

Division of Science, Research and Technology

Research Project Summary

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The New Jersey Toxics Reduction Workplan for New York - New Jersey Harbor: Phase One POTW, SWO, and CSO Studies

Authors

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Abstract

The presence of toxic chemicals in water and sediments throughout New York-New Jersey Harbor has resulted in reduced water quality, fisheries restrictions/advisories, and general adverse impacts to the estuarine and coastal ecosystems. To help remediate the harbor, Phase One of the New Jersey Toxics Reduction Workplan for NY-NJ Harbor (NJTRWP) included a set of ambient water quality studies designed to provide the New Jersey Department of Environmental Protection (NJDEP) the information it needs to identify sources of the toxic chemicals of concern, and to prioritize these sources for appropriate action. In addition, discharges from the twelve New Jersey publicly-owned wastewater treatment plants (POTWs) and selected stormwater outfalls (SWOs) and combined sewer overflows (CSOs) that discharge to the harbor were sampled. The POTW, SWO, and CSO samples were analyzed using high resolution methods for polychlorinated biphenyls (PCBs), dioxins/furans (PCDD/Fs), polyaromatic hydrocarbons (PAHs), pesticides, cadmium (Cd), lead (Pb), mercury (Hg), and methyl-Hg. In general, mean contaminant concentrations for the sampled SWOs and CSOs were considerably higher than the mean concentrations in the POTW effluents. The mean total Hg concentration in the POTW effluents were typically less than 37 ng/L, with the effluents from only three of the POTWs (Passaic Valley Sewage Commission [PVSC], North Bergen-Central, and West New York) exceeding the New Jersey Saline Human Health Water Quality Criteria (NJ WQC; 51 ng/L). Mean total Hg concentrations in the SWOs (277 ng/L) and CSOs (242 ng/L) were considerably greater. The mean total Cd concentrations in the POTW effluents were typically less than about 200 ng/L, with higher mean concentrations observed in the SWOs (792 ng/L) and CSOs (497 ng/L). The mean total Pb concentration in the POTW effluents was less than 3.5 ug/L, while the mean total Pb concentrations in the SWOs (101 ug/L) and CSOs (51 ug/L) exceeded the New Jersey Aquatic Chronic WQC (24 ug/L). The total dioxin/furan (PCDD/F) concentration in each of the collected POTW samples ranged from 0.23 pg/L to 153 pg/L; the mean concentrations for all of the samples collected at the selected SWOs (2,409 pg/L) and CSOs (2,633 pg/L) were substantially higher. 2,3,7,8-TCDD was detected in only one POTW sample, but was detected in most of the SWO and CSO samples. Mean total PCB concentrations ranged from 6.8 ng/L to 23 ng/L at the POTWs, except for PVSC (72 ng/L) and Linden-Roselle (61 ng/L). The mean concentrations for all of the samples collected at the selected SWOs (52 ng/L) and CSOs (58 n/L) were higher than the total PCB concentrations observe in most of the POTW samples. PCB 11 accounted for about 76% of the total PCBs at PVSC, but was present at only low concentrations (if at all) in the other POTWs and in the CSO and SWO samples. The NJ Saline Human Health WQC for total PCBs (0.064 ng/L) was exceeded by the mean concentration at all of the POTWs and CSO/SWO sampling locations. The NJ Saline Aquatic Chronic WQC (30 ng/L) was exceeded by the mean total PCB concentrations at PVSC, Linden-Roselle, and in the CSO and SWO samples. Mean total pesticide concentrations ranged from about 10 to 30 ng/L at the POTWs, with the mean concentrations at the selected SWOs (70 ng/L) and CSOs (79 n/L) higher than the total pesticide concentrations observed in the POTW samples. The applicable NJ Saline Human Health WQC for total chlordane, dieldrin, and various DDT compounds were exceeded by the mean concentrations observed at most of the POTWs, and in the mean CSO and SWO concentrations. The total chlordane and dieldrin Saline Aquatic Chronic WQC were also exceeded by the mean CSO and SWO concentrations, and by the mean concentrations at most of the POTWs. Mean total PAH concentrations ranged from 527 to 6,760 ng/L at the POTWs. The mean total PAH concentrations were substantially higher at the CSOs (54,600 ng/L) and SWOs (19,400 ng/L). There were strong correlations between the annual contaminant loads discharged by each POTW and the volume of wastewater flow - in general, the larger the POTW wastewater flow volume, the larger the load of contaminant discharged by that POTW. In contrast, there were no (or only weak) correlations between the annual contaminant loads and the mean contaminant concentrations in the POTW effluents. The Phase One NJTRWP POTW, SWO, and CSO data and analyses will be used, together with other CARP data and the CARP Model results, to develop the NJTRWP Implementation Plan.

Introduction

The New York-New Jersey Harbor estuary system is of enormous and interdependent ecological and economic importance. The Port of New York and New Jersey is central to the economy of the region, and is the largest port on the East Coast of the United States. The presence of toxic chemicals in water and sediments throughout the harbor results in reduced water quality, fisheries restrictions and advisories, reproductive impairments in some coastal species, and general adverse impacts to the estuarine and coastal ecosystems. Problems associated with the management of contaminated dredged material have resulted in uncertainty regarding construction and future maintenance of the maritime infrastructure that supports shipping in the Harbor.

The New York-New Jersey Harbor Estuary Program Comprehensive Conservation and Management Plan (HEP CCMP; March 1996) has identified at least fifteen chemicals of concern, including polychlorinated biphenyls (PCBs), dioxins/furans (PCDD/Fs), chlorinated pesticides, polycyclic aromatic hydrocarbons (PAHs), and metals. The HEP CCMP includes a number of actions to achieve its goals and objectives related to the "Management of Toxic Contamination":

- (1) reduce continuing discharges of the chemicals of concern to the estuary;
- (2) remediate selected contaminated sediments;
- (3) minimize human health risks due to the consumption of fish and shellfish;
- (4) better understand the problem and take additional actions as more is learned.

The Joint Dredging Plan for the Port of New York and New Jersey (October 7, 1996) stresses the economic importance of the port, and the associated need to dredge navigation channels and maintain port facilities. The Joint Dredging Plan has two major objectives:

- (1) to promote greater certainty and predictability in the dredging project review process, and dredged material management;
- (2) to facilitate effective long-term environmentally sound management strategies for addressing dredging and disposal needs for the region.

