PENOBSCOT RIVER MERCURY STUDY

Chapter 9

Upstream limit of mercury contamination in surface sediments

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By R.A. Bodaly[1] and A.D. Kopec[1]

1. Penobscot River Mercury Study

1 SUMMARY

This study was performed to determine the geographic extent of present-day mercury (Hg) contamination of the intertidal surface sediments along the Penobscot River in the region of Bangor/Brewer, Maine. Surface (0-3 cm) sediments were sampled at six sites in 2009 and the results compared to intertidal sediments sampled at Brewer – Orrington (BO) reach sites in 2006-2007 and to dated cores sampled in 2009 and presented in Chapter 5. The results showed large declines in total Hg concentrations between the upstream end of the BO reach (the former Brewer paper mill) and the Interstate 395 bridge over the Penobscot, confirming previous sampling. Thus, surface sediments are not presently contaminated upstream of the Interstate 395 bridge. However, it has been shown that sediments below the surface in this area are significantly contaminated with Hg and thus surface sediments were much higher in the past.

2 INTRODUCTION

The purpose of this study was to determine the present-day upstream limit of mercury (Hg) contamination from the HoltraChem site in the surface sediments of the Penobscot River, that is, how far upstream of HoltraChem is Hg contamination evident in surface sediments. Previous work (Phase I and Phase I Update reports) showed that surface sediments of the Penobscot were heavily contaminated with Hg at five sampling sites in the BO (Brewer – Orrington) sampling reach. The furthest upstream site was BO3, located on the east side of the river, about 1.5 km downstream of the old Brewer paper mill, the defined upstream limit of the BO sampling reach. It was also shown that surface sediments in the OV (Old Town – Veazie) sampling reach, located upstream of the Veazie dam and upstream of the tidal influence of the Penobscot estuary and any possible aquatic influence of the HoltraChem site at Orrington, were not heavily contaminated with Hg. Also, sampling of wetlands in the Penobscot system had shown previously that wetland W05, located near the Interstate 395 bridge over the Penobscot River and about 2 km upstream of the Brewer paper mill site, was not heavily contaminated with Hg (Phase I report). This raised the obvious question of where the upstream limit of heavily contaminated surface sediments was.

3 METHODS

On September 9, 2009, surface sediment samples were taken from six sites in the intertidal zone of the Penobscot River between Bangor and Brewer, Maine. All sampling sites were located between the upstream end of the BO sampling reach and W05 (near the Interstate 395 bridge over the river). Samples were taken by hand and were all 0-3 cm deep. They were analyzed for total Hg by Flett Research Ltd. by standard methods. Locations of sampling sites and raw data are given in Appendix 9-1.

4 RESULTS AND DISCUSSION

Figure 9-1 shows total Hg in the top 3 cm at the 6 new sites sampled in 2009, compared to total Hg at the BO sites and W05. Total Hg is generally lower on the East side of the river compared to the West side, for stations located across the river from each other. These differences are perhaps related to upstream flow patterns during flood tides which bring contaminated sediments upstream in the Penobscot, that is, there must be stronger upstream currents on the west side of the river in this reach than on the east side. Total Hg is low on the east side of the river from site SED-5 (see Figure 9-1 for location) and to the upstream of that site. On the west side, concentrations gradually decline towards the Interstate 395 bridge.

Concentrations change abruptly between BO sites, sampled in 2006 and 2007, and the new sites sampled further upstream 2009. This is apparent on both sides of the river. Could this abrupt geographic change be due to a significant decline in total Hg concentrations between 2006-2007 and 2009? This would appear to be unlikely because monitoring of total Hg in surface sediments throughout the Penobscot system over the period 2006 to 2010 has shown only slight downward trends in concentrations (see Chapter 15). Also, three of the four sites sampled by Drs. Kevin Yeager and Peter Santschi (see Chapters 5 and 6) between Veazie dam and the Interstate 395 bridge

showed surface concentrations that were similar to those sampled for this study in 2009. Therefore, the decline from BO3 and BO5 further downstream to SED-3 and SED-5 more upstream was real.

