PCB Congener Concentrations in a Municipal Sewer System in New Jersey, USA

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Introduction

Major urban and industrial centers, sewage discharges are one of the important routes for increase loadings of semivolatile organic compounds (SOC) to proximate waters[1]. The New York/New Jersey (NY-NJ) Harbor Estuary has been greatly impacted by anthropogenic inputs of from the adjoining metropolitan area[1, 2]. The NY-NJ Harbor Estuary Program Comprehensive Conservation and Management Plan (HEP CCMP)[3] identified at least fifteen chemicals (or classes of chemicals) of concern including polychlorinated biphenyls (PCBs), dioxins/furans, chlorinated pesticides, polycyclic aromatic hydrocarbons (PAHs), and metals[3]. The toxic chemicals discharged to New York/New Jersey Harbor originated from uncontrolled industrial and municipal sources, distant sources atmospheric deposition and rivers, and local sources such as municipal and industrial wastewater treatment facilities, combined sewer and storm water outfalls, and rainfall induced runoff (non-point sources)[2 - 5] . As part of New Jersey Toxics Reduction Program, Liu et al. and Schrock et al reported the profiles of PCBs, PAHs, organochlorine pesticides and dioxins in four seasonal sets of wastewater collected from twelve publicly owned treatment works (POTWs) in New Jersey [4, 6]. However, there exists significant information gaps in understanding the sources of contamination, especially PCBs, to the Harbor, due to limited toxics monitoring programs, inadequate analytical methods etc., The U.S. Environmental Protection Agency (EPA) requested to monitor sewer collection systems of the treatment plants to locate the unknown discharges of PCBs. Several of the compounds including some PCB congeners are known endocrine disruptors. Endocrine disruptors present at very low concentrations in drinking water, streams or lakes could affect biota or influence human fetaldevelopment[7] . Elemental composition of several isomers found in a municipal well that serviced Toms River, New Jersey, where an increased incidence of childhood cancer had been observed[8] . Very limited studies have been conducted to trackdown PCBs in municipal sewers, therefore, it is necessary to devise suitable sampling techniques for the trackdown studies. Therefore, PCB trackdown study was initiated with joint effort by ten member agencies of the New Jersey Harbor Discharges Group (NJHDG) to, among other things, to compare the whole water and passive in situ chemical extraction sampling (PISCES) methods. The Linden Roselle Sewerage Authority (LRSA) was selected as the site for the PCB trackdown pilot study.

This paper presents total PCB concentrations in whole water samples (dissolved and particulate phases) collected at selected locations in LRSA. In addition, PCB loading estimates for dry weather using selected set of samples are described.

Methods and Materials

Sampling: Automatic composite sampler equipped with peristaltic pump mechanisms were used to collect the sewer samples. All sampling equipment and containers were thoroughly cleaned before initiating each sample collection. Four rounds of sampling were done at five sewer locations and the LRSA primary influent channel. The samplers were installed inside of the sewer manholes and on the grate over the LRSA influent channel. The samplers were programmed to collect samples every 10-15 minutes in order to fill 10 L pre-cleaned glass container over a 24-hr period. Upon completion of 24-hr collection period, or in some cases (round 3) short term composite samples of wet weather, the samplers were retrieved, and the sample bottle was closed with Teflon lined stopper and shipped in ice to Murray State University Chemical Services Laboratory for analysis.

Chemical Analysis: Whole water samples were filtered through 150 mm diameter, 0.7 µm pore size, pre-cleaned Whatman Glass Fiber Filters (GFF) and the filtrate (dissolved phase) and the residue (particulate phase) were

preconcentrated and extracted separately. The dissolved phase was passed through XAD-2 (Supelpak 2B, Supelco, Bellefonte, PA)) resin and the resin was Soxhlet extracted for 16 h using 1:1 mixture of acetone and hexane. Suspended solids collected on the GFFs were also Soxhlet extracted similar to the XAD resins. The extracts of the dissolved (water) and particulate phase (suspended solids) phase were combined. Volume reduction, silica gel column chromatographic clean-up, sulfuric acid treatment and activated copper treatment of the extracts were done using standard procedures. The sample extracts were analyzed using gas chromatograph (GC) equipped with an electron capture detector (ECD) for PCB congener analysis. Quality assurance analyses include: Field blanks, calibration and calibration verification, duplicate sample analysis, relative accuracy using SRM 1941a, triplicate analysis for precision, matrix spike sample and matrix spike duplicate.