As part of the commitments included in the Joint Dredging Plan, the States of New Jersey and New York agreed to implement the HEP CCMP as it relates to a number of sediment and toxic contamination concerns. In response, the HEP Contaminant Assessment and Reduction Program (CARP) was developed and implemented. The New Jersey Toxics Reduction Workplan for NY-NJ Harbor (NJTRWP) is the New Jersey component of CARP.

The NJTRWP includes a series of studies designed to provide the NJ Department of Environmental Protection (NJDEP) with the information it needs to identify sources of the toxic chemicals of concern, and to prioritize these sources for appropriate action. In addition, the data from

these studies have been compiled with the CARP data collected by the New York State Department of Environmental Conservation in the CARP Database. Finally, the CARP data collected by the two states has been used to develop the CARP sediment and contaminant fate, transport and bioaccumulation model. The CARP Database and CARP Model can be accessed at www.carpweb.org.

Phase One of the NJTRWP (NJDEP 2007, 2001) included a set of ambient water quality studies, summarized in Pecchioli et al. (2007). Samples were collected at the heads-of-tide and within the tidal reaches of the five major New Jersey tributaries to the harbor (the Passaic, Hackensack, Elizabeth, Rahway, and Raritan Rivers), and within the estuarine areas of Newark Bay, the Kill van Kull, and the Arthur Kill. In addition, hydrodynamics studies (summarized in Pecchioli et al., 2006) were conducted in the NY-NJ Harbor estuary. Finally, NJTRWP Study I-G sampled the discharges from publicly-owned wastewater treatment plants (POTWs), combined sewer overflows (CSOs), and stormwater outfalls (SWOs). This is by far the most comprehensive sampling for toxic contaminants ever to occur in this economically important and complex estuarine system.

The major objective of NJTRWP Study I-G (undertaken by the New Jersey Harbor Dischargers Group and the Great Lakes Environmental Center) is to determine the concentrations and loadings of selected organic and inorganic toxic contaminants discharged from all of the New Jersey POTWs into NY-NJ Harbor. A second objective is to provide measurements of contaminant concentrations in discharges from New Jersey SWOs and CSOs that discharge to the harbor. This data will be used to (a) develop and calibrate the CARP sediment and contaminant fate, transport and bioaccumulation model, and (b) develop the NJTRWP Implementation Plan to trackdown and identify sources of the toxic contaminants.

The following NJTRWP workplan and project reports detail the objectives, sampling and analytical methods, quality assurance protocols, and results of the NJTRWP studies:

- NJDEP NJTRWP Workplan – Volume I (Revised/Version 2 – February 2, 2001)
- NJDEP NJTRWP Workplan – Volume II/QAPP (Version 2.3 – June 2007[Final])
- Study I-C: Concentrations and Loads of Organic Compounds and Trace Elements in Tributaries to Newark and Raritan Bays, New Jersey (Wilson and Bonin, 2007)
- Study I-C: Organic Compounds, Trace Elements, Suspended Sediment, and Field Characteristics at the Heads-of-Tide of the Raritan, Passaic, Hackensack, Rahway, and Elizabeth Rivers, New Jersey, 2000-03. (Bonin and Wilson, 2006)
- Study I-D/E: The New Jersey Toxics Reduction Workplan for NY-NJ Harbor – Ambient Monitoring of Water Quality Within Major Tributaries and the Estuary, Final Report – April 2007 (Stevens Institute of Technology, 2007)

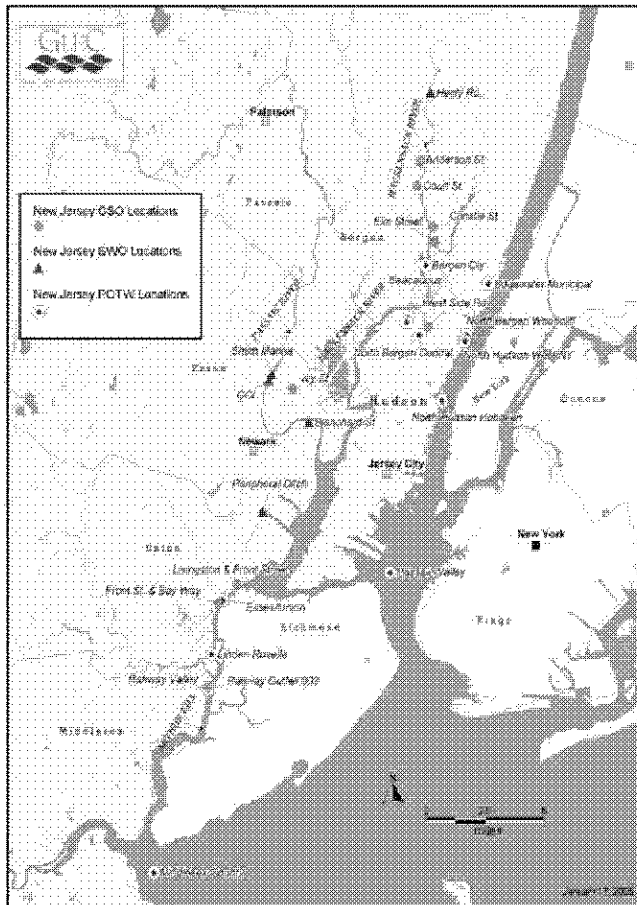
- Study I-G: The New Jersey Toxics Reduction Workplan Study I-G Project Report (revised-final, February 2008)

These documents are available in electronic format at <http://www.state.nj.us/dep/dsr/njtrwp/>.

Methods and Data Analysis

Study I-G of the NJTRWP consists of the sampling of discharges from all twelve (12) New Jersey municipal wastewater treatment facilities (POTWs), and selected combined sewer outfalls (CSOs) and storm water outfalls (SWOs), which discharge to NY-NJ Harbor (Figure 1). Sampling of the POTWs was initiated in October 2000 and completed in August 2001. The six (6) largest POTWs (see Table 1), each with significant industrial/commercial service areas, were each sampled four (4) times apiece (October and December 2000, May and August 2001). The six (6) smallest POTWs, serving mostly residential areas, were sampled twice (December 2000 and August 2001). Sampling of the CSOs and SWOs (during defined wet weather events) began in September 2001 and was completed in April 2004. Five (5) SWOs were sampled three (3) times each, while nine (9) CSOs were sampled from one to three times each.

