70232

DATA REPORT

for

TASK II

of

STUDY OF PCB IN NEW YORK/NEW JERSEY POINT SOURCES

EPA Contract No. 68-C8-0105
Work Assignment 4-304

to

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Wetlands, Oceans, and Watersheds

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1.0 INTRODUCTION

The New York/New Jersey Harbor Estuary has among the highest polychlorinated biphenyl (PCB) concentrations in sediment and bivalve tissue along the coastal United States. Tributaries, combined sewer overflows (CSO), and effluent discharges from Publicly Owned Treatment Works (POTW) that discharge into the lower New York/New Jersey (NY/NJ) Harbor Estuary have recently been estimated to contribute approximately one-half of the total PCB loading to the estuary. This calculation is based on a limited set of historical data that was used in a mathematical model developed by The Hudson River Foundation. Proper evaluation and quantification of the present day PCB loadings to the entire NY/NJ Harbor Estuary requires highly sensitive and specific analytical methods. Such methods should allow for detection of PCBs at sub-nanograms per liter (parts-per-trillion) concentrations in samples from major point sources to the estuary.

Under this work assignment, Battelle verified analytical methods used to measure low-level PCB concentrations for the quantification of PCB loadings in point sources in NY/NJ Harbor Estuary (Task I — reported on September 30, 1992). Different sample processing approaches were evaluated in Task I and appropriate modifications were recommended, so as to optimize the analyses for the particular matrices and analytes of interest. In Task II of this Work Assignment, these matrix- and analyte-specific analytical procedures were applied to determine PCB concentrations in effluents from five POTWs whose discharge accounts for approximately 50% (by volume) of the total POTW discharge into the NY/NJ Harbor Estuary, in influents from the same POTWs, and in four major tributaries that flow into the NY/NJ Harbor Estuary. The POTW influents were collected during a high flow (POTW bypass) event and serve as an estimation of CSO discharges to the NY/NJ Harbor Estuary. The PCB data will subsequently be used in studies by other investigators to verify and/or revise previous estimates of PCB loadings from point sources in the lower NY/NJ Harbor Estuary derived from a mathematical model.

2.0 OBJECTIVES AND SCOPE OF WORK

This study consisted of two major tasks, the Scoping Task (Task I) and the Primary Task (Task II). The objectives and scope of these two tasks are summarized below.

- **Task I.** Evaluate and verify suitability of analytical procedures for low-level PCB analysis of river water, POTW influent, and POTW effluent. Recommend method modifications, if appropriate.

- **Task II.** Collect and analyze aqueous samples from rivers and POTWs discharging into the NY/NJ Harbor Estuary for low-level PCB concentrations.

In Task I, the suitability of existing Battelle procedures were evaluated and verified on a limited number of samples, and appropriate method modifications were identified and recommended (reported on September 30, 1992). This data report presents the Task II data.

In Task II, PCB concentrations were determined in influent samples (collected during storm events when CSOs were triggered, thus representing CSO discharge) from four maior POTWs, effluent samples from five major POTWs, and in water from four major tributaries that discharge into the NY/NJ Harbor Estuary. The POTWs that were sampled were Passaic Valley, Newtown Creek, North River, Wards Island, and Owls Head (effluent only). Influent sample was not collected from the Owls Head POTW because of field logistics problems during the limited number of storm events that resulted in bypass and triggered the CSOs. The rivers that were sampled were the Hudson, Passaic, Hackensack, and Raritan Rivers during normal flow conditions for November. A second, high flow, river sampling had originally been planned for this Work Assignment but was eliminated from the scope, per direction by the Work Assignment Manager, because of scheduling issues.

3.0 TECHNICAL APPROACH - Task II (Primary Task)

In this task analytical methods designed for low-level PCB congener determination were used to measure PCB concentrations in river water, POTW influent, and POTW effluent. The suitability of these analytical procedures for these matrices, including assessment of the low method detection limits (MDL) required for the program, had been evaluated in Task I, and appropriate method modifications/optimizations were made for the Task II work. The results of the Task II analyses are presented below.

3.1 SAMPLE COLLECTION

EPA Region II staff collected the river samples (from the Hudson, Passaic, Hackensack, and Raritan Rivers) and POTW staff collected the influent and effluent samples (from the Passaic Valley, Newtown Creek, North River, Wards Island and Owls Head POTWs), using sample bottles, coolers, and following instructions provided by Battelle. Samples were collected in pre-cleaned glass bottles (I-Chem, certified 200-series). Table 1 lists the sources and types of field samples collected, along with the collection date, sampling method, and approximate average flow (POTW only) at the source. POTW influent samples were collected and composited using either manual (North River POTW) or automatic (Passaic Valley, Newtown Creek, and Wards Island POTWs) sampling devices, with samples being collected during POTW bypass (CSO overflow) resulting from a storm event over a period of 100 to 225 minutes. No POTW influent was collected at the Owls head POTW because sampling could not be coordinated with a bypass event. POTW effluent samples were collected and composited using either manual (North River, Newtown Creek, Wards Island, and Owls Head POTWs) or automatic (Passaic Valley POTW) sampling devices, with samples being collected during "normal" flow (not a storm event) over a period of 24 hours. River samples were single grab samples, except for the Hudson River sample which was a composite of water collected at two depths at two locations across the river. Field blank samples were collected and processed at the Hudson River site, at two POTWs during influent collection (Passaic Valley and Wards Island POTWs), and at three POTWs during effluent sample collection (Passaic Valley, Wards Island, and North River POTWs) by pouring Milli-Q laboratory water provided by Battelle into the sample collection equipment and into a sample bottle and handling the sample like all field samples.

After sample collection, the sample bottles were packaged securely in coolers with ice-packs and packing material to ensure that they were kept cool and did not break while in transit. The samples were shipped to Battelle using Federal Express overnight service. Upon arrival at Battelle, the samples were logged in and stored at approximately 4 °C until processing began. Laboratory processing of the field samples began within approximately 1 week of sample receipt.

Table 1. Task II Sample Collection Information

Sample/Source	Collection Date	Other Information
Influent		
Passaic Valley	12/11/92	Automatic compositing over 225 min, no flow data provided[a]
Newtown Creek	12/11/92	Automatic compositing over 120 min, ~400 MGD average flow
North River	01/05/93	Manual compositing over 120 min, ~240 MGD average flow
Wards Island	12/02/92	Automatic compositing over 100 min, ~380 MGD average flow
Owls Head	Not sampled	
Effluent[b]		
Passaic Valley	11/16/92	Automatic compositing over 24 hrs, ~260 MGD flow[c]
Newtown Creek	11/17/92	Manual compositing over 24 hrs, ~130 MGD average flow
North River	11/19/92	Manual compositing over 24 hrs, ~320 MGD average flow
Wards Island	11/19/92	Manual compositing over 24 hrs, ~520 MGD average flow
Owls Head	11/18/92	Manual compositing over 24 hrs, ~120 MGD average flow
River		
Hudson River	11/18/92	Four grab samples composited[d]
Passaic River	11/19/92	Single grab sample, 1 mile south of A8
Hackensack River	11/19/92	Single grab sample
Raritan River	11/19/92	Single grab sample, west of Parkway bridge

[a] Passaic Valley flow data for the influent sample can probably be obtained from the POTW. Sample was collected from 7:30 AM to 11:15 AM on 12/11/92.

[b] Passaic Valley effluent was collected post-chlorination. All other were collected pre-chlorination.

[c] The Passaic Valley effluent sampler was set to collect flow proportionate. A 200 mL subsample was collected for every 8 MG of flow. A total of 33 subsamples were collected in 24 hrs, for a total flow of approximately 260 MGD.

[d] Hudson River sample: East side subsample: Lat: 40°54.84' Long: 73°55.10'. Sub-samples collected at 10 and 22 ft. depth. River depth was 44 ft. at this location.

West side subsample: Lat: 40°53.97' Long: 73°55.23'. Subsamples collected at 10 and 17 ft. depth. River depth was 34 ft. at this location.

Passaic River sample: Lat: 40°43.31' Long: 74°06.32'. Sample collected at ~3 ft. depth.

Hackensack River sample: Lat: 40°33.24' Long: 74°04.90'. Sample collected at ~3 ft. depth.

Raritan River sample: Lat: 40°30.52' Long: 74°18.35'. Sample collected at ~3 ft. depth.

3.2 LABORATORY SAMPLE ANALYSIS

The Task II samples were processed in the laboratory in three batches; a POTW influent, a POTW effluent, and a river water set of samples. This was done because of the difference in the matrices and because all samples did not arrive at Battelle at the same time. In fact, one influent sample (from the North River POTW) was processed by itself along with a laboratory procedural blank approximately three weeks after the other influent samples because of the timing of the sampling and subsequent arrival at the laboratory. A total of 35 samples were analyzed in the laboratory as part of Task II: four influent samples, five effluent samples, four river samples, three field sample duplicates (one of each sample type), six field blanks, six matrix spikes (two of each sample type), three blank spikes (one with each sample type/set), and four laboratory procedural blanks (one with each set of samples processed in the laboratory). Analysis of blank spike samples was beyond the original scope of this Work Assignment, but were efficiently processed at no additional cost, and included because of their recognized quality control value. The blank spike samples give a measure of the method accuracy and efficiency for each target analyte (by determining percent recoveries) independent of any matrix effects.

The original scope of work required individual PCB congener concentrations be determined and reported for a total of 25 PCB congeners, and, when possible, to identify the most abundant PCB Aroclor. In addition to these 25 congeners, we were able to efficiently determine 25 more major congeners with minimal additional effort and no added cost to the program. Concentrations of 50 PCB congeners are presented in this report. These 50 congeners include the 47 congeners that each constitute more than 2% of the PCB in any Aroclor formulation, and the coplanar PCB congeners Cl_4(77), Cl_5(126), and Cl_6(169). The sum of these 50 congeners constitutes approximately 75% to 95% of the total PCB in any Aroclor formulation.

Field samples were also processed and sent for dissolved and particulate organic carbon (DOC/PC) analysis. This analysis was performed by Chesapeake Biological Laboratory (CBL), Solomons, Maryland. CBL also provided out-of-scope particulate nitrogen (PN) analysis at no cost to the program.

3.2.1 Sample Preparation for PCB Analysis

Procedures derived from modifications of EPA methods 3510, 3640, and 8080, that have successfully been used by Battelle for low-level PCB determinations in complex environmental matrices were further modified for the matrices and analytes of interest in this work. Achieving low detection limits and reducing potential interferants from these complex samples was fundamental to this work, and the methods were contrived accordingly.

Approximately 2.5-L of sample (influent and effluent) was spiked with surrogate internal standards (SIS) and serially extracted three times with hexane in a 3-L separatory funnel. A total volume of approximately 5-L was used for the river water analyses (two aliquots of approximately 2.5-L were extracted and the extracts were combined). The use of hexane as the extraction solvent produces a "cleaner", more PCB-specific, sample extract than if a more polar solvent (e.g., dichloromethane) had been used, particularly for the POTW samples. The extract was concentrated using a Kuderna-Danish apparatus and nitrogen gas evaporation. The extract was purified using an automated high performance liquid chromatographic (HPLC) silica gel cleanup procedure and treated with activated copper for removal of residual sulfur. The silica column purification procedure employs a 100 mm × 25 mm μPorasil (125Å pore size, 10 μm particle size) semipreparative HPLC silica column (Waters Corp.), with a 25 mm × 25 mm μPorasil pre-column. The HPLC system was calibrated with Cl_1(1) and Cl_{10}(209), to cover the entire molecular weight and silica retentivity range of PCB congeners, prior to the fractionation of each set of samples. The sample was loaded onto the column, eluted with 100% hexane, the eluant monitored with a UV detector set at 254 nm, and the target analyte fraction collected using a fraction collector. The column was then backflushed with more polar solvents (methanol and dichloromethane) and regenerated with hexane for the next sample. The entire procedure is automated, and the accuracy and reproducibility of the cleanup process far exceeds what can be obtained with traditional, manually packed, gravity-fed liquid chromatography columns.

The volume of the purified sample was adjusted to approximately 150 μL using a gentle stream of nitrogen and spiked with the recovery internal standard (RIS) prior to submittal for instrumental analysis by gas chromatography/electron capture detection (GC/ECD).

3.2.2 Instrumental Analysis and PCB Quantification

Analysis for PCB was performed by high-performance capillary gas chromatography/electron capture detection (GC/ECD). Gas chromatographic separation and quantification was carried out on a 30-m, 0.25-mm inner diameter, 0.25-μm film thickness, DB-5 fused silica capillary column (J&W Scientific, Inc.). A 2 μL sample extract was injected onto the instrument and split between this primary analysis column, and a second column (a 30-m DB-1701) of different retention characteristics than the primary column. The purpose of the addition of the second column was to acquire chromatographic data that, if requested, could be used to confirm and complement the data from the primary analyses that are reported in this document.

