Mass Flux and Forensic Assessment Using PAHs: Informed Remediation Decision Making at One of Canada's Most Contaminated Sites

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Introduction: Sydney Harbour, Nova Scotia, Canada has been subject to effluent and atmospheric contaminant inputs, including polycyclic aromatic hydrocarbons (PAHs) from a coking and steel plant which operated for nearly a century. Coal tar residues were discharged into a small tidal tributary, known as the Sydney Tar Ponds (STPs), and subsequently discharged into Sydney Harbour [1]. Immobilizing STPs contaminants using solidification and stabilization was identified as the primary source control remedy to mitigate continued transport of contaminated sediments into Sydney Harbour [2]. Monitoring of PAH concentrations in marine resulted in significant increase in PAH concentrations in surface sediments in Sydney Harbour during year one of remediation which raised serious concerns with federal and provincial regulators, who called for termination of this $400M (CAD) remediation project [1].

Methods: Forensic source evaluations have been increasingly used as a tool for understanding origins of PAH contaminants in sediments [3]. This study used mass flux techniques and forensic source evaluations to help determine "mobile" *vs.* "immobile" PAH contaminants. Flux and forensic source evaluation-informed decision-making was used to confirm remediation end point goals to reduce off-site exposure and manage potential ecological risk in Sydney Harbour [4]. Previous STPs flux studies were reviewed [5], and an independent simultaneous flux study was also compared. A forensic assessment using PAH diagnostic ratios were used to identify sources of PAHs in surrounding soils, marine and freshwater sediments [3].

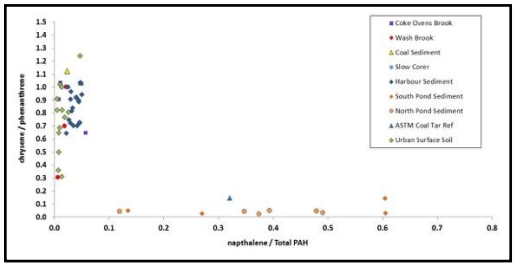

Fig. 1: Diagnostic ratio plots of chrysene / phenanthrene *vs.* naphthalene / Total PAH.

Results: Significant increases in PAHs were measured during year one of remediation, resulting in some government regulators calling for termination of remediation [2]. Historically, the STPs was thought to be the major source of PAH contamination in Sydney Harbour with estimated discharges of between 300-800 kg/year. However, only 17-97 kg/year of PAHs were discharged from the STPs using mass estimates during remediation. Results were also corroborated by an independent PAH flux study during year one of remediation which estimated 119 kg/year. Most of this flux was surface water derived, with groundwater contributing negligible quantities (0.002-0.005 kg/year).

Discussion: Estimated mass efflux of PAHs from STPs during remediation was in stark contrast to ~2000 kg loading thought necessary to cause a short term increase in harbour sediment PAH concentrations. Mass flux estimates were between 3-8 times lower than PAHs discharged from STPs a decade prior to remediation [5]. PAH concentrations in surface sediments were also within predicted natural recovery levels [6,7]. Flux results were also corroborated using PAH diagnostic ratios which found a common source of PAHs for urban soils, marine and aquatic sediments in and around Sydney (**Fig. 1**). Coal combustion (from historical coking) and coal dust transshipment (from current coal trans-shipment facilities), were likely the principal source of PAHs in these media and not migration of PAH laden sediments from the STPs during remediation [3].

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