Figure 1. POTW, CSO and SWO Locations for the Harbor Estuary Program Contaminant Assessment and Reduction Program

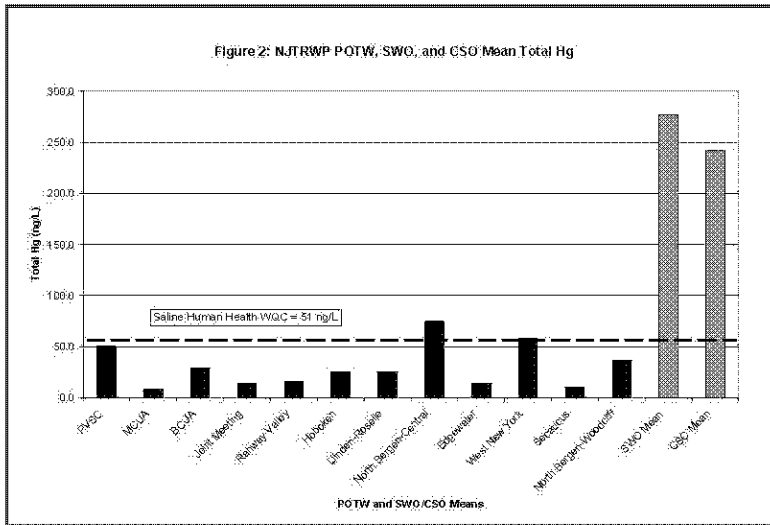


NJ POTW	Hg Load (g/yr)	Cd Load (kg/yr)	Pb Load (kg/yr)
Passaic Valley (PVSC)*	20,159	130.7	741.9
Bergen County UA (BCUA)*	2,841	7.8	227.5
Linden Roselle*	465	2.0	31.1
Joint Meeting Essex Union*	1,120	8.9	120.5
Rahway Valley*	572	4.8	85.9
Middlesex County UA (MCUA)*	1,339	9.3	108.1
North Bergen (NB)-Central	709	1.2	32.7
Secaucus	43	0.3	6.0
North Bergen (NB)-Woodcliff	147	0.8	9.2
Hoboken	755	1.3	67.7
West New York	884	2.9	43.6
Edgewater	62	0.1	6.5
Total	29,095	170.1	1,480.7

* "large" POTWs

Twenty-liter (20 L) 24-hour whole water composite samples of effluent from the POTWs, and 20 L whole water grab samples of CSO and SWO discharges, were collected. Each sample was split into four 2.5 L samples for organic contaminant analyses, three 500 ml subsamples for metals analyses, and additional subsamples for suspended solids (SS) and organic carbon (total organic carbon [TOC], particulate organic carbon [POC], and dissolved organic carbon [DOC]) analyses. The samples were analyzed using high-resolution methods for PCBs (modified USEPA Method 1668a), dioxins/furans (modified USEPA Method 1613b), PAHs (high-resolution [HR] GC/MS-SIM), and pesticides (HR GC/MS). The grab and composite metals samples were analyzed for Cd and Pb (USEPA Method 1638), Hg (modified USEPA Method 1631b), and methyl-Hg (modified USEPA Method 1630). The raw data for these studies, as reported by the analytical laboratories, are available in the CARP Database.

Because of the number and nature of the samples and associated blanks collected, a "maximum blank" approach was developed to assess the impact of blank contamination on the usability of the sample data. In this "maximum blank" approach, the Method, Equipment, and Field Blanks associated with a sample are evaluated for each target analyte. Of the three blank results, that having the largest value – i.e. the "maximum blank" – is used to assess the effects of blank contamination on the sample result. In order for a sample result to be usable, it must be at least five times (5x) greater than the "maximum blank" (3x for PCBs). Most of the analytical data were blank corrected using the standard "NJTRWP Maximum Blank Approach". However, exceptions to this approach were made in some sampling events for some contaminants.



mean total Hg concentration in the POTW effluents were typically less than 37 ng/L, with the effluents from only three of the POTWs (Passaic Valley Sewer Commissioners [PVSC], North Bergen-Central, and West New York) exceeding the New Jersey Saline Human Health Water Quality Criteria (NJ WQC: 51 ng/L). Mean total Hg concentrations in the SWOs (277 ng/L) and CSOs (242 ng/L) were considerably greater.

Results and Discussions

Comparisons between the POTW and CSO/SWO data are constrained because the CSO/SWO samples were obtained as grab samples, while the POTW samples were all collected as 24-hour composite samples. Nevertheless, it is apparent that contaminant concentrations were much higher in the CSO/SWO samples compared to the concentrations in the POTW effluents. In addition, SS and POC concentrations were also considerably elevated in the CSO/SWO samples, which may account in part for the observed higher contaminant concentrations (due to the affinity of most of the measured contaminants to solids).

Figure 3 shows the mean total Cd concentration at each of the POTWs, and the mean concentration for all of the samples collected at the selected SWOs and CSOs. The mean total Cd concentration in the POTW effluents were typically less than about 200 ng/L, while those for the SWOs (792 ng/L) and CSOs (497 ng/L) were considerably greater. No POTW, SWO, or CSO sample had a total Cd concentration that exceeded the NJ Saline Human Health WQC (16,000 ng/L).

With a number of exceptions, in general the average concentrations of the measured individual contaminants and contaminant classes were found to be quite similar among the New Jersey POTWs that participated in this program. This similarity in contaminant profile was unexpected, considering that the NJ POTWs ranged from small facilities, treating primarily sanitary waste, to very large POTWs with substantial industrial contributions.

CSO sample had a total Cd concentration that exceeded the NJ Saline Human Health WQC (16,000 ng/L).

