FT. EDWARD DAM PCB REMNANT DEPOSIT CONTAINMENT

ENVIRONMENTAL MONITORING PROGRAM

PRECONSTRUCTION AND CONSTRUCTION MONITORING STUDIES

REPORT OF 1990 RESULTS
March - December 1990

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EXECUTIVE SUMMARY

In accordance with agreed upon Plans of Study (POS) with the USEPA, General Electric Company continued conducting an environmental monitoring program during 1990 in conjunction with the containment of the Ft. Edward Dam PCB Remnant Sites along the Hudson River near Ft. Edward, NY. The monitoring program began in August 1989, and the results of the 1989 portion of the program have been previously reported. In accordance with the reporting requirements in the POS, this document describes the results of the environmental monitoring conducted in 1990.

During 1990, environmental monitoring for PCBs in air, sediments, water and aquatic biota was conducted both prior to, and during, containment construction activities on the four existing Ft. Edward Dam PCB Remnant Sites. Over 3,500 samples were analyzed for total PCB and Aroclor content. Preconstruction monitoring began in late March and continued through June. Construction monitoring was conducted July through December.

Preconstruction Monitoring

Air quality monitoring during the preconstruction period consisted of taking two simultaneous, 24-hour ambient air samples every three days at five fixed stations, which constituted a background network. Four of these stations were located in the residential area surrounding the remnant area; the fifth was located in a remote residential area, some five miles from Ft. Edward. Additionally, three temporary ambient air samplers were operated adjacent to Remnant Sites 2, 4 and 5. These samplers took two simultaneous 8-hour ambient air samples on a daily basis during the week prior to the commencement of construction activities on those sites. Of the 370 samples collected during the 1990 preconstruction period, none contained PCBs above the detection limit of 0.05 μg.

Aquatic monitoring during the 1990 preconstruction period consisted of taking surface sediment samples, mid-water grab water samples, hexane-filled dialysis membrane bag uptake samples and Hester-Dendy multiplate periphyton/silt samples at up to 16 stations in the Hudson River and at one additional station in the Mohawk River. The Hudson River stations were located from Sherman Island Dam pool to below the Troy Dam; the Mohawk River station was just upstream of the confluence with the Hudson River. Six of the Hudson River stations were located upstream of the Remnant Sites, five were interspersed among the Remnant Sites and the remaining five were downstream of the remnant area.

During the 1990 preconstruction period, one set of multiple (two to four) surface sediment samples was taken with a six-inch petite ponar dredge at 16 of the 17 aquatic monitoring stations. (One of the stations upstream of the remnant area was not sampled because of access difficulties.) Of the 40 samples collected during this period, 27 had detectable levels of Aroclor 1242 and 31 had detectable levels of Aroclor 1254. PCBs were found at all sampled stations, with the highest concentrations (40.0 μg/kg Aroclor 1242 and 6.4 μg/kg Aroclor 1254) being found just downstream of the remnant area. Aroclor 1242 was found at all Hudson River stations except one (which was located upstream of the remnant area and had only Aroclor 1254). The Mohawk River station also had only Aroclor 1254.

Of a total 233 grab water samples collected on a weekly basis from all (17) stations during the 1990 preconstruction period, 19 (8.2%) contained PCB above the 0.1 μg/L detection limit. All detectable PCB was Aroclor 1242. Most (14) of the samples with detectable PCB, as well as the samples having the highest PCB concentration (0.49 μg/L), were from stations in the vicinity of the Remnant Sites, principally in a one-mile reach of river between the sites and Rogers Island. However, detectable PCBs were found in samples from stations above Bakers Falls, upstream of the remnant area, indicating a potential source of contamination upstream of the General Electric plant discharge points in Ft. Edward and Hudson Falls.

Of a total 97 hexane-filled dialysis membrane bags retrieved biweekly from all (17) of the aquatic monitoring stations during the 1990 preconstruction period, only five contained detectable PCB (Aroclor 1242 only). Of the five, two (having a maximum concentration of 0.2 μg/L) came from below Ft. Miller and three (having a maximum concentration of 0.5 μg/L after a 238-day exposure) came from Waterford.