The following gas chromatographic conditions were used for this work:

Initial temperature	60°C
Initial hold time	1 minute
Ramp 1	15°C/minute — to 140°C
Ramp 2	1°C/minute — to 210°C
Ramp 3	5°C/minute — to 290°C
Final temperature	290°C
Final hold time	15 minutes
Injection port temperature	280°C
Detector temperature	300°C
Carrier gas flow rate (Hydrogen)	~1.8 mL/minute
Makeup gas flow rate (Argon/Methane)	~50 mL/minute
Injection mode	Splitless

The instrumental analysis method used a 5-point calibration curve with analyte concentrations ranging from 0.005 to 0.1 ng/μL (the concentrations of some of the mono- and dichlorobiphenyls were slightly higher). The electronic analytical data were acquired from both columns/detectors, and the primary analysis data (DB-5 column) were subsequently reduced using a chromatography data system. Analytes were quantified by the method of internal standards using the SISs Cl_5(103) and Cl_5(112). The RIS Cl_6(166) was added to all samples prior to instrumental analysis to measure recovery of the surrogates. Figure 1 presents a GC/ECD chromatogram of a calibration standard containing the 20 PCB congeners targeted in the National Oceanic and Atmospheric Administration (NOAA) Mussel Watch Project, the surrogate and recovery internal standards, and the five low molecular weight congeners [(Cl_1(1), Cl_1(3), Cl_2(4), Cl_2(6), and Cl_2(15)] that were added to the original scope of this Work Assignment. Figure 2 presents a GC/ECD chromatogram of a calibration standard containing

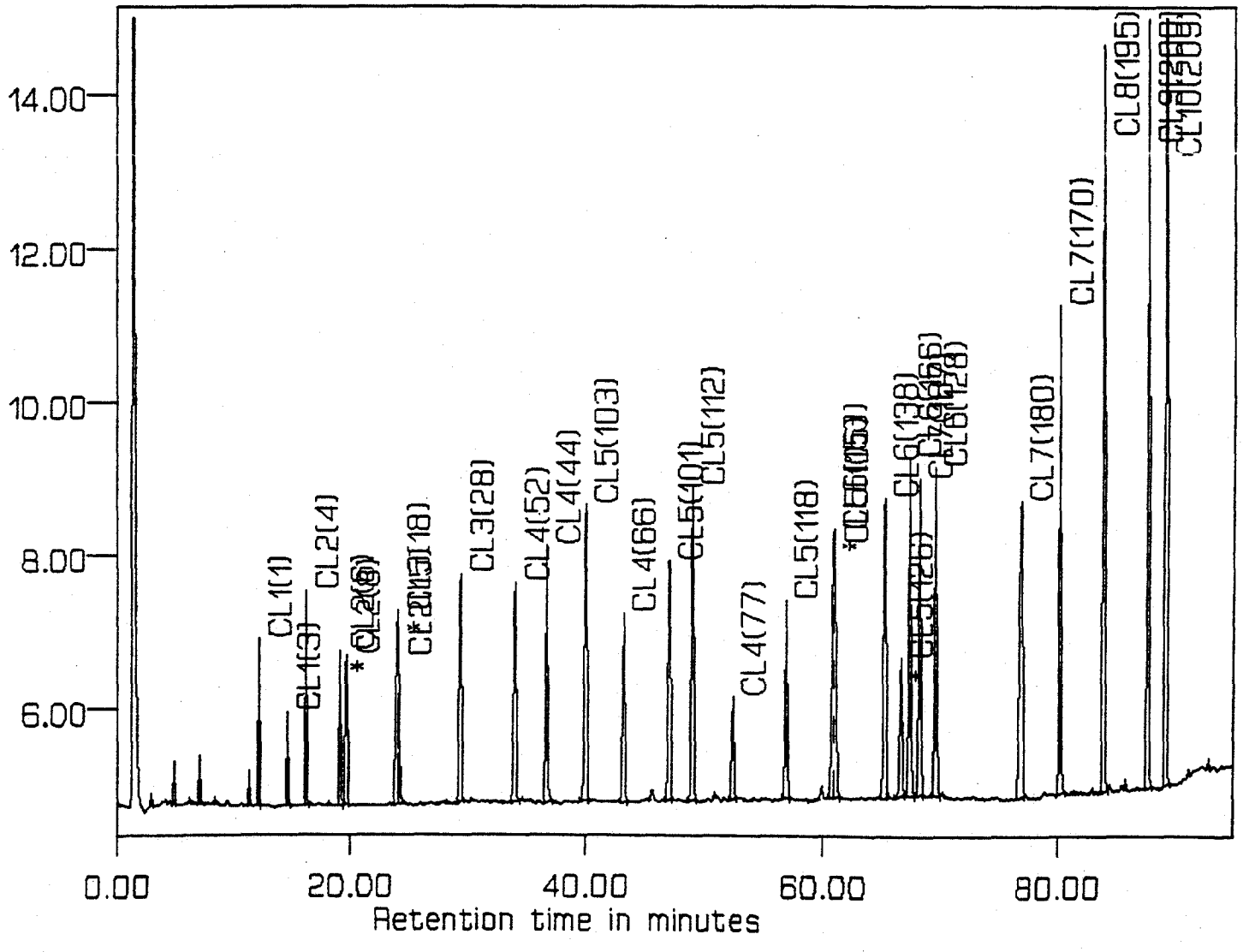

Figure 1. GC/ECD Chromatogram of Calibration Standard Containing the Mussel Watch PCB Congeners and 5 Low Molecular Weight Congeners

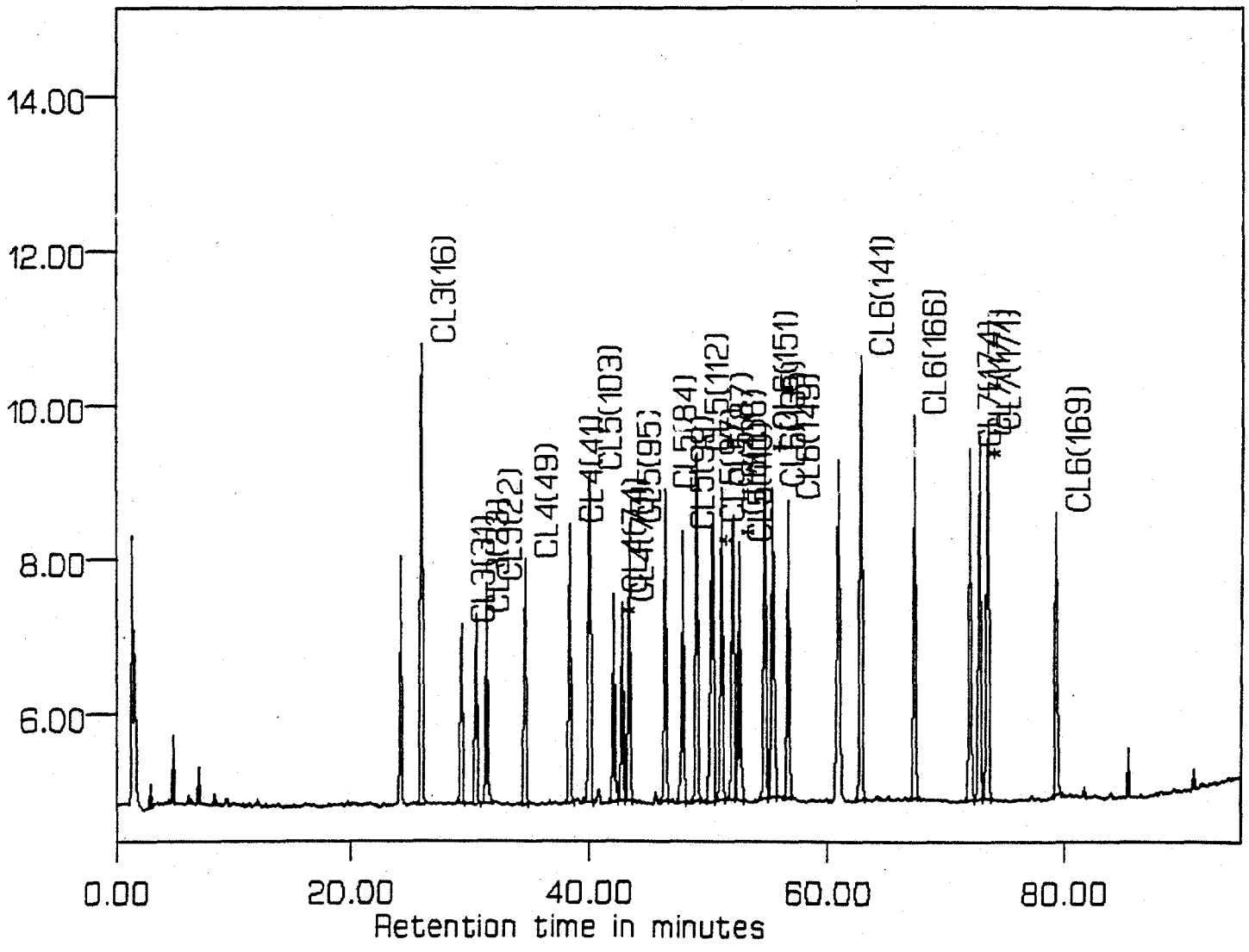

Figure 2. GC/ECD Chromatogram of Calibration Standard Containing the 25 PCB Congeners Added to the Target Analyte List

the additional 25 PCB congeners that were determined and reported outside the scope of this Work Assignment. All 50 target PCB congener analytes are listed in Table 2, along with the approximate detection limits. Actual detection limits vary from sample-to-sample (depending on sample-specific matrix components) and from analyte-to-analyte (depending on detector response) but these are good approximations of actual detection limits in the samples processed in Task II, and were verified to represent a signal-to-noise ratio of approximately 5:1 in the reported sample analyses.

Analytical standards of Aroclor formulations were analyzed in order to qualitatively determine which formulation the PCB in each sample most closely resembled. Total PCB concentrations were estimated by summing the concentrations of the individual PCB congeners and calculating the total PCB concentration based on the known approximate percentage the sum of these congeners constitute in the identified Aroclor.

4.0 RESULTS

4.1 FIELD SAMPLE RESULTS

4.1.1 PCB Analysis Results

The POTW influent, POTW effluent, and river water data are presented in Tables 3, 4, and 5, respectively. One sample was collected in duplicate for each of the three sample types, and the data for both replicates are presented in these tables. Typical chromatograms of influent, effluent, and river samples are presented in Figures 3, 4, and 5. Note that the peak identifications are not printed on the chromatograms because listing the identified PCB congener analytes on these charts would render them illegible. Please refer to Figures 1 and 2 for analyte indications, and the applicable tables for analyte identification. The target PCB congeners are listed in order of their gas chromatographic elution times in all data tables.

The influent samples had the highest PCB concentrations, followed by effluent, with the river water samples, on average, containing the lowest levels of PCB. It is important to remember that the

Table 2. PCB Analysis Parameters and Approximate Detection Limits.

Target Congener[a]	Potential Coeluter	Approximate Detection Limits (ng/L)[b] POTW Influent	POTW Effluent	River
Cl_1(1)		1	0.5	0.25
Cl_1(3)		2	1	0.5
Cl_2(4)	Cl_2(10)	1	0.5	0.25
Cl_2(6)		0.4	0.2	0.1
Cl_2(8)	Cl_2(5)	0.4	0.2	0.1
Cl_3(18)		0.2	0.1	0.05
Cl_2(15)/Cl_3(17)		1	0.5	0.25
Cl_3(16)	Cl_3(32)	0.2	0.1	0.05
Cl_3(31)		0.2	0.1	0.05
Cl_3(28)	Cl_3(20)	0.2	0.1	0.05
Cl_3(33)		0.2	0.1	0.05
Cl_3(22)		0.2	0.1	0.05
Cl_4(52)		0.2	0.1	0.05
Cl_4(49)		0.2	0.1	0.05
Cl_4(44)		0.2	0.1	0.05
Cl_4(41)	Cl_4(64)	0.2	0.1	0.05
Cl_4(74)		0.2	0.1	0.05
Cl_4(70)		0.2	0.1	0.05
Cl_4(66)		0.2	0.1	0.05
Cl_5(95)		0.2	0.1	0.05
Cl_5(84)		0.2	0.1	0.05
Cl_5(101)	Cl_5(90)	0.2	0.1	0.05
Cl_5(99)		0.2	0.1	0.05
Cl_5(97)		0.2	0.1	0.05
Cl_5(87)	Cl_5(115)	0.2	0.1	0.05
Cl_6(136)		0.2	0.1	0.05
Cl_4(77)	Cl_5(110)	0.2	0.1	0.05
Cl_5(110)		0.2	0.1	0.05
Cl_6(151)		0.2	0.1	0.05
Cl_6(135)		0.2	0.1	0.05
Cl_6(149)	Cl_5(123)	0.2	0.1	0.05
Cl_5(118)		0.2	0.1	0.05
Cl_6(153)/Cl_6(132)		0.2	0.1	0.05
Cl_5(105)		0.2	0.1	0.05
Cl_6(141)	Cl_7(179)	0.2	0.1	0.05

[a] The National Status and Trends Mussel Watch Project PCB congener analytes are bolded.
[b] Based on a signal-to-noise ratio of approximately 5:1.

Table 2 (continued). PCB Analysis Parameters and Approximate Detection Limits.

Target Congener[a]	Potential Coeluter	Approximate Detection Limits (ng/L)[b] POTW Influent	POTW Effluent	River
Cl_4(138)	Cl_6(160)	0.2	0.1	0.05
Cl_5(126)	Cl_6(129)	0.2	0.1	0.05
Cl_7(187)		0.2	0.1	0.05
Cl_6(128)		0.2	0.1	0.05
Cl_7(174)		0.2	0.1	0.05
Cl_7(177)	Cl_8(202)	0.2	0.1	0.05
Cl_7(171)		0.2	0.1	0.05
Cl_7(180)		0.2	0.1	0.05
Cl_6(169)		0.2	0.1	0.05
Cl_7(170)	Cl_7(190)	0.2	0.1	0.05
Cl_8(195)	Cl_9(208)	0.1	0.05	0.025
Cl_9(206)		0.1	0.05	0.025
Cl_{10}(209)		0.1	0.05	0.025
Total PCB (with Aroclor pattern)[c]		5-20	2-10	1-5
Aroclor 1016/1242				
Aroclor 1221				
Aroclor 1232				
Aroclor 1248				
Aroclor 1254				
Aroclor 1260				

[a] The National Status and Trends Mussel Watch Project PCB congener analytes are bolded.

[b] Based on a signal-to-noise ratio of approximately 5:1.

[c] Detection limit for total PCB determination, by Aroclor, and Aroclor pattern recognition depends on PCB congener molecular weight distribution (i.e., the specific Aroclor), the sample matrix, and the degree of Aroclor degradation/transformation. The detection limits are lower for an Aroclor with significant amount of Cl_4-, Cl_5-, and Cl_6-congeners (i.e., 1248, 1254, and 1260) than for a sample with primarily low molecular weight congeners (i.e., 1016/1242, 1221, and 1232). Additionally, the ability, and mimimum concentration needed, to recognize/identify an Aroclor depends to a significant degree on the transformation/degradation of the PCB that has occured, and the relative contribution of different Aroclor formulations that may be present in the same sample.