Results and Discussion

In dry weather (Rounds 1 and 2), total PCBs were 2.6 to 6.0-fold higher in the western sampling area compared to Roselle Flume, which receives flow from mostly residential and commercial sources in the northwest area (Table 1). The M7B (manhole 7B) and M8 (manhole 8) dry weather samples averaged 390 and 573 ng/L compared to 108 ng/L for Roselle Flume dry weather samples. Wet weather samples (Round 4) showed only slightly higher total PCBs at M7B and M8 compared to Roselle Flume. These data indicate a source of PCBs in the western portion of the sewershed that is more easily observed during dry weather. The western sewershed serves as current and former industries. The total PCB concentrations were similar during dry and wet weather among the upstream sampling locations with the exception of Roselle Flume (Table 1). Total PCBs at Roselle Flume were about three-fold higher during wet weather than dry weather. The wet weather PCB levels were relatively similar to those at M7B and M8. The similarity in the total PCB levels among these upstream locations suggests a widespread source of PCBs (e.g. atmospheric deposition) during wet weather.

Table 1. Total PCB concentrations in whole water from five sewer locations

and LRSA primary influent in dry weather (top) and wet weather (bottom).

Sampling LocationS*	Dry Weather		Wet Weather	
	PCB Concentrations (ng/L)		PCB Concentrations (ng/L)	
	Round 1	Round 2	Round 1	Round 2
RF	62	154	NA	350
M7B	375	404	252	525
M8	341	805	262	400
MC	275	310	270	560
MT	230	310	220	280
PI	460	830	190	320

*RF: Rossele Flume, M7B: Manhole 7B, M8: Manhole 8, MC: Manhole C, MT: Manhole T and

PI: Primary influent.

In dry weather, the highest PCB levels were found in the whole primary influent (PI) samples (650 ng/L average). The increased levels relative to the nearby MT (manhole T) on the main trunk line (270 ng/L average) may be related to (1) potential contribution of PCBs from grit/sludge processing waste streams within the Waste Water Treatment Plant (WWTP) which are returned to a point before the primary influent sampling location or (2) the potential contribution of PCBs from the one sewer line entering below Manhole T, which serves a portion of the western sewershed and a small residential area new the WWTP. The western portion of the sewershed served by the relief line is the same general area where elevated PCB levels were indicated (Table 1).

The pattern of greatest PCB levels in the primary influent (PI) was not observed in wet weather. Relatively lower total PCB levels in the primary influent (220 ng/L) may been caused by dilution of the suspect sources in the increased wet weather flow. The similarity in total PCBs for MT (280 ng/L), the WWTP screen house (320 ng/L) before return flows) and the primary influent (240 ng/L after return flows) during wet weather (Round 4) supports this hypothesis.

PCBs loading estimates were determined using total PCB concentrations in whole water samples. Table 2 presents estimated total PCB loadings.

Table 2. Estimated total PCB loadings (g/day) during dry weather (Rounds 1 and 2).

Round	Sampling Location (Estimated flow, MGD)*							
	RF (3)	M7B (1.5)	M8 (3)	Central (1.5)	MC (4.5)	Northeast (2.4)	MT (9.9)	PI (11)
1	0.7	2.1	3.9	0.8**	4.7	3.1+	8.5	20.6
2	1.7	2.3	9.1	NC	5.2	4.7+	11.7	33.5
Avg.	1.2	2.2	6.5	0.8	5.0	3.9	10.1	27.1

*Flow was monitored at Roselle Flume (RF) and the LRSA primary influent (PI). PI flow in Round 1 and 2 was 11.75 mgd (million gallons per day) and 10.63 mgd, respectively. Flows at M7B and M8 are estimated based on a 1991 sewer survey (ADS) and current industrial user discharge rates. Central flow was estimated by difference from MC and M8 flows. Northeastern flow was estimated by difference from MT and combined MC and RF flows [i.e. Northeast= MT-(MC+RF).

** Calculated by difference of MC and M8 loadings (i.e., Central=MC-M8)

+ Calculated by difference of MT and combined MC and RF loadings [i.e.. Northeast=MT-(MC+RF)].

As shown in Table 2, the primary influent (PI) contributed the highest average loadings (27.1 mgd) than other sampling locations.

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