Metals – Hg, Pb, and Cd

Figure 2 shows the mean total Hg concentration at each of the POTWs, and the mean concentration for all of the samples collected at the selected SWOs and CSOs. The

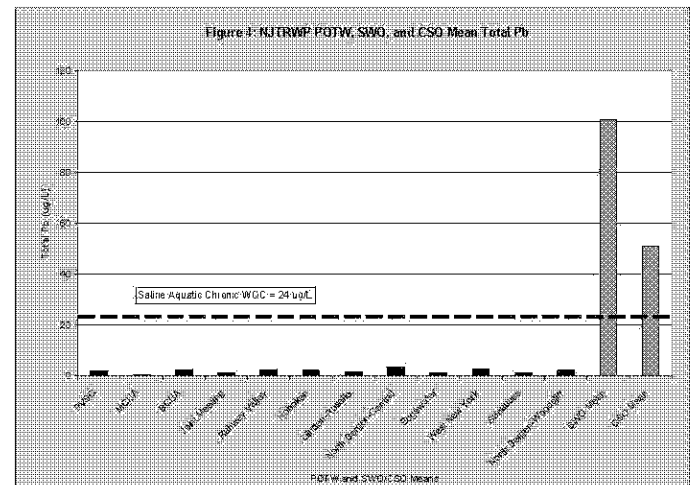
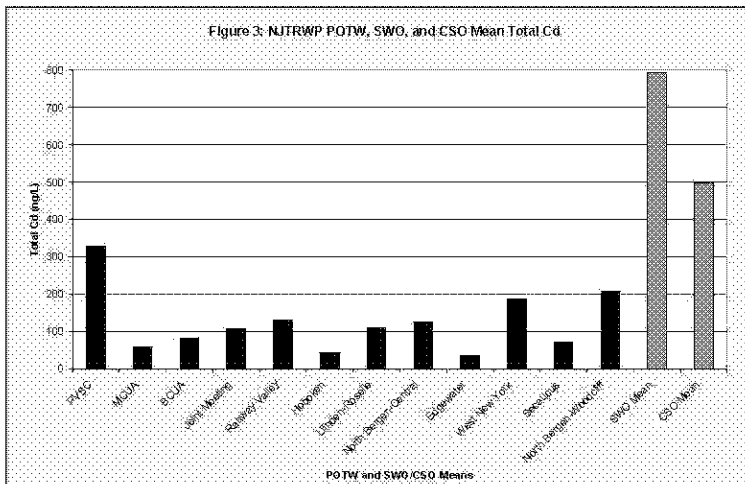


Figure 4 shows the mean total Pb concentration at each of the POTWs, and the mean concentration for all of the samples collected at the selected SWOs and CSOs. The mean total Pb concentration in the POTW effluents was less than 3.5 ug/L, while the mean total Pb concentrations in the SWOs (101 ug/L) and CSOs (51 ug/L) were considerably greater. The mean SWO and CSO total Pb concentrations exceeded the NJ Aquatic Chronic WQC (24 ug/L), but did not exceed the Aquatic Acute WQC (210 ug/L).



Estimated Hg, Cd, and Pb loads from each of the POTWs are presented in Table 1. The largest loads of all three metals were discharged by PVSC, which also has the largest wastewater discharge (1,087 million Liters per day, MLD) of the 12 NJ POTWs (other POTW discharges are from 11 to 442 MLD). Among all the POTWs, there was a strong correlation ($r^2 = 0.88-0.92$) between the volume of wastewater discharged and the annual metals loads. These correlations were much stronger than those between the POTW annual

metals loads and the POTW mean effluent concentrations for Cd ($r^2 = 0.58$), Pb ($r^2 = -0.05$), and Hg ($r^2 = 0.10$). CSO and SWO load estimates for the contaminants of concern were beyond the scope of the present study.

Dioxins/Furans (PCDD/Fs)

Because the concentrations of dioxins/furans (PCDD/Fs) were found to be extremely low in the samples collected in the initial sampling events, the large POTW samples from only the October and December 2000 events were analyzed for PCDD/Fs. The October 2000 samples were heavily impacted by blank contamination; the data for many congeners from this event were either not detected or were censored at all six large POTWs. Conversely, there was little blank contamination during the December 2000 event. Non-detections and blank contamination during the August 2001 sampling event resulted in the censorship of many dioxin/furan congeners at all of the small POTWs.

Figure 5 shows the total dioxin/furan (PCDD/F) concentration in each of the collected POTW samples. Concentrations ranged from 0.23 pg/L to 153 pg/L, and were quite variable at each of the POTWs. The mean concentrations for all of the samples collected at the selected SWOs (2,409 pg/L) and CSOs (2,633 pg/L) were similar, and substantially higher than the total PCDD/F concentrations in the POTW samples. 2,3,7,8-TCDD was detected in only one POTW sample, but was detected in most of the SWO and CSO samples.

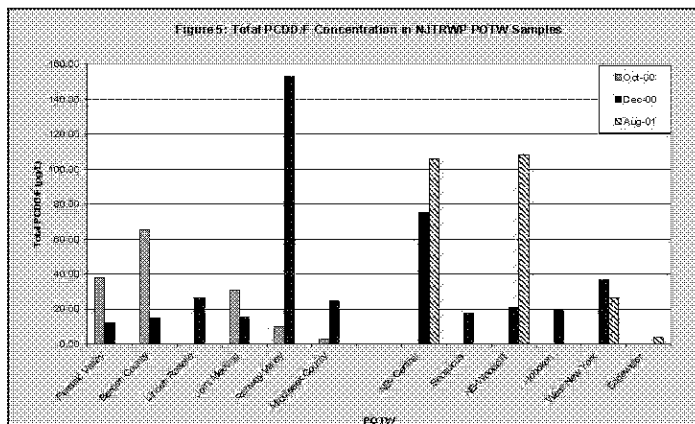
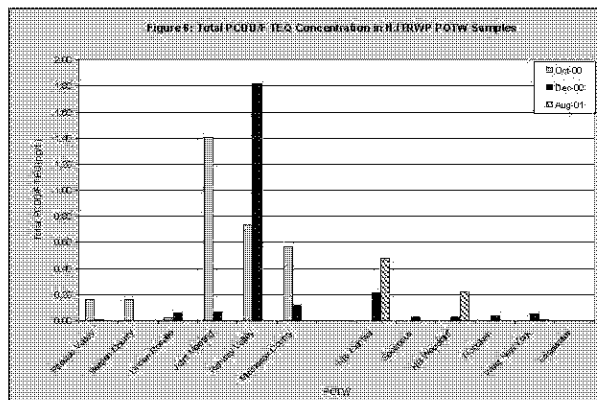


Figure 6 shows the total PCDD/F Toxic Equivalency (TEQ) concentration in each of the collected POTW samples. Concentrations ranged from 0.01 pg/L to 1.82 pg/L TEQ, and were quite variable at each of the POTWs. The mean total PCDD/F TEQ concentration for all of the samples collected at the selected SWOs (19.06 pg/L TEQ) was about twice that in the CSOs (8.56 pg/L TEQ), and the SWO and CSO mean concentrations were substantially higher than the total PCDD/F TEQ concentrations in the POTW samples.