One set of Hester-Dendy multiplate samplers (37 samples) was recovered after a nominal five-week exposure period from all but two (both above Bakers Falls) of the 17 stations during the 1990 preconstruction period. Detectable PCB (mostly Aroclor 1242) was found in 29 of the samples. The highest PCB concentrations (14.0 μg/kg Aroclor 1242; 2.2 μg/kg Aroclor 1254) were found in the remnant areas. The major exception to the predominance of Aroclor 1242 occurred in the Mohawk River, where only Aroclor 1254 (0.11 μg/kg and 0.12 μg/kg) was found.

Construction Monitoring

During the 1990 construction period, air and water quality monitoring intensified at the Remnant Sites. Sediment, dialysis bag and aquatic biota sampling continued at the preconstruction level of effort, as well as water quality monitoring at stations upstream and downstream of the remnant area.

In addition to the background air quality monitoring at three-day intervals, daily on-site monitoring was conducted at sites where construction activity was occurring. The total resulting 759 analyzed air quality samples had detectable PCB in 110 (14.5%) samples. All but one sample (containing Aroclor 1254) contained only Aroclor 1242. Most (96%) of the detections occurred on the construction sites; only four of the background network samples had detectable PCBs. The highest concentration measured (2.77 $\mu g/m^3$ Aroclor 1242) occurred on Remnant Site 3. The average PCB concentration at all sites was 0.5 $\mu g/m^3$.

Because of the overlap in construction activities on and among sites, the impact of a particular activity is difficult to isolate. However, the majority of the detectable PCB samples occurred during site clearing and during the placing of the initial sand layer on the sites, when many heavy construction vehicles were moving over exposed soils.

Aquatic monitoring was increased during the 1990 construction monitoring period by the installation of ISCO™ automatic water samplers at eight stations adjacent to the remnant sites. The samplers were located at the upstream and downstream boundaries of each remnant site, and took daily integrated samples while a site was under construction. Mid-water grab water samples continued to be taken at the 17 aquatic stations sampled during the 1990 preconstruction period, plus the addition of one station immediately downstream of the remnant area, resulting in 18 aquatic stations being sampled on a weekly basis. Sediment, dialysis bag and Hester-Dendy sampling also continued at these 18 stations. Sediments were sampled quarterly; dialysis bags, biweekly; and multiplates at nominal five-week intervals. Additional aquatic biota sampling was conducted during the construction monitoring period in the form of caddisfly larvae collections at four stations (once only) and by in-situ fathead minnow assays at six stations at nominally three-week intervals.

Of 77 sediment samples taken during the construction monitoring period, 47 samples had detectable levels of Aroclor 1242 and 52 samples had detectable levels of Aroclor 1254. Nearly all of the Hudson River samples from Bakers Falls to below the Troy Dam had detectable levels of both Aroclor 1242 and Aroclor 1254, with the highest concentrations (61.0 μg/kg Aroclor 1242; 15.0 μg/kg Aroclor 1254) occurring in the vicinity of the remnant area. Both Aroclors were also detected at the upstream control station in Sherman Island Pool. However, only Aroclor 1254 was detected in sediment samples from the Mohawk River.

Aroclor 1242 and Aroclor 1254 were the only two Aroclors found in the weekly-collected mid-water grab and automated daily water samples, with Aroclor 1242 being predominant.

Aroclor 1242 was found in 13 (2.9%) of 448 mid-water grab samples and in 230 (27.8%) of 827 automated water samples. Aroclor 1254 was found in 3 (0.7%) grab samples and in 30 (3.6%) automated samples. Detectable levels of Aroclor 1242 were between 0.10 μg/L and 0.49 μg/L in mid-water grab samples and between 0.10 μg/L and 25.1 μg/L in automated samples. Detectable levels of Aroclor 1254 were 0.14 μg/L to 0.35 μg/L in the grab samples and 0.11 μg/L to 1.65 μg/L in the automated samples. Nearly all of the detectable waterborne PCBs in the grab samples were found in the vicinity of the remnant area. (The automated samplers were only located in the remnant area.)

Because of the overlap in construction activities on a site, detectable waterborne PCBs could generally not be associated with a specific activity. However, the installation of the temporary bridge from the west bank to Remnant Site 3 resulted in detectable PCBs in the water column immediately downstream. Additionally, regrading, subgrade placement and channel work on the sites appears to be associated with increased numbers of samples with detectable PCBs. However, as in the 1990 preconstruction samples, there was no statistically significant ($P=0.05$) correlation between PCB concentrations and precipitation, nor (with the exception of samples at Remnant Site 3) between PCB concentration and Hudson River discharge.