Table 3. POTW Influent Data — PCB Congener Concentrations in ng/L

	POTW INFLUENT SAMPLES				
POTW:	Passaic Valley	Passaic Valley	Newtown Creek	North River	Wards Island
Sample ID:	PV-IN-T2	PV-IN-T2-DUP	NC-IN-T2	NR-IN-T2	WI-IN-T2
Sample Volume (L):	2.40	2.40	2.21	2.35	2.10
Cl1(1)	ND	ND	ND	ND	ND
Cl1(3)	ND	ND	ND	ND	ND
Cl2(4)	8.90	9.45	ND	ND	ND
Cl2(6)	5.26	5.28	4.77	ND	ND
Cl2(8)	11.11	11.06	2.19	ND	ND
Cl3(18)	27.97	25.84	2.47	1.29	0.90
Cl2(15)/Cl3(17)	30.65	27.91	7.35	4.87	3.27
Cl3(16)	12.10	12.57	2.80	13.02	0.83
Cl3(31)	16.62	16.40	1.80	2.22	1.43
Cl3(28)	9.54	9.16	2.83	1.67	0.82
Cl3(33)	9.67	10.46	0.64	1.09	1.00
Cl3(22)	3.96	3.60	0.28	0.42	0.17
Cl4(52)	16.34	15.77	4.12	3.74	1.16
Cl4(49)	9.37	10.23	0.94	2.62	0.93
Cl4(44)	11.27	10.29	2.69	1.87	1.16
Cl4(41)	5.21	5.37	1.84	1.80	ND
Cl4(74)	7.27	7.35	0.84	0.87	0.57
Cl4(70)	18.62	18.01	2.36	2.93	1.46
Cl4(66)	14.12	14.46	1.70	1.73	0.84
Cl5(95)	6.86	6.84	5.74	7.63	2.96
Cl5(84)	3.69	3.43	1.55	1.59	0.77
Cl5(101)	13.00	15.34	9.76	7.48	2.65
Cl5(99)	5.73	5.58	2.64	2.85	1.09
Cl5(97)	4.36	4.16	1.79	1.90	0.43
Cl5(87)	6.14	5.90	4.12	3.86	1.23
Cl6(136)	ND	ND	ND	ND	ND
Cl4(77)	ND	ND	ND	ND	ND
Cl5(110)	16.74	17.19	11.69	9.89	3.28
Cl6(151)	3.41	3.25	1.52	1.74	0.48
Cl6(135)	2.73	2.54	1.24	1.11	0.51
Cl6(149)	13.23	12.72	6.52	5.44	2.42
Cl5(118)	9.03	9.02	8.12	6.03	2.23
Cl6(153)/Cl6(132)	18.91	19.21	12.38	10.09	3.34
Cl5(105)	3.01	2.86	3.37	2.27	0.64
Cl6(141)	3.76	3.48	1.66	1.50	1.14
Cl6(138)	12.79	15.09	12.58	12.29	3.72
Cl5(126)	ND	ND	ND	ND	ND
Cl7(187)	5.16	5.26	3.41	2.27	0.17
Cl6(128)	2.23	2.22	2.74	1.56	0.39
Cl7(174)	5.13	5.21	2.10	1.89	0.59
Cl7(177)	3.82	3.44	1.09	1.49	0.35
Cl7(171)	2.24	2.28	1.02	1.30	0.54
Cl7(180)	9.90	10.72	5.26	3.83	1.58
Cl6(169)	ND	ND	ND	ND	ND
Cl7(170)	6.77	8.29	9.91	6.95	3.36
Cl8(195)	1.13	1.31	1.54	2.37	0.16
Cl9(206)	2.58	2.31	2.48	5.69	0.28
Cl10(209)	1.51	1.68	1.75	1.76	0.42
Sum of PCB Congeners	381.8	382.2	155.6	144.9	49.2
Aroclor ID *	1232	1232	1254	1254	ND
Surrogate Recovery (%)					
Cl5(103)	89	103	111	101	90
Cl5(112)	86	96	108	100	89

* - The Aroclor which the PCB pattern most closely resembles. Other formulations may be contributing to a lesser degree.

Table 4. POTW Effluent Data — PCB Congener Concentrations in ng/L

	POTW EFFLUENT SAMPLES					
POTW:	Passaic Valley	Passaic Valley	Newtown Creek	North River	Wards Island	Owls Head
Sample ID:	PV-EFF-T2	PV-EFF-T2-DUP	NC-EFF-T2	NR-EFF-T2	WI-EFF-T2	OH-EFF-T2
Sample Volume (L):	2.49	2.48	2.24	2.39	2.38	2.36
Cl1(1)	ND	ND	ND	ND	ND	ND
Cl1(3)	ND	ND	ND	6.25	ND	3.31
Cl2(4)	10.57	11.48	ND	ND	ND	1.18
Cl2(6)	1.41	1.28	ND	ND	ND	ND
Cl2(8)	8.02	8.10	0.76	ND	ND	ND
Cl3(18)	8.00	7.15	0.24	0.26	0.17	0.24
Cl2(15)/Cl3(17)	21.94	24.03	2.45	0.00	0.62	1.09
Cl3(16)	6.39	5.87	0.82	0.98	0.31	1.82
Cl3(31)	5.25	6.42	0.53	0.41	0.38	ND
Cl3(28)	4.18	4.94	0.30	0.50	ND	ND
Cl3(33)	4.78	5.85	0.58	ND	ND	0.83
Cl3(22)	2.73	2.75	0.63	ND	ND	ND
Cl4(52)	2.91	3.14	1.29	0.69	1.39	0.85
Cl4(49)	1.36	1.52	0.43	0.28	0.24	0.57
Cl4(44)	2.11	2.31	0.96	0.26	0.25	0.42
Cl4(41)	1.44	1.42	ND	ND	ND	ND
Cl4(74)	1.07	1.01	0.24	ND	ND	0.13
Cl4(70)	2.51	2.54	0.96	1.02	0.39	0.72
Cl4(66)	1.53	1.48	0.37	0.19	0.16	0.26
Cl5(95)	0.63	0.47	1.48	0.45	0.36	0.46
Cl5(84)	0.17	0.18	0.26	0.06	ND	0.14
Cl5(101)	0.61	0.53	1.61	0.50	0.43	0.64
Cl5(99)	0.44	0.54	0.55	0.44	0.25	0.57
Cl5(97)	0.26	0.26	0.37	0.14	0.19	0.22
Cl5(87)	0.30	0.30	0.57	0.29	0.24	0.29
Cl6(136)	0.07	0.08	1.87	1.18	0.35	1.48
Cl4(77)	ND	ND	ND	ND	ND	ND
Cl5(110)	0.74	0.72	1.41	0.59	0.48	0.67
Cl6(151)	ND	ND	0.94	0.11	ND	0.05
Cl6(135)	ND	ND	0.73	ND	ND	ND
Cl6(149)	0.39	0.36	3.06	0.54	0.31	0.30
Cl5(118)	ND	ND	0.64	0.44	0.35	0.45
Cl6(153)/Cl6(132)	0.44	0.48	4.57	0.56	0.51	0.54
Cl5(105)	0.16	0.14	0.54	0.10	0.14	0.09
Cl6(141)	ND	ND	1.14	ND	ND	ND
Cl6(138)	0.21	0.28	2.81	0.56	0.34	0.38
Cl5(126)	ND	ND	ND	ND	ND	ND
Cl7(187)	ND	ND	1.38	0.19	0.07	0.08
Cl6(128)	ND	ND	0.26	ND	0.06	0.06
Cl7(174)	ND	ND	1.47	0.08	ND	ND
Cl7(177)	ND	ND	0.93	ND	ND	ND
Cl7(171)	ND	ND	0.54	ND	ND	ND
Cl7(180)	ND	ND	3.52	ND	ND	ND
Cl6(169)	ND	ND	ND	ND	ND	ND
Cl7(170)	0.07	0.08	1.40	0.08	0.05	0.03
Cl8(195)	ND	ND	0.23	ND	0.03	ND
Cl9(206)	0.03	0.03	0.13	0.21	0.15	ND
Cl10(209)	0.04	0.05	0.10	0.07	0.06	0.07
Sum of PCB Congeners	90.8	95.8	43.1	17.4	8.8	17.9
Aroclor ID *	1232	1232	1254	ND	ND	1232
Surrogate Recovery (%)						
Cl5(103)	64	59	60	37	53	56
Cl5(112)	69	69	70	40	61	67

* - The Aroclor which the PCB pattern most closely resembles. Other formulations may be contributing to a lesser degree.

Table 5. River Water Data — PCB Congener Concentrations in ng/L

	RIVER SAMPLES				
River:	Hudson	Passaic	Hackensack	Raritan	Raritan
Sample ID:	HUD-N-T2	PAS-N-T2	HAC-N-T2	RAR-N-T2	RAR-N-T2-DUP
Sample Volume (L):	5.00	5.00	4.98	4.97	4.93
Cl1(1)	ND	ND	ND	ND	ND
Cl1(3)	ND	ND	ND	ND	ND
Cl2(4)	1.15	0.79	1.16	0.69	0.78
Cl2(6)	0.09	ND	ND	ND	ND
Cl2(8)	0.17	ND	ND	ND	ND
Cl3(18)	0.84	0.73	0.70	0.45	0.40
Cl2(15)/Cl3(17)	4.95	2.67	3.02	1.63	1.69
Cl3(16)	0.70	0.58	0.75	0.46	0.45
Cl3(31)	0.81	0.89	0.99	0.78	0.64
Cl3(28)	1.14	0.97	0.99	0.66	0.67
Cl3(33)	0.21	0.18	0.16	0.26	0.27
Cl3(22)	0.20	0.26	0.27	0.23	0.23
Cl4(52)	1.35	1.98	1.60	0.79	0.80
Cl4(49)	1.37	0.90	0.95	0.47	0.47
Cl4(44)	0.83	0.87	0.87	0.43	0.39
Cl4(41)	0.46	0.61	0.60	0.30	0.31
Cl4(74)	0.28	0.54	0.45	0.24	0.24
Cl4(70)	0.59	0.99	0.87	0.41	0.46
Cl4(66)	0.53	0.63	0.65	0.20	0.20
Cl5(95)	0.77	0.76	0.67	0.29	0.35
Cl5(84)	0.28	0.25	0.23	0.10	0.12
Cl5(101)	0.71	0.86	0.80	0.38	0.42
Cl5(99)	0.41	0.40	0.45	0.18	0.23
Cl5(97)	0.31	0.28	0.34	0.16	0.15
Cl5(87)	0.27	0.32	0.35	0.21	0.21
Cl6(136)	0.39	0.92	0.92	0.47	0.52
Cl4(77)	ND	ND	ND	ND	ND
Cl5(110)	1.04	0.98	1.03	0.47	0.54
Cl6(151)	0.15	0.18	0.16	0.06	0.07
Cl6(135)	0.13	0.22	0.16	0.04	0.05
Cl6(149)	0.70	0.63	0.65	0.28	0.30
Cl5(118)	0.48	0.58	0.61	0.24	0.24
Cl6(153)/Cl6(132)	0.87	0.93	1.07	0.43	0.45
Cl5(105)	0.14	0.19	0.14	0.07	0.10
Cl6(141)	0.14	0.20	0.09	0.04	0.04
Cl6(138)	0.53	0.61	0.61	0.28	0.29
Cl5(126)	ND	ND	ND	ND	ND
Cl7(187)	0.19	0.23	0.23	0.08	0.08
Cl6(128)	0.15	0.09	0.09	0.03	0.03
Cl7(174)	0.14	0.20	0.18	0.06	0.05
Cl7(177)	0.09	0.10	0.11	ND	ND
Cl7(171)	0.54	0.08	0.07	ND	ND
Cl7(180)	ND	0.27	0.41	0.15	0.16
Cl6(169)	ND	ND	ND	ND	ND
Cl7(170)	0.10	0.15	0.15	0.05	0.04
Cl8(195)	0.06	0.06	0.06	0.05	0.04
Cl9(206)	0.11	0.08	0.08	0.41	0.07
Cl10(209)	0.34	0.06	0.09	0.03	0.03
Sum of PCB Congeners	24.7	23.2	23.8	12.6	12.6
Aroclor ID *	1248	1248	1248	1242/1016	1242/1016
Surrogate Recovery (%)					
Cl5(103)	63	73	70	65	65
Cl5(112)	67	75	72	71	71

* - The Aroclor which the PCB pattern most closely resembles. Other formulations may be contributing to a lesser degree.