The results of this sampling show that the contamination of surface sediments does decline between the BO sampling reach and W05 further upstream, confirming previous sampling.

However, sediment cores taken from near W05 and further upstream show that sediments in deeper strata do show significant contamination (See Chapters 5 and 6). Cores PBR_1.5B, PBR_04C, PBR_06C and PBR_09A were taken between about the Interstate 395 bridge and the Veazie dam and all show elevated total Hg inventories (Figure 5-9, Chapter 5). PBR_09A is very close to our station W05, whereas the furthest upstream core was taken just downstream of Veazie Dam. Total Hg inventories do increase from upstream to downstream in these four sediment cores, as expected. The information from these four cores supplement and contrast with the surface sediment sampling presented here. They show much higher total Hg concentrations near the Interstate 395 bridge than the present sampling. They also demonstrate that the deeper layers of sediments in this region of the river have much higher concentrations of total Hg than those on the surface (Table 9-1).

Table 9-1: Total Hg concentrations in surface and deep sediments in four sediment cores taken in 2009 from between the Veazie Dam and downstream of the Interstate 395 bridge (data from Chapter 5).

Core	Location	Total Hg (ng/g dry wt.) at surface	Total Hg (ng/g dry wt.) at peak	Depth of peak Total Hg (cm)
PBR_09V	Just downstream of Veazie Dam	42	1270	65-70
PBR_04C	Between Bangor and Veazie	108	2790	75-80
PBR_06C	Bangor, just upstream of railway bridge	140	2580	30-32
PBR_09A	Brewer, just downstream of Interstate 395 bridge	1976	n/a	n/a

Thus, surface sediments in this region of the river were much more contaminated in the past than they are today. Analysis of a large number of radio-dated sediment cores from the Penobscot system (see Chapters 5 and 6 of this report) demonstrate that the highest levels of Hg contamination occurred in the late 1960's, coincidentally with the beginning of the operation of the HoltraChem plant at Orrington.

5 CONCLUSIONS AND IMPLICATIONS

This sampling confirms that the surface sediments of the Penobscot River are not presently contaminated upstream of the Interstate 395 bridge.

If dredging of surface sediments in the rivers were recommended as a remediation tool, the remediation methods would have to take into account that much higher total Hg concentrations are present in deeper sediments (30 – 80 cm) than in surface sediments. That is, sediments should be left in place to leave more contaminated layers undisturbed or all sediments down to 80 cm or deeper would have to be removed, and the removal method would have to avoid exposing the environment of the river to these more contaminated sediments.