Estimated total PCDD/F loads from each of the POTWs are presented in Table 2. The largest load was discharged by PVSC (9.93 g/yr), followed by Bergen County Utilities Authority (BCUA), Rahway Valley, and Middlesex County Utilities Authority (MCUA). Among all the POTWs, there was



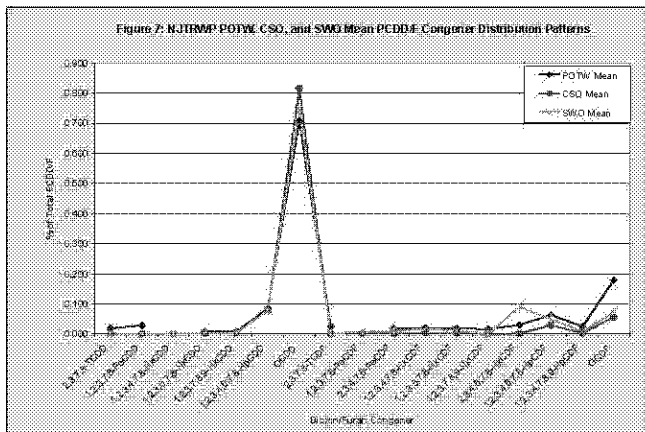
a strong correlation ($r^2 = 0.89$) between the volume of wastewater discharged and the annual PCDD/F load. There was no correlation between the POTW annual total PCDD/F loads and the POTW mean total PCDD/F effluent concentrations ($r^2 = 0.002$).

Table 2: Estimated annual loads of total PCDD/Fs (grams/year), total PCBs (g/yr), total PCBs-PCB11 (g/yr), and total PAHs (kilograms/year) from the 12 NJ POTWs that discharge to NY-NJ Harbor.

NJ POTW	Total PCDD/F Load (g/yr)	Total PCB Load (g/yr)	Total PCBs-PCB11 Load (g/yr)	Total PAH Load (kg/yr)
PVSC*	9.93	34,367	5,797	1,619
BCUA*	3.86	2,146	2,106	241
Linden/Roselle*	0.24	1,108	1,106	23
Joint Meeting*	1.80	1,126	1,117	50
Rahway Valley*	2.97	290	286	31
MCUA*	2.20	3,822	3,522	169
NB-Central	0.86	227	219	28
Secaucus	0.04	30	30	2
NB-Woodcliff	0.26	46	45	7
Hoboken	0.57	479	479	21
West New York	0.46	162	161	104
Edgewater	0.02	32	31	3
Total	23.33	43,834	44,896	2,299

* "large" POTWs

Figure 7 shows the POTW, CSO, and SWO mean dioxin/furan congener distribution patterns. In the POTW samples, OCDD was the dominant congener, on average accounting for 71% of the total PCDD/Fs in the samples, followed by OCDF (18%), 1,2,3,4,6,7,8-HpCDD (8.4%), and 1,2,3,4,6,7,8-HpCDF (6.3%). These four congeners were observed in at least 16 of the 21 POTW samples that were analyzed for dioxins/furans; the other 14 congeners were found in only 7 or fewer samples. While OCDD was also dominant in the CSO (82%) and SWO (75%) samples, OCDF accounted for only 5.7-7.3% of the total PCDD/Fs in these samples. 1,2,3,4,6,7,8-HpCDD (7.6%) and 1,2,3,4,6,7,8-HpCDF (2.9 - 4.9%) were also important in the CSO and SWO samples. In contrast to the POTW samples, except for 1,2,3,7,8,9-HxCDF, all of the dioxin/furan congeners were found in most of the CSO and SWO samples.

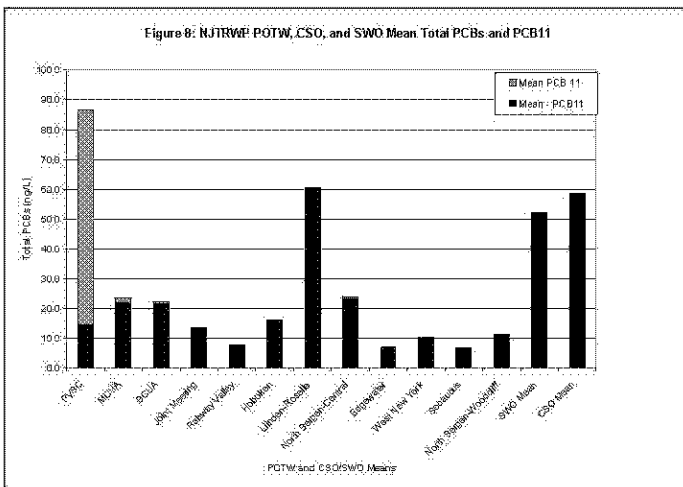
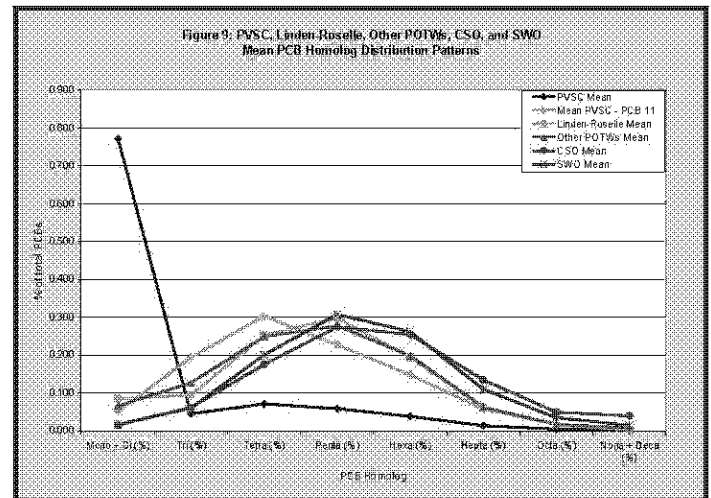