During the 1990 construction monitoring period, nine sets of dialysis bags were placed at 17 of the 18 aquatic construction monitoring stations. (One station upstream of Bakers Falls was dropped after repeated vandalism.) Of 211 bags recovered, seven stations yielded a total of 32 samples with detectable PCB (Aroclor 1242 only). Half of the detectable PCB samples were from the lower portion of the remnant area and all but one (having 0.2 μg/L) contained a PCB concentration of 0.1 μg/L. The remaining detectable PCB samples came from the Ft. Miller and Waterford stations; 44% of those samples contained PCB concentrations of 0.1 μg/L, while 56% contained 0.2 μg/L.

The Hester-Dendy multiplate samplers, caddisfly larvae samples and in-situ fathead minnow assays had similar geographic patterns in the stations having detectable PCBs, with the highest concentrations (23.6 μg/kg in periphyton/silt; 12.6 μg/kg in caddisflies; and 6.1 μg/g in fathead minnow) occurring in the vicinity of the remnant area. Both Aroclor 1242 and Aroclor 1254 were detected in the aquatic biota samples, with Aroclor 1242 being predominant. However, only Aroclor 1254 (0.07 μg/kg) was found in the Hester-Dendy periphyton/-silt samples in the Mohawk River. One set of the in-situ fish assays just above Bakers Falls also contained only Aroclor 1254 (3.8 μg/g).

That detectable PCBs were found in Hester-Dendy periphyton/silt samples (up to 5.3 μg/kg Aroclor 1242 and 1.6 μg/kg Aroclor 1254), and up to 0.73 μg/g Aroclor 1242 and 3.80 μg/g Aroclor 1254 was in the fish assay samples upstream of Bakers Falls (above the remnant area) raises questions regarding the PCB source. Although not found in the mid-water grab samples and dialysis bags samples above Bakers Falls, detectable PCBs were also found in sediment samples above the falls. Although the concentrations are substantially less than those in the remnant area, the presence of detectable PCBs (especially Aroclor 1254) above Bakers Falls suggests a potential source of PCBs above the GE plants in Ft. Edward and Hudson Falls.

1.0 INTRODUCTION

The PCB remnant deposits consist of PCB-contaminated sediments and debris remaining after the 1973 removal of Niagara Mohawk's Ft. Edward Dam on the Hudson River. Malcolm Pirnie, Inc. (1986) identified five remnant deposits, herein called Remnant Sites. Four Sites can be identified today. The four Sites are on the riverbanks. Sites 2 and 4 are on the Saratoga County (west) shore and Sites 3 and 5 are on the Washington County (east) shore (Figure 1).

Much of the concern regarding the remnant areas is based on their potential contribution of PCBs to air in the immediate vicinity of the Sites, and to the Hudson River between the Sites and Waterford. Waterford is the only municipality between Ft. Edward and the tidal portion of the Hudson River (downstream of the Troy Dam) that uses the Hudson as a source of drinking water. The U.S. Environmental Protection Agency (USEPA) and New York State Department of Environmental Conservation (NYSDEC) estimated that 37% of the PCBs in the water column of the Hudson River at Waterford "originated upstream of the [Thompson Island] Pool in the remnant deposit sites" (USEPA/NYSDEC 1987 pg. I-22).

Some remedial actions (riprap cover and bank stabilization) had been taken during the 1970's at Sites 2, 3 and 5 (USEPA/NYSDEC 1987). In 1975, riprap was placed at Remnant Sites 3 and 5, and the angle of the riverbank slope was cut back at Remnant Site 2. Approximately 17,000 cubic yards of contaminated sediments were removed from Remnant Site 3 in 1977 and 1978. Additional riprap was also placed at Remnant Site 3 in 1978, and a low earthen dam was placed across the northern end of Remnant Site 3 to reduce the possibility of the river overtopping the northern end of the Site and causing erosion and scouring of PCBs from the Site.