6 ACKNOWLEGEMENTS

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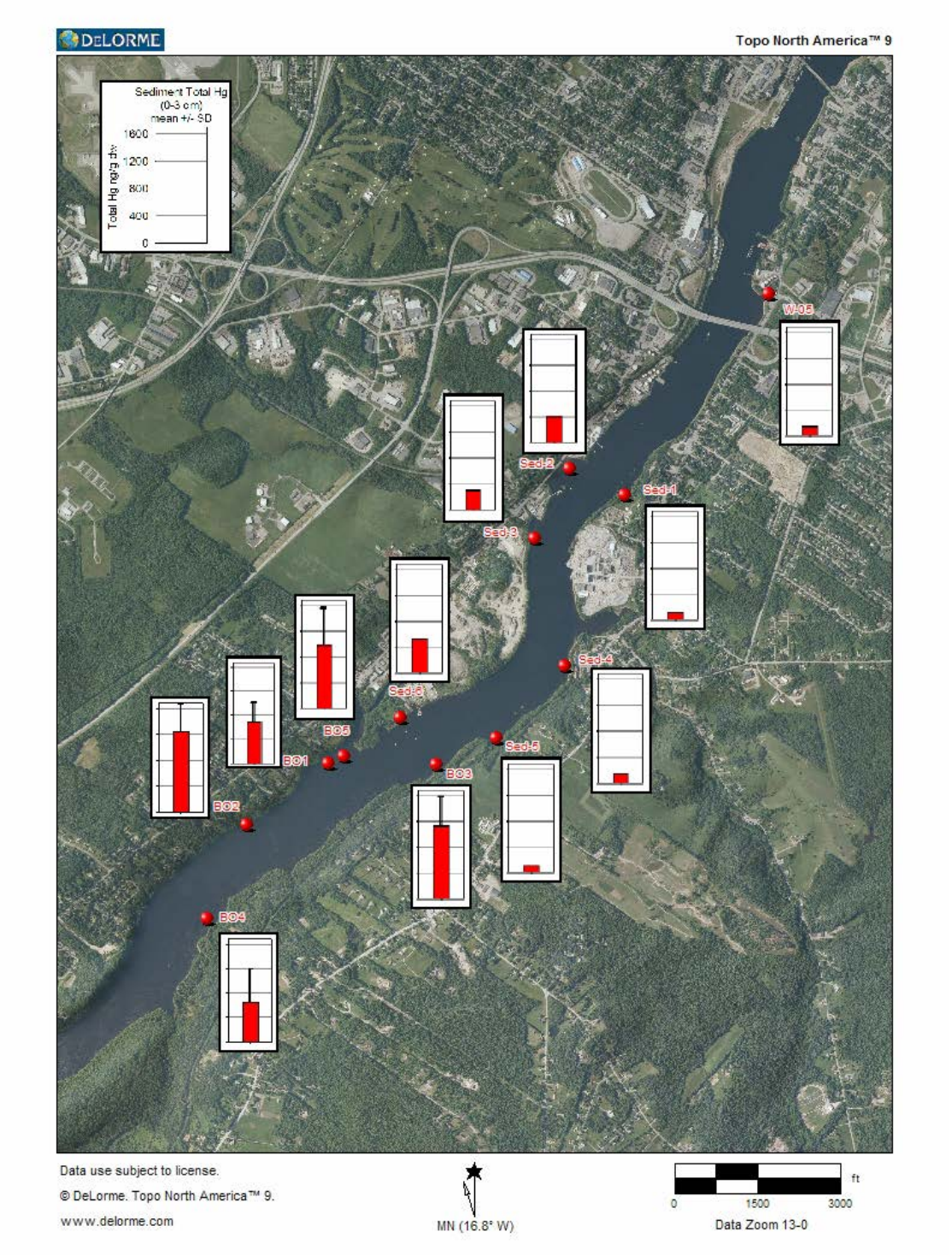

Figure 9-1. Map of the Penobscot River from Brewer/Bangor to near Orrington, showing concentrations of total Hg (ng/g dry wt.) in surface (0-3 cm) sediments at six sites sampled in September 2009, denoted as SED-1 through SED-6. Data for BO sites are from samples collected during Phase I of the Study (See Phase I and Phase I Update reports).

APPENDIX 9-1:

Raw data for total Hg in surface (0-3 cm) sediment sampled at six sites near Brewer ME, on September 9, 2009

Sample ID	Sampling date	Latitude (degrees North)	Longitude (degrees West)	Side of River	Total Hg ng/g wet wt.	Total Hg ng/g dry wt.
SED-1	September 9, 2009	44 46 32.5	68 46 54.5	East	31.1	115
SED-2	September 9, 2009	44 46 37.2	68 47 08.2	West	112.5	414
SED-3	September 9, 2009	44 46 24.9	68 47 17.1	West	53.9	293
SED-4	September 9, 2009	44 46 02.2	68 47 09.4	East	54.4	146
SED-5	September 9, 2009	44 45 49.2	68 47 26.8	East	36.1	109
SED-6	September 9, 2009	44 45 53.0	68 47 50.7	West	95.3	523