Polychlorinated Biphenyls (PCBs)

Figure 8 shows the mean total PCB and PCB 11 concentrations at each of the POTW, and the mean concentrations for all of the samples collected at the selected SWOs and CSOs. Mean total PCB concentrations ranged from 6.8 ng/L to 23 ng/L at the POTWs, with higher concentrations observed at PVSC (87 ng/L) and Linden-Roselle (61 ng/L). The mean concentrations for all of the samples collected at the selected SWOs (52 ng/L) and CSOs (58.5 ng/L) were similar, but higher than the total PCB concentrations observed at most of the POTW samples. PCB 11 accounted for about 76% of the total PCBs at PVSC, but was present at only low concentrations (if at all) in the other POTWs and in the CSO and SWO samples.

included in the calculation. The largest total PCB load was discharged by PVSC (34,367 g/yr), but this decreases to only 5,797 g/yr if PCB 11 is not included in the total PCB calculation.

Among all the POTWs, there was a strong correlation ($r^2 = 0.89$) between the volume of wastewater discharged and the annual total PCB load; this correlation is slightly stronger ($r^2 = 0.94$) if PCB 11 is not included in the total PCB calculation. The correlation between the POTW annual total PCB loads and the POTW mean total PCB effluent concentrations ($r^2 = 0.67$) was weaker, and there was no correlation ($r = 0.02$) when PCB 11 was not included in the total PCB calculation.



The NJ Saline Human Health WQC for total PCBs (0.064 ng/L) was exceeded by the mean concentration at all of the POTWs and CSO/SWO sampling locations. The NJ Saline Aquatic Chronic WQC (30 ng/L) was exceeded by the mean total PCB concentrations at PVSC and Linden-Roselle, and in the CSO and SWO samples.

Estimated total PCB loads from each of the POTWs are presented in Table 2. The combined total PCB load from all 12 NJ POTWs (43,834 g/yr) decreases by about 29,000 g/yr, to 14,898 g/yr, if PCB 11 (largely from PVSC) is not

Figure 9 shows the mean PCB homolog distribution patterns for the PVSC (with and without PCB 11 included in the calculation of total PCBs) and Linden-Roselle POTW effluent samples, and the overall mean PCB homolog distribution patterns for the remaining POTW, CSO, and SWO samples. The distribution pattern in the PVSC effluent samples (with PCB 11) differs from the others, with 77% of the total PCBs found in the mono+di homolog group (i.e. PCB 11). Removing PCB 11 from the calculation of the PVSC total PCB concentration results in a homolog distribution pattern that is still different than that observed in the other POTWs. Despite its greater total PCB concentration compared to the other POTWs, the mean PCB homolog distribution pattern from the Linden-Roselle samples is comparable to that in the other (non-PVSC) POTW samples. The CSO and SWO samples have similar mean PCB homolog distribution patterns. The (non-PVSC) POTWs are dominated by penta- and tetra-PCBs (25-30%), but the CSO and SWO samples are dominated by the penta- and hexa-PCBs (25-31%). In addition, compared to the CSO/SWO samples, the POTWs have higher percentages of the lower molecular weight PCB congeners (mono+di, tri-, and tetra-PCBs), whereas the CSO and SWO samples had higher percentages of the higher molecular weight congeners (hexa-, hepta-, octa-, and nona+deca-PCBs).

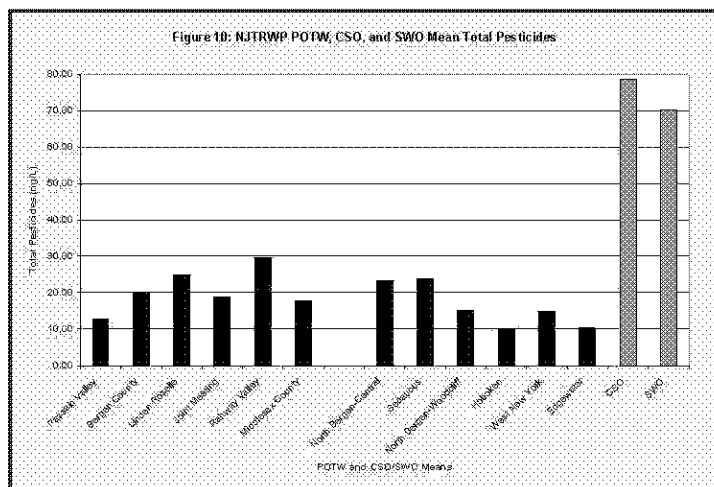
As expected, the (non-PVSC) POTW, SWO, and CSO PCB homolog distribution patterns indicate a mixture of the various commercial Arochlors. Given its high percentage of

PCB 11, the PVSC homolog distribution pattern does not correspond to any commercial Aroclor mixture. Removing PCB 11 from the calculations, the PVSC effluent samples also show a pattern indicative of a mixture of the various commercial Aroclors. However, compared to the other POTW's, the PVSC (without PCB 11) samples had higher percentages of tri- and tetra-PCBs, and lower percentages of penta- and hexa-PCBs (see Figure 9).

Pesticides

Figure 10 shows the mean total pesticide concentration at each of the POTW's, and the mean concentrations for all of the samples collected at the selected SWOs and CSOs. Mean total pesticide concentrations ranged from about 10

all three classes of pesticides were high in the CSO and SWO samples compared to the POTW effluents. On average, these three classes of pesticides accounted for about 33% of the total pesticides in the PVSC and MCUA samples, and 52-75% of the total pesticides in the effluents from the other POTW's. However, on average, total DDTs, chlordanes, and dieldrin accounted for about 90% of the total pesticides in the CSO and SWO samples. Gamma-BHC accounted for about 45% and 27% of the total pesticides at PVSC and MCUA, respectively (and a relatively high % gamma-BHC was also observed at the Rahway Valley [35%] and Hoboken [24%] POTW's). Although blank correction and/or non-detections combined to affect the POTW, SWO, and CSO pesticide data, the total chlordanes, dieldrin, and DDT data were minimally impacted.



to 30 ng/L at the POTW's. The mean concentrations for all of the samples collected at the selected SWOs (70 ng/L) and CSOs (79 ng/L) were similar, and higher than the total pesticide concentrations observed in the POTW samples.