In accordance with the USEPA Record of Decision (1984), construction efforts for in-place containment of Sites 2, 3, 4 and 5 began in July 1990. Remediation at the Sites is being

performed in accordance with the with the Administrative Order on Consent II CERCLA-90224. The Consent Order requires the General Electric Company (GE) to cap, or contain in place, Remnant Sites 2, 3, 4 and 5. Containment is being effected by clearing and grading of the Sites, followed by placement of a subgrade sand layer, a layer of contained finely-ground bentonite known as Claymax®, additional sand, topsoil and seeding with grass, and erosion controls, such as the placement of riprap along the shoreline and construction of channels to funnel runoff away from the remnant areas.

As part of the remedial activities, GE has been conducting an environmental monitoring program. Begun in 1989, this program will continue through (and following) the remediation construction activities on the remnant deposits. The sampling matrices conducted in the 1990 monitoring program included: sediment samples, water samples, dialysis membrane bags, multiplate samples, caddisfly samples, in-situ fish assays, and air quality samples. The program described herein is patterned after, and uses many of, the same monitoring techniques used by NYSDEC and NYSDOH in their previous Hudson River monitoring studies (NYSDEC 1982, Simpson et al. 1986, Jones and Sloan 1989).

This report describes the results of the monitoring program from March through December 1990. The results of the 1989 program have been reported by Harza/Yates & Auberle (1990a), and an interim report of the 1990 air and water sampling results through mid-October was provided in Harza/Yates & Auberle (1990b). Because the program changed from preconstruction monitoring to construction monitoring in early July 1990, the report is separated accordingly. To the extent warranted by the 1989-1990 data, comparisons among stations and seasonal trends in PCB concentrations at a station are also described.

2.0 PRECONSTRUCTION MONITORING PROGRAM

2.1 Monitoring Strategy

The 1990 Preconstruction Monitoring Program was principally a continuation of the 1989 monitoring effort (Harza/Yates & Auberle 1989a) and was directed at determining the baseline characteristics in the study area. However, based on the findings of the 1989 program, new baseline monitoring stations were added and, in some instances, the sampling effort was intensified to better evaluate sources of PCB upstream and downstream of the construction activities. The 1990 preconstruction program was conducted in accordance with the Plan of Study described in Harza/Yates & Auberle (1990c).

2.2 Air Quality Monitoring

2.2.1 Study Area

The study area to determine background PCB concentrations in air during the 1990 preconstruction monitoring period included various locations in the community of Ft. Edward. Locations upwind and downwind of the remnant sites were selected as well as two residential locations near the remediation construction areas. Operation of these four sampling sites provided air monitoring coverage over approximately two miles of the Hudson River in the Fort Edward area. An additional sampling site operated four miles south of Fort Edward. Additional monitoring directly adjacent to the Remnant Sites was performed in the final week of the preconstruction period. This sampling extended the study area to the river valley in the area of the Remnant Sites.

2.2.2 Station Locations

Five fixed-location air monitoring stations and three temporary location preconstruction stations operated in the community of Ft. Edward during the 1990 preconstruction period. The locations of the fixed sites are shown in Figure 2; the samplers are identified as A1, A2, A3, A4 and A5. Sampler A1 is located north of all four Remnant Sites, on the west bank of the Hudson River. Sampler A4 is located south of all four Remnant Sites, on the east bank of the Hudson River. Samplers A2 and A3 are located in residential areas, east of Remnant Site 3 and north of Remnant Site 5, respectively. Sampler A5 operated at a farm site four miles south of Remnant Site 5.

The three temporary preconstruction air monitoring stations were located adjacent to three of the Remnant Sites and operated during the week prior to construction on the respective Sites. The locations of these stations are shown in Figure 3; the samplers were designated A6, A7 and A8.

Air sampling for the 1990 preconstruction monitoring period began March 30, 1990, and continued through July 9, 1990. The following table shows when additional monitoring sites were added to the sampling network and their respective sampling frequency. Sites A1 and A4 were intended to be started concurrently with A2, A3, and A5; however, land acquisition problems delayed their startup. Preconstruction Sites A6, A7, and A8 operated daily (the sampling frequency designated for the construction monitoring period) a full week prior to the start of actual construction.

