

CYCLE FOUR EEM SUMMARY

This summary presents findings from the environmental effects monitoring (EEM) Cycle Four program for the Howe Sound Pulp & Paper Limited Partnership (HSLP) mill at Port Mellon.

The program included process effluent sublethal toxicological testing (two terms per year), a summary of the 2005 Fish Tissue Survey, and an investigation of cause (IOC) study. A formal finfish survey was not conducted as part of this investigation. Instead, greater emphasis was put on the effects on fish habitat component (i.e., the IOC study). The IOC consisted of three components:

- A conventional benthic community assessment - to assess whether benthic invertebrate community structure in the near-field was changing with time.
- A stable isotope analysis - to identify the source of observed organic enrichment. Possible sources of organic material are historical mill effluents (i.e., fibre mat), current mill effluents, nearby streams/rivers carrying terrestrial organic matter (e.g., the Squamish River), and natural marine sources of organic matter.
- A fibre mat delineation study - to determine the spatial extent of mill related organic enrichment.

Field work associated with the Cycle Four investigation was conducted in March 2005. The following sections present results by mill for each of the studies conducted for Cycle Four.

Mill Update and Sublethal Toxicity Testing of Effluent

HSLP has a current production of approximately 1,000 ADmt/d of bleached Kraft pulp and 600 ADmt/d of newsprint pulp from thermomechanical processing. Between 1998 and 1992, HSLP underwent a modernization, which resulted in a Kraft production increase and the addition of newsprint. In 2006 the mill established new production records when it produced 215,742 ADmt of newsprint and 378,421 ADmt of bleached Kraft pulp. Since June 1997, Kraft pulp has been bleached exclusively with chlorine dioxide (100% substitution); newsprint pulp is semi-bleached without the use of any chlorine containing chemicals. No major changes to mill processing or the secondary effluent treatment system (UNOX) have been made since the last mill update in the early 1990s.

Effluent was analyzed for sublethal toxicity as required by the EEM program; the results for HSLP are summarized as follows:

- Topsmelt (*Atherinops affinis*) larvae tests indicated no toxic effect on growth (IC25 endpoint) and survival (LC50 endpoint) at the highest effluent concentration. Echinoderm reproduction tests indicated IC25 endpoint toxicity at an average of 18.9% v/v effluent. *Champia parvula* reproduction tests indicated IC25 endpoint toxicity at an average of 10.2% effluent.

- Using Environment Canada's dilution model to predict the radial distance of sublethal effect, maximum potential distance were <20 m for fish, 106 m for invertebrate reproduction, and 196 m for algal growth. However, the lowest effluent concentration resulting in toxicity (IC25 for algal growth = 10.2% effluent) was still above the highest concentration observed in the near-field area (2.3% effluent), thus a 196 m radial zone of possible sublethal toxicity is likely an over estimate.

Fish tissue Survey

- Long-term (16-yr.) annual monitoring of fish tissue in Howe Sound generally shows a decreasing trend in concentration of dioxin and furan congeners. Crab hepatopancreas dioxin and furan concentrations at two stations are currently above the Health Canada consumption advisory threshold (30 pg/g).
- The mean 2005 dioxin and furan levels in dogfish liver remain above the Health Canada consumption advisory threshold, whereas dioxin and furan concentrations in muscle of dogfish were below the muscle consumption criteria of 15 pg/g. A tainting survey was not required for Cycle Four.

Investigation of Cause (IOC study)

Conventional benthic community assessment - The conventional benthic invertebrate community survey in the vicinity of HSLP (based on five near-field stations and five reference stations) indicated the following results:

- Significant statistical differences were observed in the benthic community from HSLP near-field sediments for the Bray-Curtis index only; however, the effect was not ecologically significant.
- The strongest correlations were between total nitrogen and richness and evenness, and the proportion of 15N and distance from the diffuser with Simpson's Diversity. Density was positively correlated with the C:N ratio and negatively correlated with the percentage of clay and silt, Total nitrogen and the proportion of organic material with a marine signature. These correlations indicate that pulpmill-related sources of organic material are likely contributing to observed organic enrichment.
- Density and Bray-Curtis were negatively correlated to distance from the diffuser, while Evenness and Simpson's Diversity were positively correlated with distance from the diffuser. Again, these correlations indicate that pulpmill-related sources of organic material are likely contributing to observed organic enrichment.
- A comparison of density, richness, evenness, Bray-Curtis indices and Simpson's Diversity between Cycles Two, Three and Four indicated that Simpson's Diversity at the near-field stations exhibited a statistically significant decreasing trend with time. Given that diversity is not an EEM effects endpoint and that no other trends were detected, the condition of the near-field benthic communities generally does not appear to have changed markedly with time (between Cycles Two and Four).

Stable isotope study – The stable isotope study conducted on HSLP near-field sediment, HSLP effluent and biota indicated the following:

- Sediments in the near-field areas contained a higher proportion of organic material having a terrestrial isotopic signature (i.e., more depleted in ^{13}C and ^{15}N) than reference areas, indicating that historic pulpmill and/or log booming related activities have been contributing to the observed benthic enrichment. Historical sediments (near-field sediments) and current effluent had distinctly different $\delta^{15}\text{N}$ isotope signatures, indicating that the two potential sources of organic matter are distinct.
- The $\delta^{15}\text{N}$ isotope signatures of filter feeders and deposit feeders were most similar to the $\delta^{15}\text{N}$ isotope signatures of sediments, indicating that historical sediments/fibre mats are likely contributing more to the observed enrichment than ongoing effluent discharges.

Fibre mat delineation study – The fibre mat delineation study conducted within the HSLP near-field area indicated the following:

- The fibre mat adjacent to HSLP appears to be patchy. It was not possible to delineate the fibre mat based on the variables measured.
- Mill related organic deposits appeared to be greatest to the south and east of the HSLP diffuser.

Conclusions

- Sublethal toxicity testing indicated that effects would be observed at relatively high concentrations (10.2% or more), which have not been observed in the receiving environment adjacent to HSLP.
- Concentrations of dioxins and furans in fish tissue collected from Howe Sound generally show a decreasing trend since the early 1990's for crab and since 2000 for dogfish. Crab hepatopancreas at two out of four locations, and dogfish liver had concentrations above the Health Canada consumption advisory threshold. Dogfish muscle and bottom fish liver were below the Health Canada consumption advisory threshold.
- Historical pulpmill effluents (with possible contributions from log booming) appear to be the primary cause of the observed enrichment effect on benthic invertebrate communities at near-field stations. Benthic invertebrates are likely attaining a greater proportion of their diet from fibre mat/sediment organic material than ongoing effluent discharges.
- The condition of the near-field benthic communities generally does not appear to have changed with time (between Cycles Two and Four).
- The fibre mat appeared to be patchy and not well defined, but is greatest to the south and the east of the HSLP diffuser.