The HEP CCMP identified the pesticides DDT (with its metabolites DDE and DDD), chlordanes (and its metabolites), and dieldrin as chemicals of concern. Figure 11 shows the mean total concentrations for these pesticides at each of the POTW's, and the mean concentrations for all of the samples collected at the selected SWOs and CSOs. The mean concentrations of

Table 3: Exceedances of the applicable NJ Saline Water Quality Criteria by the mean pesticide concentrations observed for the POTW's, CSOs, and SWOs and

Contaminant - WQC	WQC (ng/L)	POTW	CSO	SWO
Total chlordanes				
Human Health	0.11	All POTW's	Yes	Yes
Aquatic Chronic	4	All but *	Yes	Yes
Aquatic Acute	90	None	No	No
Dieldrin				
Human Health	0.054	All POTW's	Yes	Yes
Aquatic Chronic	1.9	Some**	Yes	Yes
Aquatic Acute	710	None	No	No
4,4-DDD Human Health				
	0.31	All but ^	Yes	Yes
4,4-DDE Human Health				
	0.22	All POTW's	Yes	Yes
4,4-DDT Human Health				
	0.22	All but PVSC	Yes	Yes
* except at PVSC, MCUA, Hoboken, and West New York				
** BCUA, Linden-Roselle, Rahway Valley, North Bergen-Central, and Secaucus				
^ except at BCUA, MCUA, North Bergen-Woodcliff, and Edgewater				

Table 3 summarizes the comparison of the mean concentrations for total chlordanes, dieldrin, and various DDT compounds with applicable New Jersey Water Quality Criteria.

Estimated pesticide loads from each of the POTW's are presented in Table 4. The combined total chlordanes, dieldrin, and total DDTs loads (6,305 g/yr) account for 45% of the total pesticide load (13,923 g/yr) for all 12 of the NJ POTW's. The largest pesticide loads were discharged by PVSC. However, the PVSC total pesticide load (5,058 g/yr) is only 36% of the combined load from all of the POTW's – this is low considering that the PVSC wastewater flow accounts for 46% of the total flow from all 12 of the NJ POTW's.

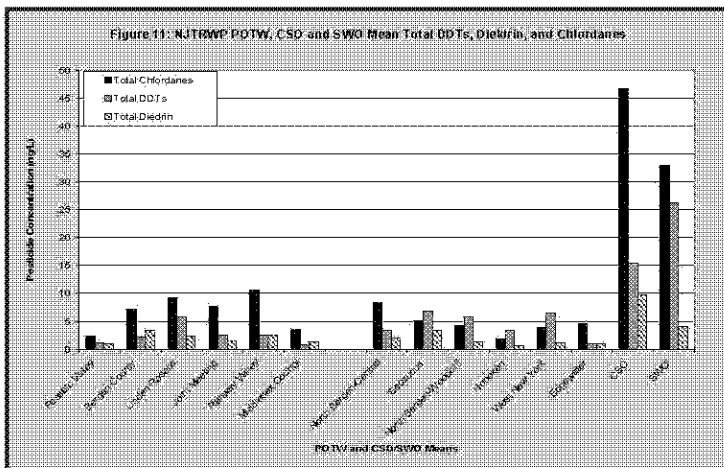


Table 4: Estimated annual loads of total pesticides, chlordanes, dieldrin, and DDTs (grams/year) from the 12 NJ POTWs that discharge to NY-NJ Harbor.

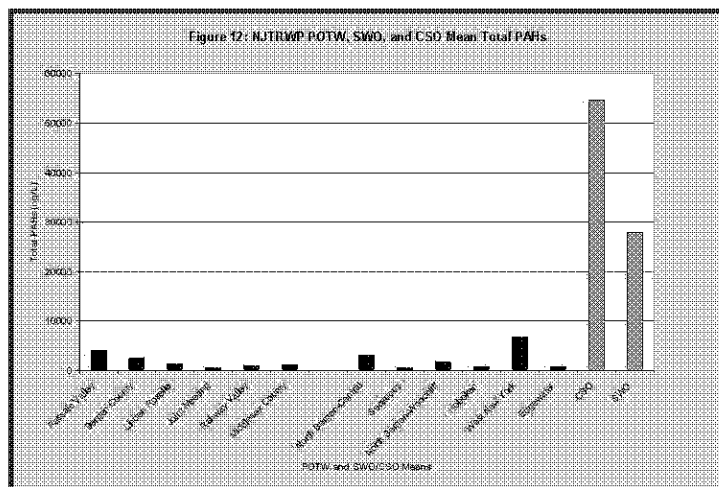
NJ POTW	Total Pest Load (g/yr)	Total Chlordane Load (g/yr)	Total Dieldrin Load (g/yr)	Total DDTs Load (g/yr)
PVSC*	5,058	949	354	417
BCUA*	1,951	691	323	203
Linden/Roselle*	456	169	41	105
Joint Meeting*	1,551	626	116	205
Rahway Valley*	1,084	395	94	99
MCUA*	2,877	569	217	136
NB-Central	220	79	20	33
Secaucus	104	22	15	30
NB-Woodcliff	90	47	5	23
Hoboken	289	54	18	98
West New York	228	59	17	99
Edgewater	45	20	4	4
Total	13,923	3,643	1,222	1,441

* "large" POTWs

Among all the POTWs, there was a very strong correlation ($r^2 = 0.96$) between the volume of wastewater discharged and the annual total pesticide load. There was no correlation ($r^2 = -0.02$) between the POTW annual total pesticide loads and the POTW mean total pesticide effluent concentrations. Similarly, there were strong correlations between the volume of wastewater discharged and the annual total chlordane, dieldrin, and total DDTs loads ($r^2 = 0.72-0.85$), while there were no correlations between the POTW annual total pesticide loads and the POTW mean total pesticide effluent concentrations for these three classes of pesticides ($r^2 = 0.001$ to -0.20).