1990 Preconstruction Monitoring Air Sampling Station Start Dates and Frequencies

Site Designation	Location	Sampling Start Date	Sampling Frequency
A1	Bakers Falls	5/11/90	Every 3 Days
A2	May Street	3/30/90	Every 3 Days
A3	McCrea Street	5/11/90	Every 3 Days
A4	Scott Paper	3/30/90	Every 3 Days
A5	Cary Road	3/30/90	Every 3 Days
A6	Remnant Site 2	7/3/90	Daily
A7	Remnant Site 4	7/3/90	Daily
A8	Remnant Site 5	7/3/90	Daily

2.2.3 Materials And Methods

The principal objective of air sampling during the 1990 preconstruction period was to determine the background concentration of potential PCBs in the community of Ft. Edward. This was done by locating air monitoring stations at varying distances from the Remnant Sites. Each sampler was designed to concentrate airborne PCBs, measure sample time and maintain a steady sample flowrate. The sample volume was calculated from field measurements of sample time and flowrate. The mass of PCB was determined by laboratory analysis. Ambient PCB concentrations were then calculated by dividing the laboratory quantified PCB mass by the sample volume. The PCB concentration is expressed in the units of micrograms per cubic meter ($\mu g/m^3$).

All samplers were constructed using the same basic design. Each sampler consists of a control box with two sampling trains. The control box is mounted on a platform; a pipe from the control box leads to the sampling trains located approximately eight feet above

ground. The control box, shown in Figure 4, consists of a vacuum system, a vacuum gauge, six-day timer and a clock to measure sample time.

Each sampler was set to take two simultaneous, 24-hour ambient air samples. The 6-day timer in the control box automatically started and stopped the vacuum system. Because the 6-day timer was accurate only to the nearest 15 minutes, the control panel was fitted with a clock that measured the elapsed time to the nearest one tenth of a minute. A single sample line ran from the vacuum system and then branched into two separate lines. Both sample lines fed through a metal piping support system to the two separate sampling trains (identified as the Red Channel and Green Channel, respectively). A critical orifice was inserted in each branch to control the sample flow rate. Each sampler used 110V AC power.

The temporary preconstruction samplers, A6, A7, and A8, operating immediately adjacent to the Remnant Sites, provided information on the background PCB concentrations just prior to construction. These preconstruction samplers operated on an 8-hour sampling frequency. Two of the sample locations, A6 and A7, were trailer-mounted samplers equipped with a generator. This arrangement permitted access to the remote remediation sites. Sample location A8 was the same as the permanent location A5 (Scott Paper). The sample site identification was redesignated to reflect its change of status to an 8-hour preconstruction monitor. All three stations took two simultaneous, 8-hour ambient air samples. The sampling period commenced at approximately 9:00 a.m. and terminated at approximately 5:00 p.m. Figure 5 is a schematic drawing of the trailer-mounted samplers.

The PCB sampling train was identical for all samplers. It is illustrated in Figure 6 and consists of a glass fiber filter followed by two florisil packed glass tubes in series. Each glass tube contains a front and rear section of florisil adsorbent. Series arrangement of the tubes reduced the chances of PCB breakthrough. The combination of a glass fiber filter and

florisil packed tubes ensured that the sampling system would catch both particulate (or PCB adsorbed to particulate) and vaporous PCB.

Each tube is affixed with a label using a sampling identification convention that gives the sampler location, date and channel. Similar labels were affixed to the vials in which the filters were placed upon completion of sampling.

Field personnel visited each monitoring location between scheduled sample dates to remove collected samples, reload the equipment, and record pertinent sample data. Flow rates were measured before and after each sample event. Flow rate calibration consisted of three consecutive flow rate measurements taken with an SKC Model 712 electronic calibrator. The sample volume was calculated by multiplying the difference in the elapsed time meter readings by the average of the flow rate measurements.

Field personnel prepared collected samples for shipment to the laboratory. The florisil tubes were removed from their holders and both open ends were sealed with tube caps. The glass fiber filter was removed from the sampling train, placed in a labelled glass vial, and the vial was capped. The three components of each channel (filter, 1st tube and 2nd tube) were placed in plastic bags and sealed. All samples were stored in a clean area, free of airborne contamination, until shipped to the analytical laboratory.

2.2.4 Meteorology

Meteorological data were obtained from the National Weather Service Station in Glens Falls, NY. However, the meteorological information was not assembled for the preconstruction monitoring period because no detectable levels of PCBs were found during this period.