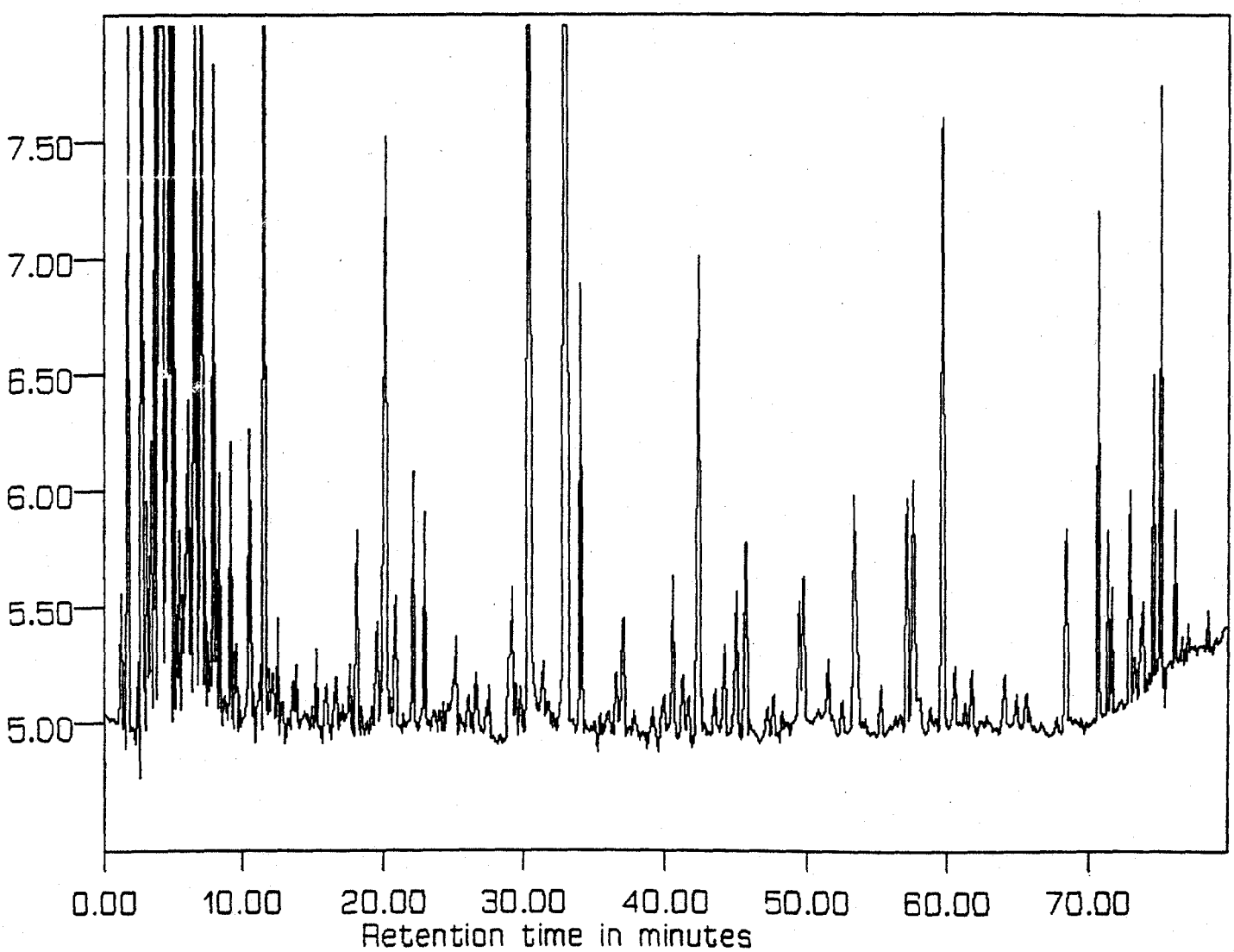

Figure 3. GC/ECD Chromatogram of a Typical Influent Sample - North River POTW

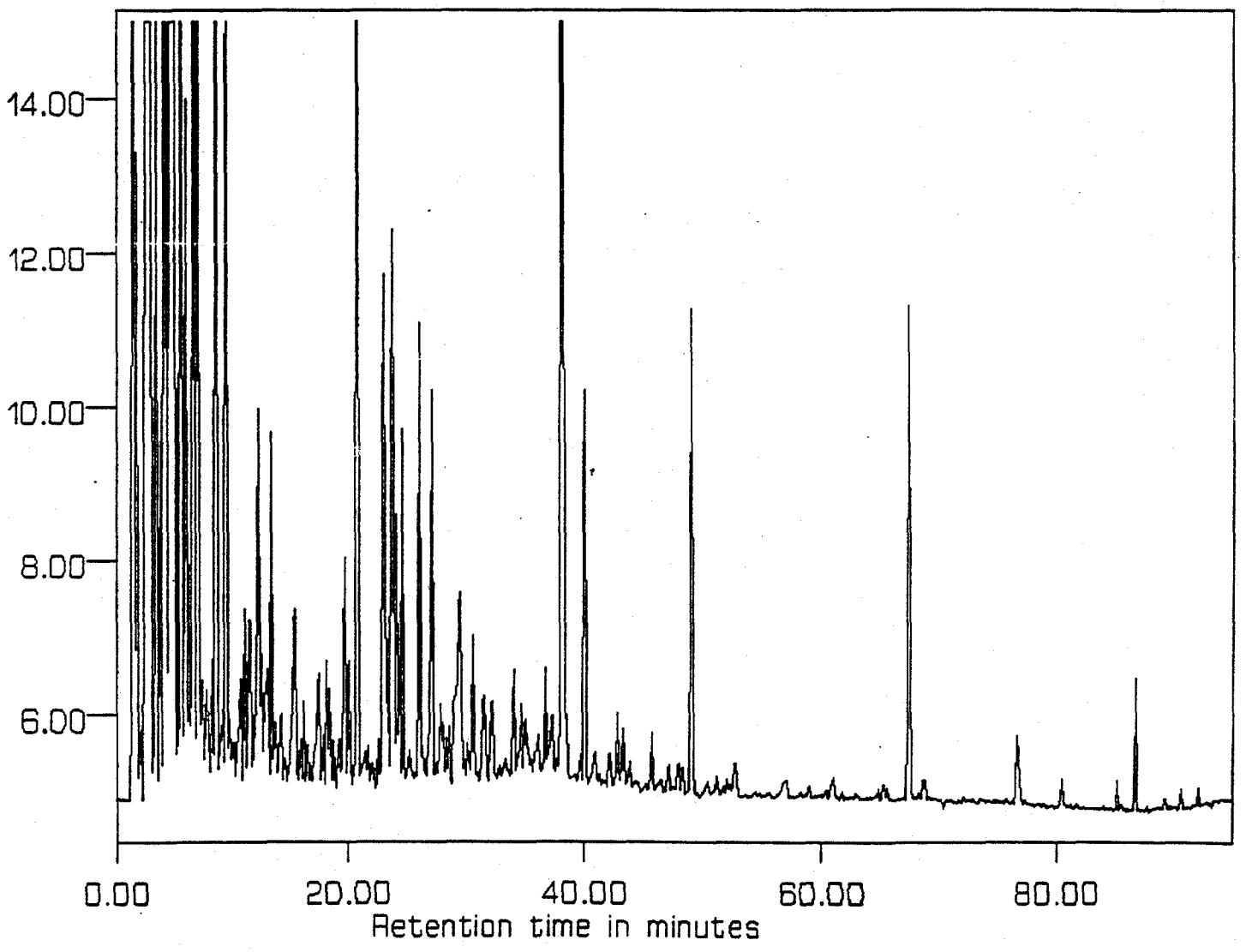

Figure 4. GC/ECD Chromatogram of Typical Effluent Sample - Passaic Valley POTW

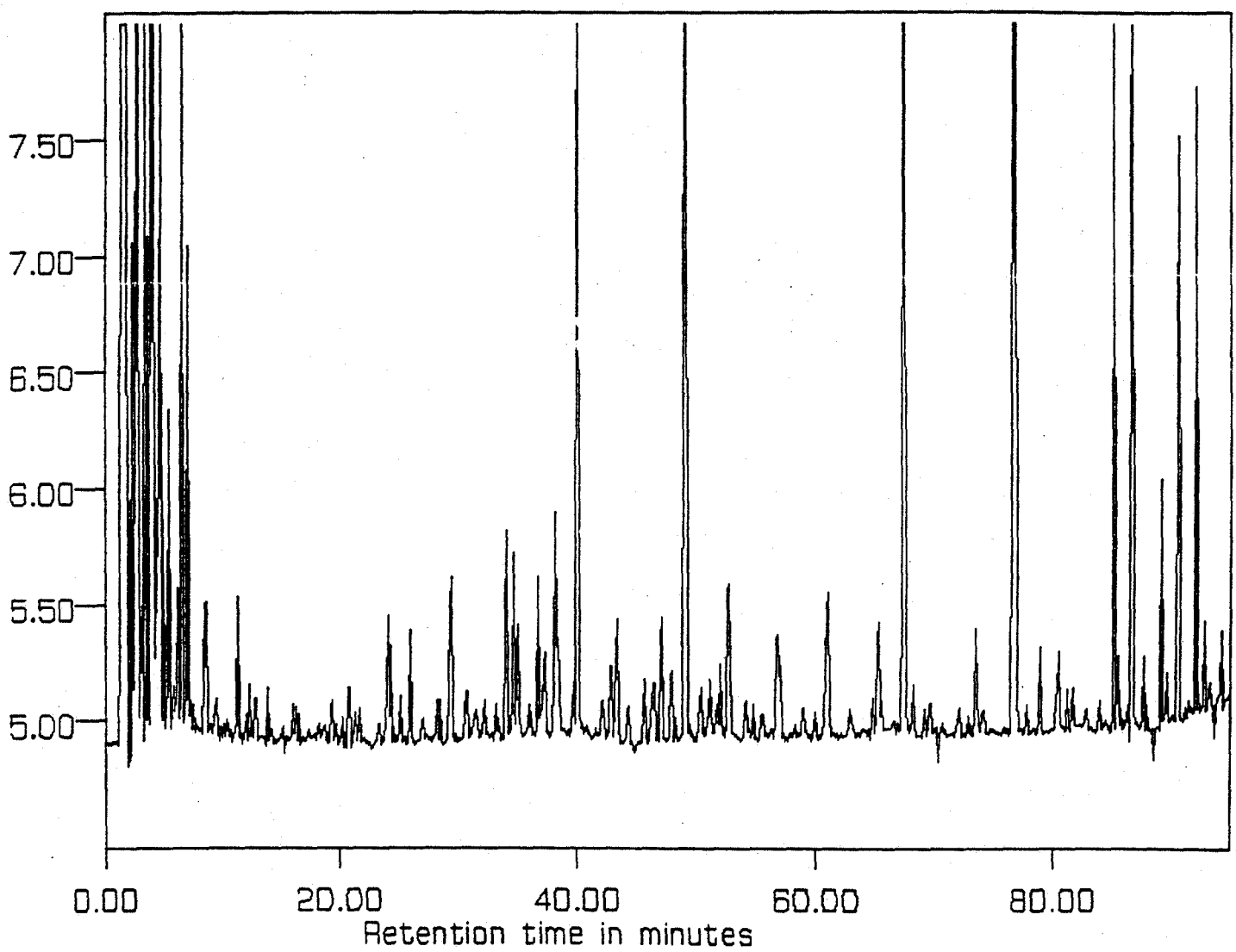

Figure 5. GC/ECD Chromatogram of Typical River Sample - Hudson River

influent samples were collected during storm events that triggered CSO discharges. These influent samples were collected as surrogates for CSO discharges, and their composition do not represent "normal" POTW influent.

The sum of the PCB congener concentrations was approximately 380, 150, 150, and 50 ng/L for Passaic Valley, Newtown Creek, North River, and Wards Island influent, respectively. This translates into total PCB concentration of *approximately* 400, 160, 160, and 55 ng/L for Passaic Valley, Newtown Creek, North River, and Wards Island influent, respectively, because the sum of the listed congeners constitute approximately 90-95% of the total PCB in the identified Aroclors. The Passaic Valley, Newtown Creek, and North River influent had identifiable PCB Aroclor patterns. However, because of the complex nature of these samples a significant amount of degradation/transformation has undoubtedly occurred in the PCB composition of these samples, and there are likely numerous sources of the PCB, so an exact Aroclor pattern match can not be expected. The PCB pattern for the Passaic Valley influent most closely resembled Aroclor 1232, although it also had PCB congener composition that was indicative of contributions from Aroclors 1242/1016, 1254, and/or 1260. The PCB pattern for the Newtown Creek and North River influent most closely resembled Aroclor 1254, although they also had PCB congener composition that were indicative of contributions from Aroclors 1242/1016 and 1260. No distinct Aroclor pattern could be identified in the Wards Island influent, although the large number of PCB congener identifications - mostly in the molecular weight range indicative of Aroclor 1254 - indicate that there was low-level PCB in this influent. The concentrations of the individual PCB congeners in the five POTW influent samples ranged from approximately 0.2 ng/L to approximately 30 ng/L. The reported concentration of $Cl_3(16)$ in the North River influent (13 ng/L) is uncharacteristically high, and may be an overestimate by approximately 10 ng/L due to an interfering matrix component. This overestimation also affects the reported sum of the PCB congener concentrations, and the estimated total PCB. Similarly, an ND (not detected) is reported for $Cl_4(41)$ for the Wards Island influent although it is most likely present, but a significant, and obvious, interferant eluted exactly at this point in the chromatogram, thus masking any $Cl_4(41)$ that may be present.

The sum of the PCB congener concentrations was approximately 90, 40, 18, 9, and 18 ng/L for Passaic Valley, Newtown Creek, North River, Wards Island, and Owls Head effluent, respectively. This translates into total PCB concentration of *approximately* 100, 45, 20, 10, and 20 ng/L for

Passaic Valley, Newtown Creek, North River, Wards Island, and Ow's Head effluent, respectively. The Passaic Valley, Newtown Creek, and Owls Head effluent had identifiable PCB Aroclor patterns. However, because of the complex nature of these samples an exact Aroclor pattern match can not be expected. The PCB pattern for the Passaic Valley and Owls Head effluent most closely resembled Aroclor 1232, although they had PCB congener composition that were indicative of contribution of Aroclors 1242/1016, 1248, and/or 1260. The PCB pattern for the Newtown Creek effluent most closely resembled Aroclor 1254, although it also had PCB congener composition that was indicative of contributions from Aroclors 1242/1016 and 1260. No distinct Aroclor pattern could be identified in the North River or Wards Island effluent, although the PCB congener identifications - mostly in the molecular weight range indicative of Aroclor 1254 - indicate that there were low-level PCB in these effluents. The concentrations of the individual PCB congeners in the six POTW effluent samples ranged from less than 0.1 ng/L to approximately 20 ng/L. Some of the reported PCB congener concentrations (e.g., $Cl_2(4)$ in the Passaic Valley samples and $Cl_1(3)$ in the North River and Owls Head samples) are uncharacteristically high (compared with any Aroclor formulation), and may be due to coeluting interferants that result in overestimations of these congener and the total PCB concentrations (on the other hand, this may be the result of PCB degradation/transformation).