Polyaromatic Hydrocarbons (PAHs)

Figure 12 shows the mean total PAH concentration at each of the POTWs, and the mean concentrations for all of the samples collected at the selected SWOs and CSOs. Mean total PAH concentrations ranged from 527 to 6,760 ng/L at



the POTWs. The mean total PAH concentrations were substantially higher at the CSOs (28,000 ng/L) and SWOs (54,600 ng/L). The calculation of the SWO mean total PAH concentration includes two samples with very high concentrations (Blanchard Street - 598,495 ng/L and Smith Marina - 103,328 ng/L); omitting these two samples lowers the SWO mean total PAH concentration to 15,200 ng/L. Likewise, the CSO mean total PAH calculation includes two samples with a very high concentrations (West Side Road - 138,054 ng/L and Rahway Outfall 003 - 79,121 ng/L); omitting these two samples lowers the CSO mean total PAH concentration to 14,500 ng/L. These "adjusted" CSO and SWO mean total PAH concentrations are very similar, and still higher than the POTW mean total PAH concentrations. Blank contamination by PAHs affected the POTW sample data to varying degrees, but the CSO and SWO PAH data were minimally impacted by the NJTRWP blank correction procedures.

Estimated total PAH loads from each of the POTWs are presented in Table 2. The largest load was discharged by PVSC. In addition, the PVSC total PAH load (1,619 kg/yr) was 70% of the combined load from all of the POTWs - this is elevated considering that the PVSC wastewater flow accounts for 46% of the total flow from all 12 of the NJ POTWs. Among all the POTWs, there was a strong correlation ($r = 0.89$) between the volume of wastewater discharged and the annual total PAH load. There was no correlation ($r = 0.16$) between the POTW annual total PAH loads and the POTW mean total PAH effluent concentrations.

Discussions and Conclusions

Contaminant concentrations in the CSO and SWO samples were typically substantially higher than those observed in the POTW effluent samples. This is not surprising, since the POTW effluent is the result of various wastewater treatment processes, while the CSO/SWO discharges have not been treated. Mean CSO and SWO concentrations exceeded various applicable New Jersey Saline WQC for total Hg, total Pb, total PCBs, total chlordane, dieldrin, and 4,4'-DDT/DDD/DDE, and individual PAHs. The mean effluent concentrations observed at all of the POTWs exceeded the applicable New Jersey Saline WQC for total PCBs, total chlordane, dieldrin, and 4,4'-DDE, while WQC exceedances were observed at some/most of the POTWs for total Hg, 4,4'-DDT, 4,4'-DDD, and individual PAHs.

The estimated annual loads of the contaminants from the POTWs were strongly correlated with the POTW wastewater flow - in general, the larger the POTW wastewater flow volume, the larger the load of contaminant discharged by that POTW. In contrast, except for total PCBs and Cd, there was no correlation between the mean contaminant concentration in the POTW effluents and the annual contaminant loads. This indicates that, in order to produce the largest reductions in overall POTW contaminant loads to NY-NJ Harbor, future contaminant source trackdown efforts should be focused in the service areas of those POTWs with

the largest wastewater flows – PVSC, MCUA, BCUA, and Joint Meeting Essex-Union Counties.

In addition, based on the data collected and analyses conducted to date, note the following conclusions and recommendations:

(1) PVSC accounts for about 46% of the total New Jersey POTW wastewater flow to NY-NJ Harbor. However, loads of total PCBs (including PCB11, 78%), total PAHs (70%), and total Hg (69%) from PVSC were about 25-30% higher than would otherwise be expected. Thus, future source trackdown efforts in the PVSC service area should focus on these contaminants.

(2) PCB 11 source trackdown activities have been implemented by PVSC, and should be continued to identify sources of this congener.

(3) BCUA accounts for about 11% of the total New Jersey POTW wastewater flow to NY-NJ Harbor. However, loads of PCDD/Fs (16.5%) and total pesticides (14%) were slightly higher than would be expected. Thus, future source trackdown efforts in the BCUA service area should include consideration of these contaminants.

Table 5: POTW, CSO, and SWO locations where elevated contaminant concentrations were observed in individual samples.

Contaminant	POTWs	CSOs	SWOs
total Cd	PVSC	West Side Road	Henley Road Smith Marina
total Hg	NB-Central West New York	West Side Road Court Street	Henley Road Smith Marina
total Pb	BCUA Rahway Valley	West Side Road Ivy Street	Smith Marina
total PCDD/F TEQ	Rahway Valley Joint Meeting	West Side Road	Henley Road
2,3,7,8-TCDD			Henley Road Blanchard Street
total PCBs	Linden-Roselle	Ivy Street Front & Bay Way Court Street	Henley Road Blanchard Street
PCB 11	PVSC		
total chlordanes	Linden-Roselle Rahway Valley	West Side Road Rahway Outfall 003	Henley Road
dieldrin	BCUA	Christie Street Rahway Outfall 003	Henley Road
total DDTs	Linden-Roselle Secaucus	West Side Road	
methoxychlor	MCUA		
gamma-BHC	Rahway Valley		
total PAHs	PVSC West New York	West Side Road Rahway Outfall 003	Blanchard Street Smith Marina

(4) Elevated contaminant concentrations (compared to those typically seen) were observed in individual POTW, CSO, and SWO samples (see Table 5). This is indicative of potentially large sources of these contaminants, and should be considered in future source trackdown efforts.

In addition, some POTWs, CSOs, and SWOs had samples with elevated concentrations for multiple contaminants: POTWs - Rahway Valley, Linden-Roselle; CSOs – West Side Road, Rahway Outfall 003; SWOs – Henley Road, Smith Marina, Blanchard Street. Future source trackdown activities should be further focused in the services areas of these facilities.

The Phase One NJTRWP data and analyses will be used, together with other data and information - including the New York State CARP data, the CARP modeling results, and other studies - to develop the NJTRWP Implementation Plan. This plan will integrate and evaluate the available information for each toxic contaminant and recommend a future course of action for source trackdown and reduction/elimination.

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RESEARCH PROJECT SUMMARY

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