2.2.5 Laboratory Methods

Trinity Environmental Technologies Inc., at the request of Yates & Auberle, Ltd., employed a modified version of NIOSH Method 5503 to quantify the PCB content. The modifications consisted of separate analysis of the filter and front half of the first florisil tube and the use of jumbo florisil tubes in place of the standard size. The larger tubes reduce the chance of PCB breakthrough in the sampling train; analyzing the filter separate from the tube potentially provides information on the vapor/particulate ratio of quantified PCB.

2.2.6 QA/QC

2.2.6.1 Field Study. QA/QC procedures were established to ensure the integrity of both the field data and the ambient air samples. These procedures can be grouped into the following general areas:

1. Development of Standard Operating Procedures for sampler operation
2. Training of all field technicians.
3. Completion of PCB field data forms for each sampling event.
4. Maintenance of sampler log books.
5. Collocated sampling for each sample day.

For the preconstruction sampling period, collocated samples were taken at each sampling site for each sampling event. In addition, one full set of field blanks was collected for each sampling day. All site visits were recorded in a station log book along with other pertinent observations and notes from the field technician. Operational data and the calibration

records were recorded on the PCB Field Data form. The Field Data forms were forwarded weekly to Yates & Auberle's East Rutherford office for incorporation into an electronic database.

The Standard Operating Procedures defined the sample identification protocol and use of Chain of Custody forms. The ambient air samples were identified according to the sample site, the system channel, the type of media (filter or florisil tube) and the date. The identification number for each sample was recorded on a sample container vile, the PCB Field Data form, and the Chain of Custody form.

2.2.6.2 Laboratory. Laboratory analyses were performed by Trinity Environmental Technologies Inc. (Mound Valley, KS). Trinity's Quality Assurance Procedures can be found in the Quality Assurance Project Plan (QAPP) document (Harza/Yates & Auberle 1989b) prepared prior to the start of the 1989 field program.

The analytical QA/QC package can be summarized according to the following five points.

1. Standards, splits, and spikes for the gas chromatographic work in accordance with Method 5503.

2. Five point linearity calibration for three Aroclors.

3. External QC testing with a minimum of two outside laboratories.

4. Kansas State Certification.

5. Participation in EPA's internal standard analysis program.

2.2.7 Results And Discussion

2.2.7.1 Air Quality. Sampling results for the preconstruction period are contained in Appendix 1, Table 1. Appendix 1, Table 1, *Hudson River PCB Superfund Site - Preconstruction Monitoring Program, PCB Mass In Air By Sampling Component*, shows the analytical results for each component of the sample train. For the 1990 preconstruction period, none of the analyses were above method detection limit (MDL) of 0.05 μg.

A total of 370 samples was collected during the 1990 preconstruction period. A sample consists of the filter and the florisil tubes, even though each unit was analyzed separately. The lack of detectable PCB indicates that ambient PCB concentrations in the Fort Edward area are very low.

2.2.7.2 QA/QC. Only a limited number of sampling problems occurred during the preconstruction period. Sixteen samples were affected by mechanical or human errors. Power supply problems at the sampling sites resulted in the loss of four samples. Eleven samples were rejected because sample flow rate did not meet performance criteria. Failure to meet performance criteria was generally the result of a defective critical orifice or a blockage in the sample tubing. One sample filter was lost as a result of human error.

2.3 Aquatic Monitoring

2.3.1 Study Area

The study area for the aquatic portion of the 1990 Preconstruction Monitoring Program was that established in discussions with USEPA for the 1989 program and included the Hudson River in the general vicinity of the remnant deposits and downstream to below the Federal Lock and Dam at Troy. The downstream limit of the aquatic study was extended below Troy because the 1989 program showed detectable PCB levels in sediment and aquatic biota

at Waterford and the extent to which the upper river contributes PCBs to the lower river is unknown. Additionally, a station in the Mohawk River was established to determine the contribution of that river to PCBs detected at the station below Troy. However, most of the monitoring activities were focused in the vicinity of the remnant areas, with monitoring control (non-affected) stations located beyond the influence of those areas.