An interesting observation is that, within a factor of approximately two, the reduction in PCB from influent to effluent was fairly consistent from treatment plant to treatment plant. The total PCB concentration in the influent samples was approximately 4, 3.5, 8, and 5.5 times higher than in the effluent for Passaic Valley, Newtown Creek, North River, and Wards Island, respectively. With a PCB reduction in this range for the Owls Head treatment plant, the influent sample from this plant (which was not collected and analyzed) could be expected to have a total PCB concentration between 70 and 160 ng/L.

All four rivers had identifiable PCB Aroclor patterns, but an exact Aroclor pattern match can not be expected for such complex samples. The PCB pattern for the Hudson, Passaic, and Hackensack Rivers most closely resembled Aroclor 1248, although they also had PCB congener composition that were indicative of contributions from Aroclors 1242/1016, 1254, and/or 1260. The PCB pattern for the Raritan River most closely resembled Aroclor 1242/1016, although it also had PCB congener composition that was indicative of contributions from Aroclors 1248, 1254, and/or 1260. The sum of the PCB congener concentrations was approximately 24, 24, 24, and 12 ng/L for the Hudson,

Passaic, Hackensack, and Raritan Rivers, respectively. This translates into total PCB concentration of *approximately* 26, 26, 26, and 13 ng/L for the Hudson, Passaic, Hackensack, and Raritan Rivers, respectively. The concentrations of the individual PCB congeners in the five river water samples ranged from less than 0.1 ng/L to approximately 5 ng/L. The reported concentration of Cl_9(206) in the Raritan River sample (0.4 ng/L) is uncharacteristically high, and may be an overestimate of approximately 0.3 ng/L due to an interfering matrix component. This overestimation also slightly affects the reported sum of the PCB congener concentrations, and the estimated total PCB. Similarly, an ND is reported for Cl_7(180) in the Hudson River sample although it is most likely present, but a significant, and obvious, interferant eluted exactly at this point in the chromatogram, thus masking any Cl_7(180) that may be present.

4.1.2 DOC/PC/PN Analysis Results

The results of the DOC, PC, and PN analyses are reported in Table 6. This table includes the results of the analyses of both the Task I and Task II samples, because the Task I data were not available for the Task I report (September 30, 1992). The DOC/PC data may be useful to indirectly infer the relative distribution of particulate and non-particulate bound PCB in these samples, because PCB tends to be associated with the organic matter. For the Task II influent samples the PC concentrations are somewhat higher than the DOC concentrations, while for the effluent and river samples the relationship is reversed.

4.2 QUALITY CONTROL SAMPLE RESULTS

Table 7 presents the data quality objectives for this work. The quality control data for this study were consistently acceptable for the PCB analyses performed, and compared very favorably to the criteria listed in Table 7, which confirms the quality and applicability of the procedures employed.

Surrogate compound [Cl_5(103) and Cl_5(112)] recoveries (indicated for each field and quality control sample at the bottom of the datatables) ranged from 37 to 118%, with most of the surrogate recoveries falling in the 60 to 90% range. The Cl_5(103) recovery in the North River effluent sample (37%) was the only one of the 70 separate surrogate recovery datapoints that fell outside the data quality objective range (40 to 120%).

Table 6. DOC, PC, and PN Data for Field Samples — Concentrations Reported in mg/L.

Sample/Source	DOC (mg/L)	PC (mg/L)	PN (mg/L)
Task 1 Samples			
Influent			
Passaic Valley	85.8	89.4	3.46
Wards Island	21.5[a]	23.4[a]	2.25[a]
Effluent			
Passaic Valley	19.2	5.42	0.86
Wards Island	6.92	1.17	0.123
River			
Hudson River	2.76	0.41[a]	0.071[a]
Passaic River	3.77	0.48	0.082
Task 2 Samples			
Influent			
Passaic Valley	36.5	42.4	3.55
Passaic Valley - DUP[b]	33.8[a]	38.5[a]	3.26[a]
Newtown Creek	6.00	21.8	2.55
North River	6.77	23.1	2.71
Wards Island	16.4	31.2	3.34
Effluent			
Passaic Valley	22.0	6.27	0.894
Passaic Valley - DUP	23.0[a]	5.29	0.788
Newtown Creek	10.4	4.49[a]	0.600[a]
North River	8.35	2.65[a]	0.257[a]
Wards Island	NA[c]	NA	NA
Owls Head	7.87	6.93	1.05
River			
Hudson River	3.31	1.08[a]	0.100[a]
Passaic River	3.35	1.25	0.107
Hackensack River	3.87	1.25	0.111
Raritan River	3.70	0.81[a]	0.095[a]
Raritan River - DUP	2.46[a]	0.99	0.088

[a] The average value of two laboratory replicate analyses. Data for each replicate analysis are reported in Table 14.

[b] DUP: field duplicate.

[c] Task II sample bottle broke in transit and the remaining sample was used for PCB determination. Task I Wards Island effluent sample was analyzed, but may not be representative of the Task II sample.

Table 7. Data Quality Objectives.

QC Sample Analysis	Criteria Goal
Surrogate recovery	40%-120%
Blank Spike and Matrix Spike analyte *absolute* recovery	40%-120%
Blank Spike and Matrix Spike analyte *relative* recovery	70%-130%[a]
Matrix Spike/Matrix Spike Duplicate precision	≤30% RPD[b]
Field duplicate precision	≤30% RPD
Field blank	<5× detection limit
Procedural blank	<5× detection limit

[a] Data quality objective added after Work Plan preparation.
[b] RPD: relative percent difference.

Tables 8 and 9 present the laboratory procedural blank and field blank data, respectively. Figures 6 and 7 present typical procedural blank and field blank sample chromatograms. The sample types/sets with which the procedural blanks were processed and the POTW and river sampling locations associated with the field blank samples are indicated on these tables. No PCB congeners were detected in any of the laboratory procedural blanks or field blank samples, indicating that the laboratory sample processing and the field sample collection and handling procedures did not introduce detectable amounts of PCB.

Table 10 presents the results of the field duplicate sample analyses, the average concentrations, and the relative percent difference (%RPD) as a measure of precision in the replicate analyses. The precision in the duplicate analyses was consistently excellent, with %RPD datapoints falling within the data quality objective of less than 30% for all except one pair. The few %RPD datapoints that were over 20% were for analytes with measured concentrations below 1 ng/L and near the detection limit. The slightly elevated concentration of $Cl_9(206)$ in one of the Raritan River samples is probably due to an isolated low-level matrix interference, and resulted in the only data quality objective exceedance. The precision in the total PCB concentration (represented by the sum of the PCB congener concentrations) was equally good, with %RPD values of 0, 5, and 0% for the Passaic Valley influent, Passaic Valley effluent, and Raritan River field duplicate analyses. These field replicate data suggest that the field sample data are highly representative of the source at the time of sample collection.

Table 11 presents the relative and absolute recovery data for the three blank spike (BS) samples processed with the influent, effluent, and river water samples. Tables 12 and 13 present the matrix spike (MS) and matrix spike duplicate (MSD) relative and absolute recovery data, respectively, for the three sets (six samples) of MS/MSD samples processed with the influent, effluent, and river samples. Figures 8, 9, 10, and 11 present typical BS, influent MS, effluent MS, and river MS sample chromatograms. The BS and MS/MSD data are reported as relative recoveries (determined relative to the surrogate compounds used for analyte quantification) and absolute recoveries (determined relative to the recovery internal standard). The absolute recoveries show the overall efficiency of the sample preparation (similarly to the surrogate recovery data) with respect to all target

Table 8. Laboratory Procedural Blank QC Data — PCB Congener Concentrations in ng/L

	Laboratory Procedural Blank			
Sample ID:	MA17PB	MB88PB	LP44PB	LP48PB
Batch:	Influent-1	Influent-2	Effluent	River Water
Sample Volume (L):	2.50	2.50	2.50	2.50
Cl1(1)	ND	ND	ND	ND
Cl1(3)	ND	ND	ND	ND
Cl2(4)	ND	ND	ND	ND
Cl2(6)	ND	ND	ND	ND
Cl2(8)	ND	ND	ND	ND
Cl3(18)	ND	ND	ND	ND
Cl2(15)/Cl3(17)	ND	ND	ND	ND
Cl3(16)	ND	ND	ND	ND
Cl3(31)	ND	ND	ND	ND
Cl3(28)	ND	ND	ND	ND
Cl3(33)	ND	ND	ND	ND
Cl3(22)	ND	ND	ND	ND
Cl4(52)	ND	ND	ND	ND
Cl4(49)	ND	ND	ND	ND
Cl4(44)	ND	ND	ND	ND
Cl4(41)	ND	ND	ND	ND
Cl4(74)	ND	ND	ND	ND
Cl4(70)	ND	ND	ND	ND
Cl4(66)	ND	ND	ND	ND
Cl5(95)	ND	ND	ND	ND
Cl5(84)	ND	ND	ND	ND
Cl5(101)	ND	ND	ND	ND
Cl5(99)	ND	ND	ND	ND
Cl5(97)	ND	ND	ND	ND
Cl5(87)	ND	ND	ND	ND
Cl6(136)	ND	ND	ND	ND
Cl4(77)	ND	ND	ND	ND
Cl5(110)	ND	ND	ND	ND
Cl6(151)	ND	ND	ND	ND
Cl6(135)	ND	ND	ND	ND
Cl6(149)	ND	ND	ND	ND
Cl5(118)	ND	ND	ND	ND
Cl6(153)/Cl6(132)	ND	ND	ND	ND
Cl5(105)	ND	ND	ND	ND
Cl6(141)	ND	ND	ND	ND
Cl6(138)	ND	ND	ND	ND
Cl5(126)	ND	ND	ND	ND
Cl7(187)	ND	ND	ND	ND
Cl6(128)	ND	ND	ND	ND
Cl7(174)	ND	ND	ND	ND
Cl7(177)	ND	ND	ND	ND
Cl7(171)	ND	ND	ND	ND
Cl7(180)	ND	ND	ND	ND
Cl6(169)	ND	ND	ND	ND
Cl7(170)	ND	ND	ND	ND
Cl8(195)	ND	ND	ND	ND
Cl9(206)	ND	ND	ND	ND
Cl10(209)	ND	ND	ND	ND
Surrogate Recovery (%)				
Cl5(103)	118	91	63	76
Cl5(112)	76	90	69	78

Table 9. Field Blank QC Data — PCB Congener Concentrations in ng/L

Sample Source:	POTW Influent Field Blank		POTW Effluent Field Blank			River Field Blank
	Passaic Valley	Wards Island	Passaic Valley	Wards Island	North River	Hudson River
Sample ID:	PV-FBIN-T2	WI-FBIN-T2	PV-FBEFF-T2	WI-FBEFF-T2	NR-FBEFF-T2	HUD-FBN-T2
Sample Volume (L):	2.32	2.38	2.48	2.36	2.49	2.46
Cl1(1)	ND	ND	ND	ND	ND	ND
Cl1(3)	ND	ND	ND	ND	ND	ND
Cl2(4)	ND	ND	ND	ND	ND	ND
Cl2(6)	ND	ND	ND	ND	ND	ND
Cl2(8)	ND	ND	ND	ND	ND	ND
Cl3(18)	ND	ND	ND	ND	ND	ND
Cl2(15)/Cl3(17)	ND	ND	ND	ND	ND	ND
Cl3(16)	ND	ND	ND	ND	ND	ND
Cl3(31)	ND	ND	ND	ND	ND	ND
Cl3(28)	ND	ND	ND	ND	ND	ND
Cl3(33)	ND	ND	ND	ND	ND	ND
Cl3(22)	ND	ND	ND	ND	ND	ND
Cl4(52)	ND	ND	ND	ND	ND	ND
Cl4(49)	ND	ND	ND	ND	ND	ND
Cl4(44)	ND	ND	ND	ND	ND	ND
Cl4(41)	ND	ND	ND	ND	ND	ND
Cl4(74)	ND	ND	ND	ND	ND	ND
Cl4(70)	ND	ND	ND	ND	ND	ND
Cl4(66)	ND	ND	ND	ND	ND	ND
Cl5(95)	ND	ND	ND	ND	ND	ND
Cl5(8[illegible])	ND	ND	ND	ND	ND	ND
Cl5(101)	ND	ND	ND	ND	ND	ND
Cl5(99)	ND	ND	ND	ND	ND	ND
Cl5(97)	ND	ND	ND	ND	ND	ND
Cl5(87)	ND	ND	ND	ND	ND	ND
Cl6(136)	ND	ND	ND	ND	ND	ND
Cl4(77)	ND	ND	ND	ND	ND	ND
Cl5(110)	ND	ND	ND	ND	ND	ND
Cl6(151)	ND	ND	ND	ND	ND	ND
Cl6(135)	ND	ND	ND	ND	ND	ND
Cl6(149)	ND	ND	ND	ND	ND	ND
Cl5(118)	ND	ND	ND	ND	ND	ND
Cl6(153)/Cl6(132)	ND	ND	ND	ND	ND	ND
Cl5(105)	ND	ND	ND	ND	ND	ND
Cl6(141)	ND	ND	ND	ND	ND	ND
Cl6(138)	ND	ND	ND	ND	ND	ND
Cl5(126)	ND	ND	ND	ND	ND	ND
Cl7(187)	ND	ND	ND	ND	ND	ND
Cl6(128)	ND	ND	ND	ND	ND	ND
Cl7(174)	ND	ND	ND	ND	ND	ND
Cl7(177)	ND	ND	ND	ND	ND	ND
Cl7(171)	ND	ND	ND	ND	ND	ND
Cl7(180)	ND	ND	ND	ND	ND	ND
Cl6(169)	ND	ND	ND	ND	ND	ND
Cl7(170)	ND	ND	ND	ND	ND	ND
Cl8(195)	ND	ND	ND	ND	ND	ND
Cl9(206)	ND	ND	ND	ND	ND	ND
Cl10(209)	ND	ND	ND	ND	ND	ND
Surrogate Recovery (%)						
Cl5(103)	89	96	67	67	67	63
Cl5(112)	96	80	74	72	76	68

