 hour composite sampler. Interpretation of the data from sites PR6 and downstream of the WWTP indicate that the dye would arrive at PR4 4.4 hours after the injection.

Table 3: Station PR6, Blackstrap Road, at bridge on upstream side

PR6	Hours after injection	Concentration (ppb)
Leading Edge	8.75	0.22
Peak	9.75	0.32
< 20% peak	11.75	0.04

When the dye reached station PR6 results indicate 9.75 hours to peak and 11.75 hours to <20% peak. This indicates a realatively compact dye plume only spreading over a 3 hour period.

At Station PR10, Old Smelt Hill Dam at Allen Ave Extension, Falmouth, crews found tubing pulled out of the water when they arrived at the site to analyze the samples in the ISCO 24 hour discrete bottle sampler. Two samples were grabbed, one at 15:00 on September 2nd and another at 11:45 on September 3rd. Analysis of both samples indicates the dye was not detected. This indicates the dye plume went through between the times when the two samples were collected. Interpretation of the data by using the time of travel to PR6 indicates the peak should have arrived 13.7 hours after injection.

REFERENCES

Wilson, J.F., E. Cobb, F.A. Kilpatrick (1986) Fluorometric Procedures For Dye Tracing. Techniques of Water Resources Investigations of the United States Geological Survey, Book 3, Chapter A12, Revised 1986.

NHDES, FDA, EPA, Dilution, Dispersion, and Transport of Dover, New Hampshire Wastewater Treatment Plant Effluent in the Piscataqua, Cocheco and Salmon Falls Rivers, December 2005

Hubbard, E.F., Measurement of Time of Travel in Streams by Dye Tracing. Techniques of Water Resources Investigations of the United States Geological Survey, Book 3, Chapter A9, Revised 1982.

Presumbscot River Watch website, http://www.prw-maine.org/

Friends of the Presumpscot, http://www.presumpscotriver.org/

Friends of Sebago Lake, http://friendsofsebago.org/