2.3.2 Aquatic Monitoring Stations

The number of aquatic stations sampled in this portion of the monitoring program was expanded from the 1989 program to a total of 17. The locations of these stations are listed in Table 1, and are shown in Figures 7 and 8. Six "control" stations (C1, GF1, GF2, GF3, GF4 and C2) were located upstream of the Remnant Sites. All but one of these stations (C2) are located upstream of the GE outfall at Hudson Falls. Station C1 is located upstream of the Niagara Mohawk Sherman Island Dam above Glens Falls and was expected to be essentially free of PCB contamination. Stations GF1, GF2, GF3 and GF4 are located between the Sherman Island Dam and Bakers Falls. Station C2 is located below Bakers Falls but upstream of the remnant deposits. The remaining stations characterized the existing conditions in the vicinity of the Remnant Sites and downstream. Five of these stations are interspersed among the remnant deposits to measure the PCB contribution to the river from each Remnant Site (Figure 8). Additional stations between the Remnant Sites and the Troy Dam were sampled to evaluate the contribution of PCBs from the remnant deposit area to PCB levels at downstream locations. A new station, HR1, evaluated the contribution of PCBs due to construction to the lower river (below Troy) and another new station, MR1, evaluated the contribution of PCBs to the levels at HR1 coming from the Mohawk River.

2.3.3 **Station Descriptions**. The general characteristics of the aquatic stations are described below.

Station C-1 - Sherman Island Pool, between Spier Falls Dam and Sherman Island Dam - River Mile 212.8, Hudson River (Figure 7)

This station is located 1.25 miles downstream of the Niagara Mohawk Power Company boat ramp (Moreau Lake State Park). The site is approximately 30 feet from the south shore and, during 1990, the depth was between 26 and 36 feet depending on pond level fluctuation. The substrate consisted of muck and silt with boulders and rocks along the bank.

Station GF-1 - Below Sherman Island Powerplant - River Mile 210.5, Hudson River (Figure 7)

This station is located approximately 1/10 mile downstream of the hydro plant (20.0 feet from the north shoreline). Water depth at the site during 1990 varied between 6.0 and 10.0 feet, substrate consisted of sand and silt mixed with aquatic vegetation.

Station GF-2 - Downstream at Rt I-87 Bridge - River Mile 206.3, Hudson River (Figure 7)

This station is approximately 1/3 mile downstream of the Moreau boat ramp (downstream side of lodging crib). Water depth at the site during 1990 varied from 9.0 to 12.0 feet. Bottom substrate consisted of sand, gravel and slate.

Station GF-3 - Upstream of Feeder Dam - River Mile 203.5, Hudson River (Figure 7)

This station is located directly upstream of the Feeder Dam Canal (approximately 10.0 feet from the north shoreline). Water depth at the site varied between 3.0 and 6.0 feet. Bottom substrate consisted of muck and silt mixed with aquatic vegetation.

Station GF-4 - Above Bakers Falls - River Mile 197.5, Hudson River (Figure 7)

This station was originally located adjacent to Portland Cement Company (approximately 10.0 feet from the north shoreline). Water depth varied between 3.0 and 5.0 feet. The station was relocated on June 28, 1990 to the Chase Bag Pumphouse Boat Ramp (approximately 6.0 feet from shore). Water depth at this site varied between 3.0 and 6.0 feet. Bottom substrate consisted of sand and slate.

Station C-2 - West shore of Hudson River, below Bakers Falls River Mile 196.7, (Figure 8)

This station is positioned off the southeast side of the first island below Bakers Falls (Fenimore Bridge). The island is approximately 15 feet from the west shoreline and was vegetated primarily by grasses and shrubs. The water depth at the site during 1990 was between 1.0 and 4.0 feet. Bottom substrate consisted of bedrock, sand and slate.

Station E-0 - Island - River Mile 196.2, Hudson River (Figure 8)

This station is located at the southeast tip of the island just above the power line crossing. Water depth at the site during 1990 was between 1.5 and 5.0 feet. Substrate consisted of bedrock, sand, slate, and woodchips.

Station E-1 - South of Remnant Area 2 - River Mile 195.7, Hudson River (Figure 8)

This station is on the west side of the river, approximately 10 feet from the shore. The substrate consisted of sand and gravel, and depth was between 1.5 and 5.0 feet.