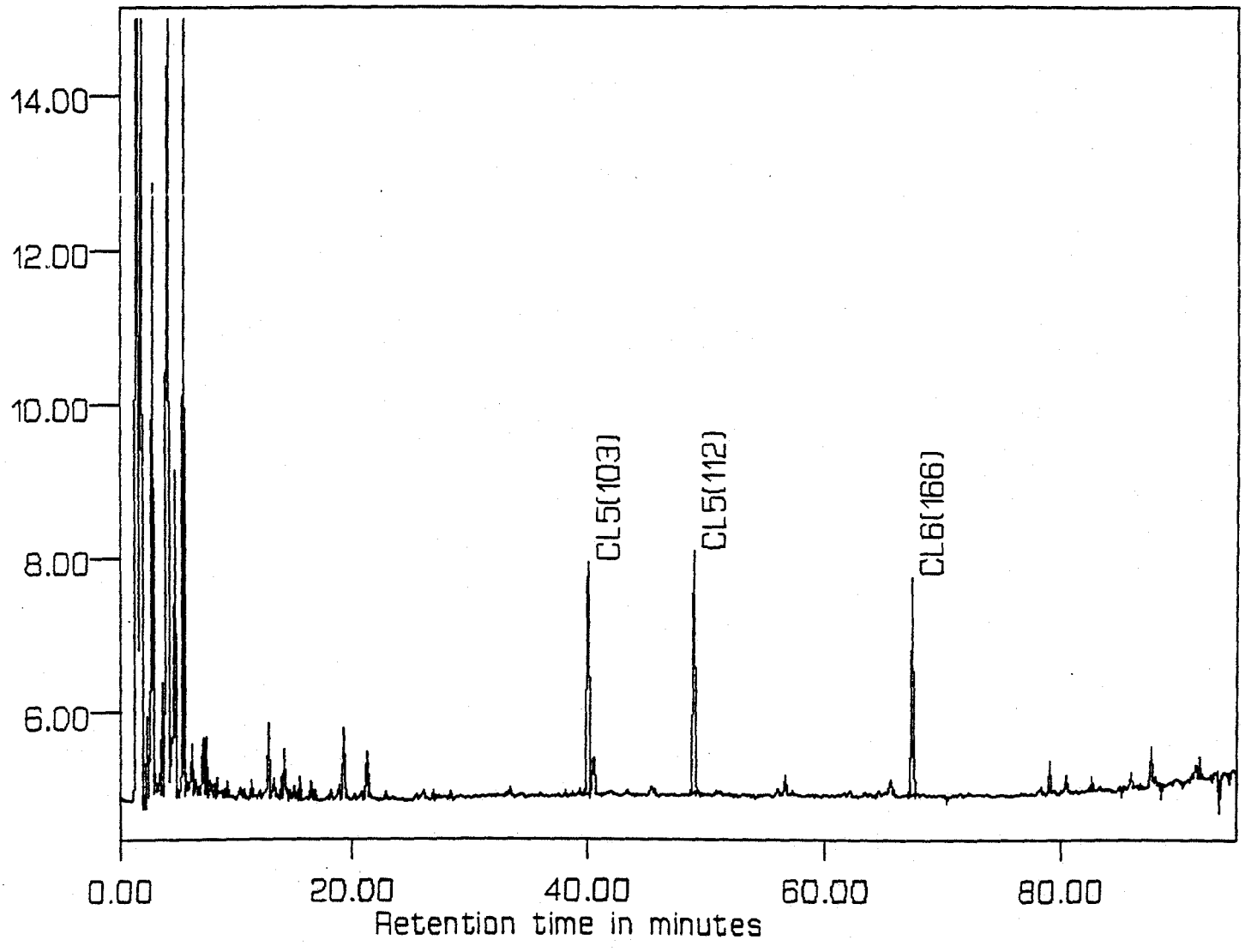

Figure 6. GC/ECD Chromatogram of a Typical Laboratory Procedural Blank Sample

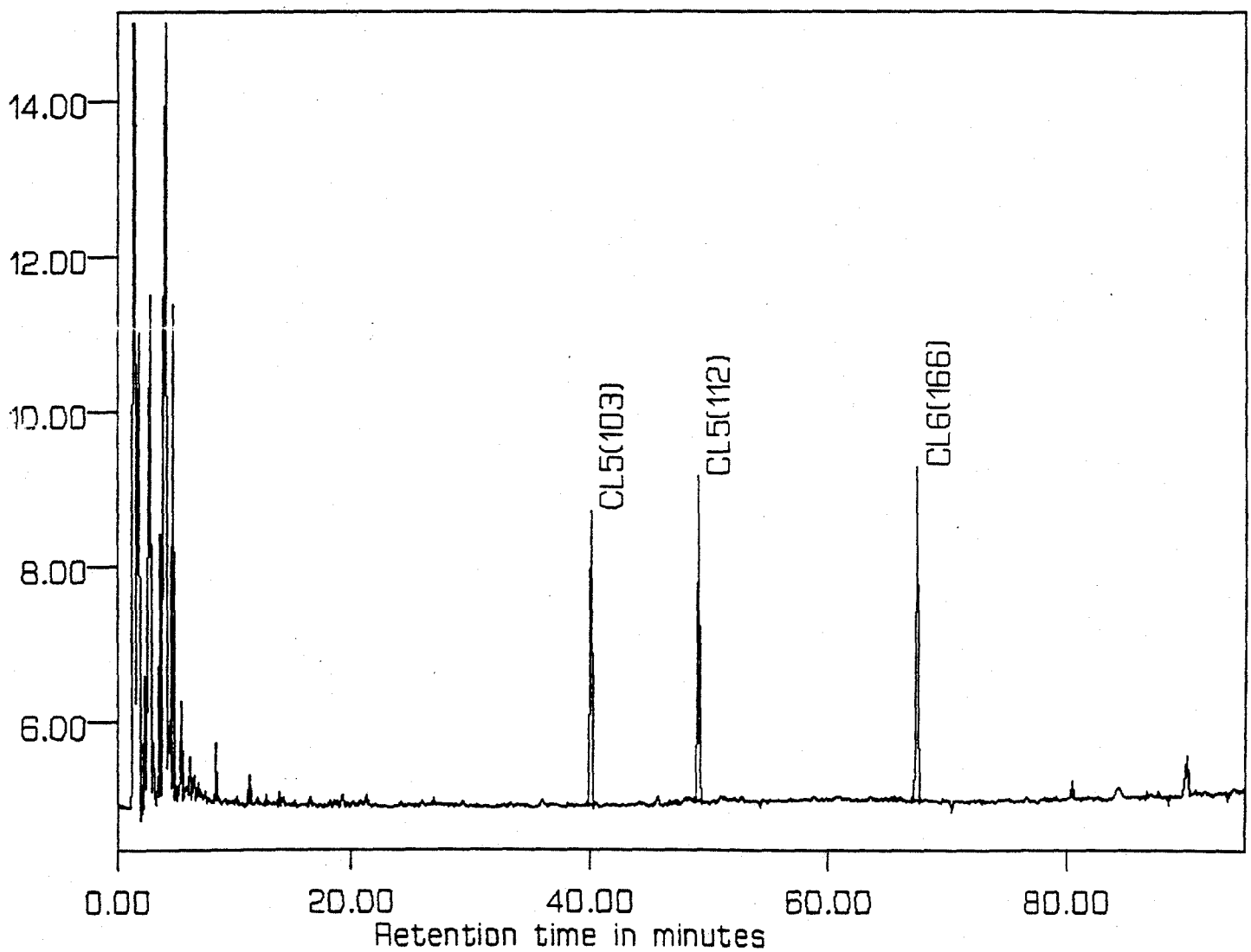

Figure 7. GC/ECD Chromatogram of a Typical Field Blank Sample — Hudson River

Table 10. Field Sample Duplicate QC Data — PCB Congener Concentrations in ng/L

Source:	POTW Influent Field Duplicate Passaic Valley POTW				POTW Effluent Field Duplicate Passaic Valley POTW				River Water Field Duplicate Raritan River			
Field Replicate:	REP-1	REP-2			REP-1	REP-2			REP-1	REP-2		
Sample Volume (L):	2.40	2.40	AVG	%RPD	2.49	2.48	AVG	%RPD	4.97	4.93	AVG	%RPD
Cl1(1)	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA
Cl1(3)	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA
Cl2(4)	8.90	9.45	9.18	6	10.57	11.48	11.02	8	0.69	0.78	0.73	13
Cl2(6)	5.26	5.28	5.27	0	1.41	1.28	1.35	9	ND	ND	ND	NA
Cl2(8)	11.11	11.06	11.09	0	8.02	8.10	8.06	1	ND	ND	ND	NA
Cl3(18)	27.97	25.84	26.91	8	8.00	7.15	7.58	11	0.45	0.40	0.42	12
Cl2(15)/Cl3(17)	30.65	27.91	29.28	9	21.94	24.03	22.98	9	1.63	1.69	1.66	4
Cl3(16)	12.10	12.57	12.34	4	6.39	5.87	6.13	8	0.46	0.45	0.45	3
Cl3(31)	16.62	16.40	16.51	1	5.25	6.42	5.83	20	0.78	0.64	0.71	20
Cl3(28)	9.54	9.16	9.35	4	4.18	4.94	4.56	17	0.66	0.67	0.67	2
Cl3(33)	9.67	10.46	10.06	8	4.78	5.85	5.32	20	0.26	0.27	0.27	3
Cl3(22)	3.96	3.60	3.78	9	2.73	2.75	2.74	1	0.23	0.23	0.23	1
Cl4(52)	16.34	15.77	16.05	4	2.91	3.14	3.02	8	0.79	0.80	0.80	1
Cl4(49)	9.37	10.23	9.80	9	1.36	1.52	1.44	11	0.47	0.47	0.47	0
Cl4(44)	11.27	10.29	10.78	9	2.11	2.31	2.21	9	0.43	0.39	0.41	9
Cl4(41)	5.21	5.37	5.29	3	1.44	1.42	1.43	2	0.30	0.31	0.30	3
Cl4(74)	7.27	7.05	7.16	3	1.07	1.01	1.04	6	0.24	0.24	0.24	0
Cl4(70)	18.62	18.01	18.32	3	2.51	2.54	2.53	1	0.41	0.46	0.43	11
Cl4(66)	14.12	14.46	14.29	2	1.53	1.48	1.51	3	0.20	0.20	0.20	2
Cl5(95)	6.86	6.84	6.85	0	0.63	0.47	0.55	29	0.29	0.35	0.32	18
Cl5(84)	3.69	3.43	3.56	7	0.17	0.18	0.18	6	0.10	0.12	0.11	16
Cl5(101)	13.00	15.34	14.17	17	0.61	0.53	0.57	14	0.38	0.42	0.40	12
Cl5(99)	5.73	5.58	5.66	3	0.44	0.54	0.49	20	0.18	0.23	0.21	21
Cl5(97)	4.36	4.16	4.26	5	0.26	0.26	0.26	1	0.16	0.15	0.15	4
Cl5(87)	6.14	5.90	6.02	4	0.30	0.30	0.30	1	0.21	0.21	0.21	3
Cl6(136)	ND	ND	ND	NA	0.07	0.08	0.08	13	0.47	0.52	0.50	11
Cl[illegible]77)	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA
Cl5(110)	16.74	17.19	16.97	3	0.74	0.72	0.73	2	0.47	0.54	0.50	13
Cl6(151)	3.41	3.25	3.33	5	ND	ND	ND	NA	0.06	0.07	0.06	18
Cl6(135)	2.73	2.54	2.64	7	ND	ND	ND	NA	0.04	0.05	0.04	26
Cl6(149)	13.23	12.72	12.97	4	0.39	0.36	0.38	6	0.28	0.30	0.29	4
Cl5(118)	9.03	9.02	9.02	0	ND	ND	ND	NA	0.24	0.24	0.24	3
Cl6(153)/Cl6(132)	18.91	19.21	19.06	2	0.44	0.48	0.46	9	0.43	0.45	0.44	3
Cl5(105)	3.01	2.86	2.93	5	0.16	0.14	0.15	18	0.07	0.10	0.08	24
Cl6(141)	3.76	3.48	3.62	8	ND	ND	ND	NA	0.04	0.04	0.04	17
Cl6(138)	12.79	15.09	13.94	17	0.21	0.28	0.25	28	0.28	0.29	0.29	4
Cl5(126)	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA
Cl7(187)	5.16	5.26	5.21	2	ND	ND	ND	NA	0.08	0.08	0.08	3
Cl6(128)	2.23	2.22	2.22	0	ND	ND	ND	NA	0.03	0.03	0.03	11
Cl7(174)	5.13	5.21	5.17	2	ND	ND	ND	NA	0.06	0.05	0.05	26
Cl7(177)	3.82	3.44	3.63	11	ND	ND	ND	NA	ND	ND	ND	NA
Cl7(171)	2.24	2.28	2.26	2	ND	ND	ND	NA	ND	ND	ND	NA
Cl7(180)	9.90	10.72	10.31	8	ND	ND	ND	NA	0.15	0.16	0.15	4
Cl6(169)	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA
Cl7(170)	6.77	8.29	7.53	20	0.07	0.08	0.07	6	0.05	0.04	0.05	18
Cl8(195)	1.13	1.31	1.22	15	ND	ND	ND	NA	0.05	0.04	0.05	10
Cl9(206)	2.58	2.31	2.44	11	0.03	0.03	0.03	8	0.41	0.07	0.24	139
Cl10(209)	1.51	1.68	1.60	11	0.04	0.05	0.04	27	0.03	0.03	0.03	4
Sum of PCB Congeners	381.8	382.2	382.0	0	90.8	95.8	93.3	5	12.6	12.6	12.6	0
Surrogate Recovery (%)												
Cl5(103)	89	103			64	59			65	65		
Cl5(112)	86	96			69	69			71	71		

%RPD: ([MS % recovery - MSD % recovery]*2*100%)/(MS % recovery + MSD % recovery)

Table 11. Blank Spil.e QC Data — % Recoveries

	Relative Recoveries			Absolute Recoveries		
Analytical Batch:	Influent	Effluent	River Water	Influent	Effluent	River Water
Sample ID:	MA16BS	LP43BS	LP47BS	MA16BS	LP43BS	LP47BS
Sample Volume (L):	2.50	2.50	2.50	2.50	2.50	2.50
Cl1(1)	107	97	96	99	65	69
Cl1(3)	102	100	99	94	67	72
Cl2(4)	99	94	95	92	63	69
Cl2(6)	100	111	113	92	75	81
Cl2(8)	95	103	92	87	70	66
Cl3(18)	90	91	86	83	62	62
Cl2(15)	94	107	99	86	72	72
Cl3(28)	85	106	92	78	72	66
Cl4(52)	90	103	96	83	70	70
Cl4(44)	88	104	96	81	71	70
Cl4(66)	89	98	94	79	74	70
Cl5(101)	97	98	97	86	74	73
Cl4(77)	90	102	101	80	77	76
Cl5(118)	90	103	94	80	77	70
Cl6(153)	90	98	101	80	74	76
Cl5(105)	83	100	92	74	75	69
Cl6(138)	89	102	96	79	76	72
Cl5(126)	86	105	102	76	79	76
Cl7(187)	93	101	103	82	76	77
Cl6(128)	86	104	96	76	78	72
Cl7(180)	86	103	99	76	77	74
Cl7(170)	87	103	97	77	77	72
Cl8(195)	87	105	100	77	79	74
Cl9(206)	88	105	109	78	79	81
Cl10(209)	87	103	104	77	77	78
Surrogate Recovery (%)						
Cl5(103)	92	68	72	92	68	72
Cl5(112)	89	75	75	89	75	75

Table 12. Matrix Spike QC Data — Relative % Recoveries

	POTW Influent				POTW Effluent				River Water			
Source:	Wards Island				Wards Island				Raritan River			
Sample ID:	MA18MS	MA19MSD	AVG	%RPD	LP41MS	LP42MSD	AVG	%RPD	LP45MS	LP46MSD	AVG	%RPD
Sample Volume (L):	1.06	1.06			1.30	1.12			2.50	2.48		
Cl1(1)	120	124	122	3	121	117	119	4	106	119	112	11
Cl1(3)	125	121	123	3	94	108	101	13	93	101	97	7
Cl2(4)	121	126	124	4	90	97	93	7	91	99	95	9
Cl2(6)	106	99	103	7	96	103	99	7	108	106	107	1
Cl2(8)	106	103	105	3	103	113	108	10	97	104	101	7
Cl3(18)	94	95	95	1	89	84	86	6	83	92	87	11
Cl2(15)	106	106	106	0	101	106	104	5	97	109	103	12
Cl3(28)	94	90	92	4	112	108	110	3	101	111	106	10
Cl4(52)	101	101	101	0	100	104	102	4	94	102	98	8
Cl4(44)	96	98	97	2	103	105	104	2	95	103	99	8
Cl4(66)	103	114	109	10	102	104	103	2	95	102	99	7
Cl5(101)	106	113	110	7	99	99	99	0	93	103	98	11
Cl4(77)	109	118	114	8	112	113	112	2	112	122	117	9
Cl5(118)	98	106	102	7	108	107	107	1	103	107	105	5
Cl6(153)	98	108	103	10	108	96	102	11	100	109	104	9
Cl5(105)	85	90	87	6	93	109	101	15	98	98	98	0
Cl6(138)	94	104	99	9	106	102	104	5	96	103	100	8
Cl5(126)	93	96	95	3	111	114	113	3	104	109	107	5
Cl7(187)	97	102	99	5	104	102	103	1	99	104	102	5
Cl6(128)	88	90	89	2	107	107	107	0	102	105	103	4
Cl7(180)	114	124	119	8	118	108	113	9	112	109	110	2
Cl7(170)	78	87	82	11	109	108	108	1	103	112	108	8
Cl8(195)	83	86	85	4	110	107	108	2	109	111	110	2
Cl9(206)	90	111	101	21	106	103	104	3	107	103	105	4
Cl10(209)	94	91	93	3	98	100	99	2	104	105	105	1
Surrogate Recovery (%)												
Cl5(103)	84	72			53	62			66	70		
Cl5(112)	78	59			59	69			71	74		

%RPD: ([MS % recovery - MSD % recovery]*2*100%)/(MS % recovery + MSD % recovery)

Table 13. Matrix Spike QC Data — Absolute % Recoveries

	POTW Influent		POTW Effluent		River Water	
Source:	Wards Island		Wards Island		Raritan River	
Sample ID:	MA18MS	MA19MSD	LP41MS	LP42MSD	LP45MS	LP46MSD
Sample Volume (L):	1.06	1.06	1.30	1.12	2.50	2.48
Cl1(1)	101	89	64	72	69	83
Cl1(3)	105	87	50	67	61	70
Cl2(4)	101	91	48	60	59	69
Cl2(6)	89	71	51	63	71	74
Cl2(8)	89	74	54	70	64	73
Cl3(18)	79	68	47	52	54	64
Cl2(15)	89	76	54	66	64	76
Cl3(28)	78	65	59	67	66	78
Cl4(52)	84	72	53	64	61	71
Cl4(44)	80	70	55	65	62	72
Cl4(66)	81	67	60	71	68	75
Cl5(101)	83	67	58	68	66	76
Cl4(77)	85	69	66	78	79	90
Cl5(118)	77	62	64	73	73	79
Cl6(153)	76	63	64	66	71	80
Cl5(105)	66	53	55	75	69	72
Cl6(138)	74	61	63	70	68	76
Cl5(126)	73	56	66	79	74	80
Cl7(187)	76	60	61	71	70	77
Cl6(128)	69	53	63	73	72	78
Cl7(180)	89	73	70	75	79	81
Cl7(170)	61	51	64	74	73	83
Cl8(195)	65	51	65	74	77	82
Cl9(206)	70	65	62	71	76	76
Cl10(209)	73	54	58	69	74	78
Surrogate Recovery (%)						
Cl5(103)	84	72	53	62	66	70
Cl5(112)	78	59	59	69	71	74

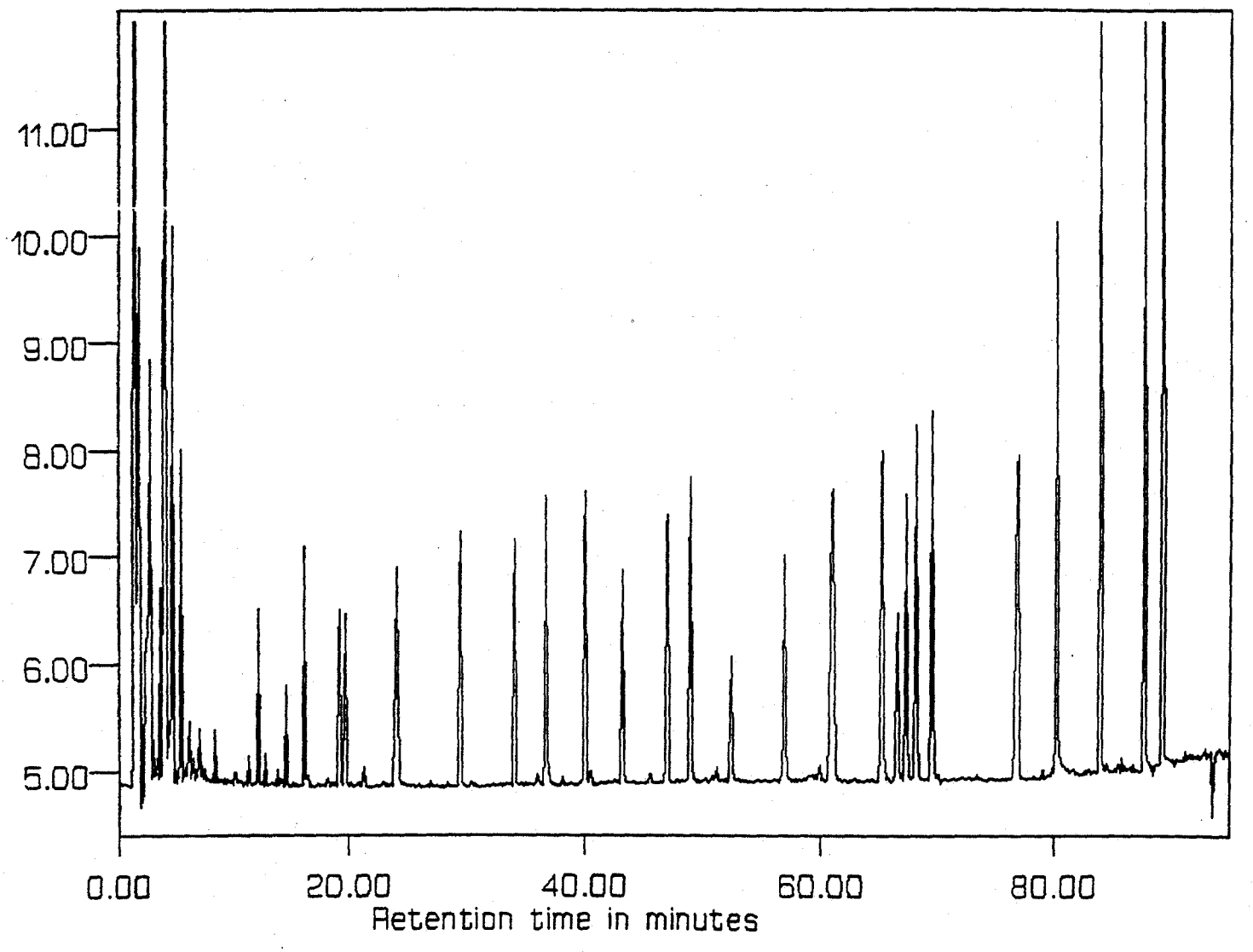

Figure 8. GC/ECD Chromatogram of a Typical Blank Spike Sample

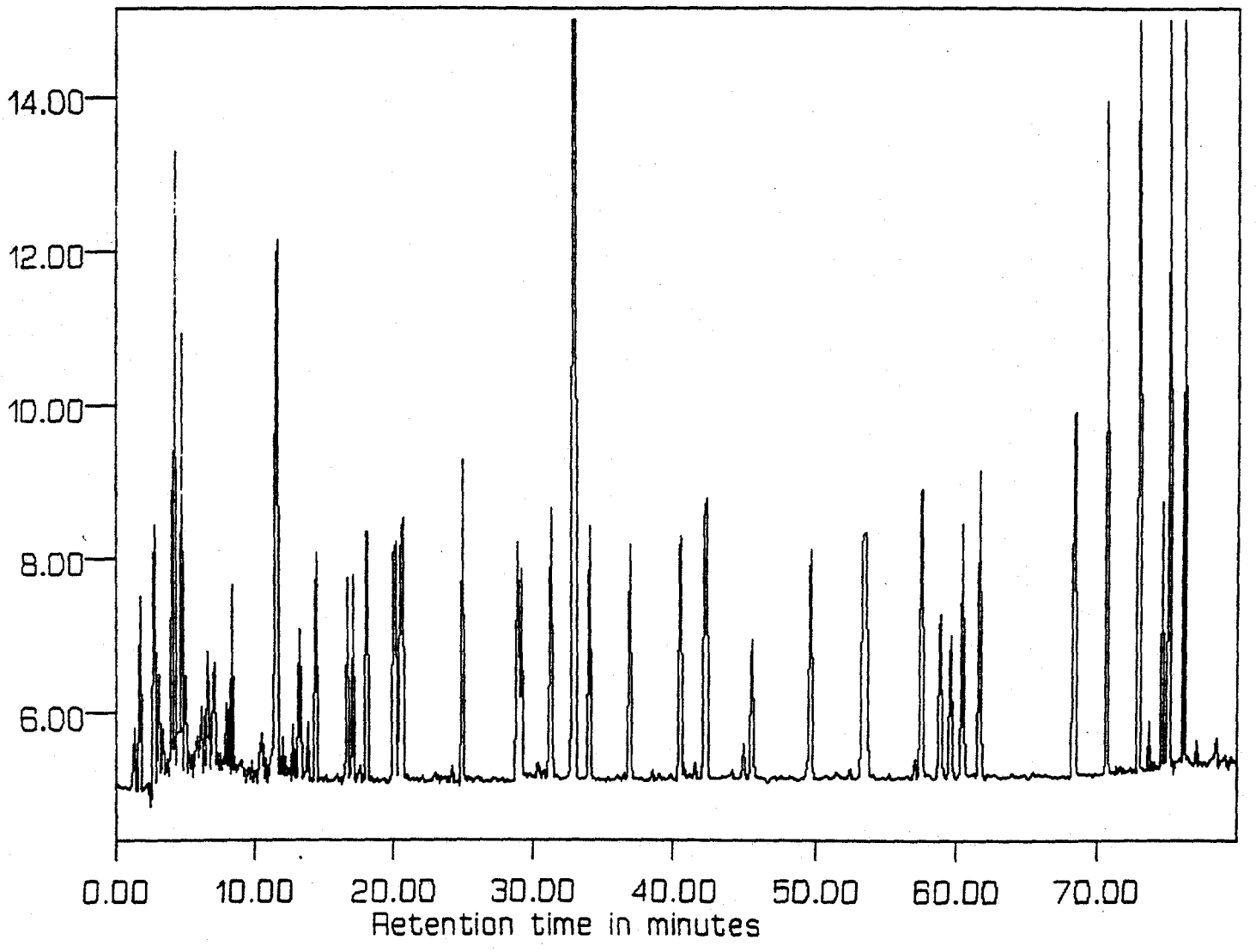

Figure 9. GC/ECD Chromatogram of a Typical Influent Matrix Spike Sample - Wards Island POTW Influent Used

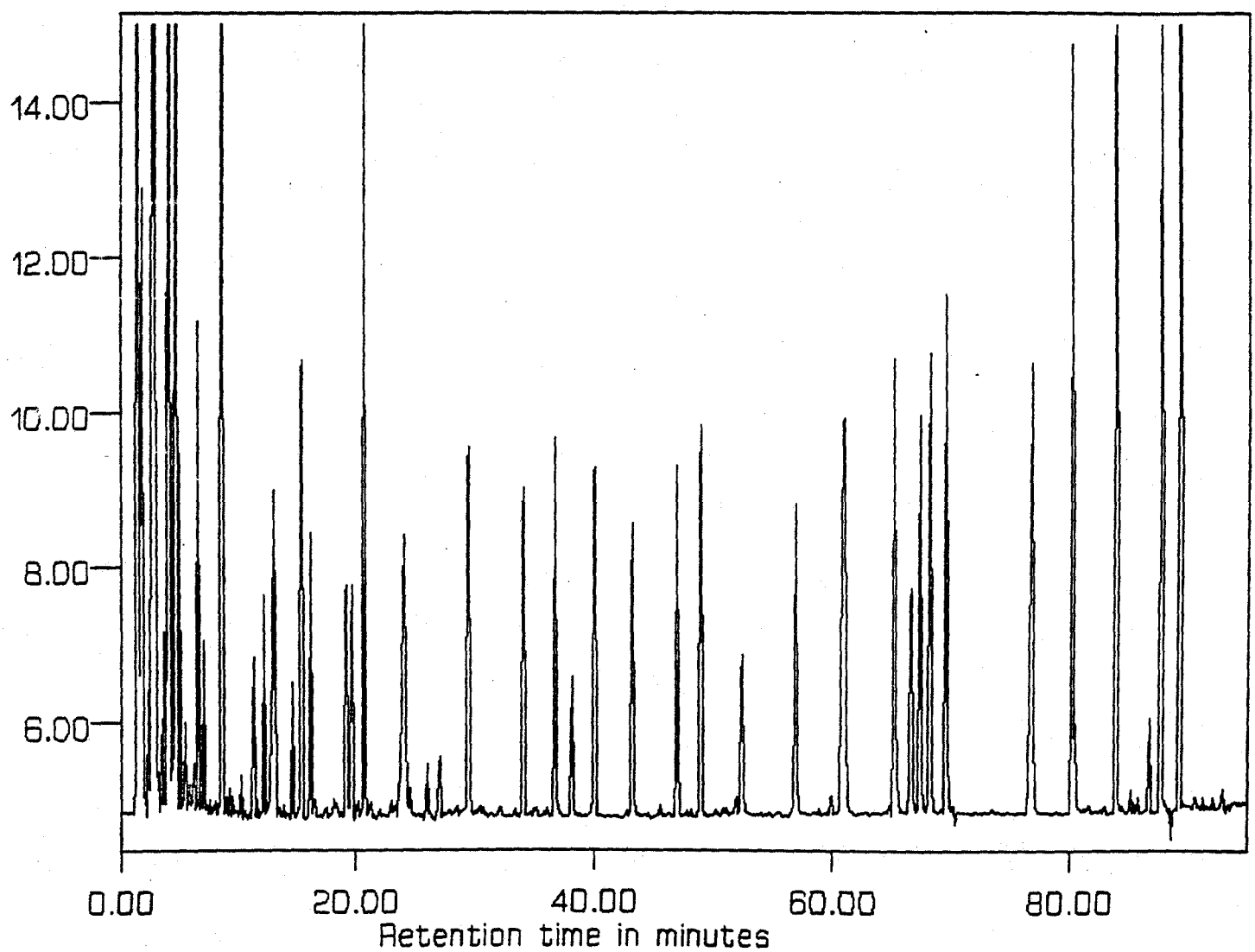

Figure 10. GC/ECD Chromatogram of Typical Effluent Matrix Spike Sample - Wards Island POTW Effluent Used

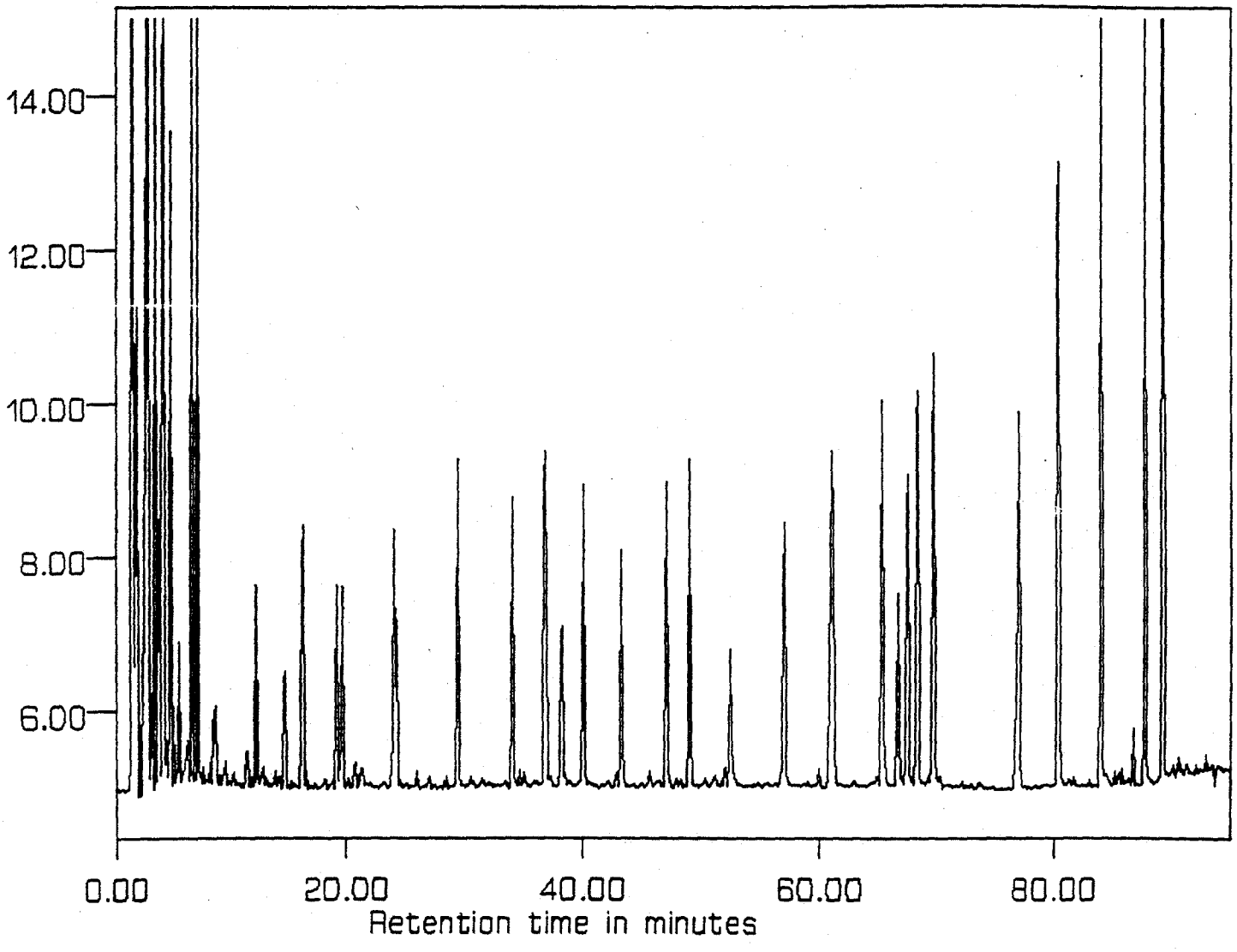

Figure 11. GC/ECD Chromatogram of River Matrix Spike Sample — Raritan River Used

analytes, and, by definition, these recoveries are expected to generally be less than 100% (a data quality objective range of 40 to 120% apply for absolute recoveries). The relative recoveries are a measure of the accuracy of the target analyte quantification if surrogate compounds are used to determine analyte concentrations, and, by definition, these recoveries are expected to be near, and approximately equally distributed about, 100%, assuming appropriate surrogate compounds were used for quantification (a data quality objective range of 70 to 130% apply for relative recoveries).

The blank spike recovery data were excellent, with relative recoveries ranging from 83 to 113%, and absolute recoveries ranging from 62 to 99% for the 25 target PCB congeners in the three separate blank spike samples. The matrix spike recovery data were equally good, with relative recoveries ranging from 78 to 126%, and absolute recoveries ranging from 47 to 105% for the 25 target PCB congeners in the six separate matrix spike samples. All BS or MS/MSD recovery data were well within the data quality objectives. These data indicate that accurate analytical methods were employed and that the sample matrices had no adverse affects on the accuracy of the analytical procedures. The analytical precision, as measured by the %RPD in the MS/MSD duplicate analyses (Table 12), consistently met the data quality objectives with %RPDs ranging from 0 to 21%.

Table 14 presents the quality control data for the DOC, PC, and PN analyses. No pre-established QC criteria were applied, but a review of these data indicate that, for the most part, these data are what could be considered good. The DOC matrix spike recoveries ranged from 100 to 111%, and the precision in the DOC laboratory duplicate analyses ranged from 0.3 to 2.3%. Detectable levels of DOC were found in the field blanks, but at levels no more than approximately 2 times the detection limit of 0.5 mg/L. The precision and field blank data for the PC and PN analyses were generally within what could be considered reasonable. A few of the replicate analyses for samples with concentrations near the limits of detection (0.37 mg/L for PC and 0.11 mg/L for PN) had, as can be expected, higher variability. With the exception for the PC determined for the Passaic Valley influent field blank, the field blank samples had PC and PN concentrations near or below the detection limits.

Table 14. DOC, PC, and PN QC Data

Sample/Source		DOC (mg/L)	PC (mg/L)	PN (mg/L)
Task 1 Samples				
Influent				
Wards Island — Rep 1		21.2	23.6	2.26
Wards Island — Rep 2		21.7	23.1	2.23
	AVG:	21.5	23.4	2.25
	%RPD:	2.3%	2.1%	1.3%
River				
Hudson River — Rep 1		NA[a]	0.37	0.068
Hudson River — Rep 2		NA	0.44	0.073
	AVG	NA	0.41	0.071
	%RPD:	NA	17.1%	7.0%
Passaic River - MS recovery		110%	NA	NA
Hudson River - field blank		1.74	0.23	0.005
Task 2 Samples				
Influent				
Passaic Valley — Rep 1		33.8	37.3	3.08
Passaic Valley — Rep 2		33.9	39.6	3.44
	AVG:	33.9	38.5	3.26
	%RPD:	0.3%	6.0%	11.0%
Wards Island field blank — Rep 1		NA[a]	0.629	0.023
Wards Island field blank — Rep 2		NA	0.934	0.051
	AVG:	NA	0.782	0.037
	%RPD:	NA	39.0%	75.7%
Passaic Valley - MS recovery		101%	NA	NA
Passaic Valley - field blank		0.73	3.05	0.162
Wards Island - field blank		1.02	0.78[b]	0.037[b]

[a] DOC only determined for one of the two replicates.
[b] The average value of two laboratory replicate analyses.

Table 14 (continued). DOC, PC, and PN QC Data

Sample/Source		DOC (mg/L)	PC (mg/L)	PN (mg/L)
Task 2 Samples (continued)				
Effluent				
Passaic Valley — Rep 1		22.8	NA	NA
Passaic Valley — Rep 2		23.2	NA	NA
	AVG:	23.0	NA	NA
	%RPD:	1.7%	NA	NA
Newtown Creek — Rep 1		NA[a]	5.13	0.699
Newtown Creek — Rep 2		NA	3.84	0.500
	AVG:	NA	4.49	0.600
	%RPD:	NA	28.7%	33.2%
North River — Rep 1		NA[a]	2.36	0.227
North River — Rep 2		NA	2.94	0.287
	AVG:	NA	2.65	0.257
	%RPD:	NA	21.9%	23.4%
Passaic Valley - MS recovery		100%	NA	NA
River				
Raritan River — Rep 1		2.45	1.26	0.139
Raritan River — Rep 2		2.46	0.363	0.051
	AVG:	2.46	0.812	0.095
	%RPD:	0.4%	110%	92.6%
Hudson River — Rep 1		NA[a]	1.12	0.074
Hudson River — Rep 2		NA	1.04	0.125
	AVG:	NA	1.08	0.100
	%RPD:	NA	7.4%	51.0%
Raritan River - MS recovery		111%	NA	NA

[a] DOC data only reported for one of the two replicates.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The analytical procedures used in this task proved to be extremely useful for low-level PCB determinations of POTW influent, effluent, and river samples. Detection limits significantly lower than commonly obtained for such complex matrices as POTW influent and effluent were consistently achieved.

The extensive list of identified PCB congeners and the PCB pattern distributions observed in this work lend strong support to the accuracy of the data. Nonetheless, because of the non-confirmatory nature of single-column GC/ECD analysis, the reported data are not necessarily exclusively due to the reported PCB congener analytes. Potentially interfering compounds may result in overestimations and even false positive determinations. Because analytical data from a second analytical column, with different retention characteristics than the primary column, were acquired with these sample analyses, Battelle can, upon request, efficiently reduce these data for analyte confirmation (no instrumental reanalyses are needed), and compile them with the primary analyses data. This would add another level of confidence and accuracy to a valuable dataset.

The list of 50 congeners used for this work proved to be a highly useful and appropriate set of analytes for detailed PCB characterization. These congeners include all those that individually constitute more than 2% of the total PCB in any Aroclor formulation, and the sum of which comprise between 75 and 95% of the total PCB in Aroclors. These congeners compose approximately 75 to 80% of total PCB in the higher molecular weight Aroclors (such as 1260, 1262, and 1268) and 90 to 95% of the total PCB in most other Aroclor formulations. For future work it may be appropriate to extend this list to include all congeners that are present at a level of greater than 1% in any Aroclor (this would add approximately 20 more congeners to the list), which would result in a target analyte list that consistently includes the congeners that make up more than 95% of the total PCB in any Aroclor. However, as when selecting any PCB congener target analyte list, there is no guarantee that the environmental samples will resemble pure Aroclor formulation, and several of the more than 100 PCB congeners that are minor, and even nonexistent, in fresh Aroclor may become significant in environmentally degraded/transformed samples. However, such environmental alteration can rarely be predicted and Aroclor standards and their known congener composition are still generally the best guide for selecting a good PCB congener analyte list.