Station E-2 - South of Remnant Area 3 - River Mile 195.2, Hudson River (Figure 8)

This station is located on the east side of the river approximately 12 feet from the shore below the timber crib where the depth was between 2.0 and 6.0 feet. Bottom substrate consisted of sand, gravel, and bedrock/slate.

Station E-3 - Above Remnant Area 4 - River Mile 195.2, Hudson River (Figure 8)

This station is located on the west side of the river approximately 10 feet from the shore. Station E-3 is directly opposite Station E-2. Water depth was between 1.0 and 4.0 feet, and the substrate consisted of sand and gravel.

Station E-4 - Below Remnant Area 4 - River Mile 194.9, Hudson River (Figure 8)

This station is on the west side of the river approximately 25 feet from shore. The depth of water at the station was between 3.0 and 6.0 feet. The substrate consisted of sand and gravel intermixed with aquatic vegetation.

Station E-5 - Below Remnant Area 5 - River Mile 194.3, Hudson River (Figure 8)

This station is located downstream of the New York State Highway Route 197 bridge (east pilar) approximately 15 feet from the shore. The water depth was between 5.0 and 9.0 feet. The substrate consisted of slate, silt, sand, and gravel intermixed with aquatic vegetation.

Station E-5A - Below Rogers Island - Channel Marker #219 - River Mile 193.5, Hudson River (Figure 8)

This station was originally located directly below Lock #7 on the east side of the river. Water depth was between 4.0 and 8.0 feet, and substrate consisted of sand. Due to vandalism, the station was relocated 1/4 river mile downstream to Channel Marker #219 on July 5, 1990. The depth of water at the station was between 15.0 and 21.0 feet, the substrate consisted of gravel and bedrock/slate.

Station E-6 - Below Ft. Miller Dam and Lock No. 6 - River Mile 185.7, Hudson River (north of Schuylerville) (Figure 7)

This station is located at river channel marker 175. Water depth at the site was between 12 and 18 feet. Bottom substrate consisted of sand, silt, and gravel with aquatic vegetation present on both shorelines.

Station E-7 - Channel Marker 13 (near Waterford) - River Mile 157.8, Hudson River (Figure 7)

This station is located approximately 1.5 miles north of a NYDEC boat ramp at the Erie Canal and Hudson River confluence. Water depth was between 12 and 21 feet. The substrate consisted of silt, sand, and gravel.

Station MR-1 - Upstream of Crescent Dam - approx. 4.5 miles from Hudson River, Mohawk River (Figure 7)

This station is located approximately 1/10 mile upstream of Crescent Dam (25 feet from the south shore line) adjacent to the Town of Colonie Landfill. Water depth at

the site was between 3.0 and 6.0 feet. Bottom substrate consisted of sand, silt, organic matter and aquatic vegetation.

Station HR-1 - Below Troy Dam - River Mile 152.8, Hudson River (Figure 7)

This station is located at the west pilar of the Green Island Bridge approximately 1/4 mile downstream of the Center Island boat ramp. Water depth was between 20.0 and 30.0 feet. Substrate consisted of sand, gravel and slate.

2.3.4 Monitoring Components

The PCB concentrations of the following components of the affected aquatic environment were monitored:

- Sediment
- Water
- Aquatic biota

The frequency and locations of sampling are different for each of these parameters. PCB concentrations will fluctuate more rapidly in some components (for example, water) than in others (e.g., sediments). The monitoring program was designed accordingly so as to evaluate the temporal changes in PCB concentrations in these components. The stations and nominal sampling frequencies for each of these parameters are provided in Table 2.

2.3.5 Materials and Methods

Sediments

To characterize temporal changes in sediment PCB concentrations, visually located surface grab samples were taken at quarterly (seasonal) intervals. In the 1990 preconstruction

survey, only the spring season (May) was sampled. Multiple (two to four) surface grab samples were taken at each monitoring station with a six-inch petite ponar dredge (Figure 9) and placed into hexane-washed 1L bottles having Teflon-lined lids. Substrate conditions at some stations limited the number of sediment samples obtained. In addition to the PCB content of the samples (quantified as Aroclors), the particle size distribution, total organic carbon (TOC), total solids (TS) and total volatile solids (TVS) content of the samples were determined if sufficient sample remained after analysis for PCBs.

Sediment sampling locations upstream of the Ft. Edward remnant areas are shown on Figures 10 and 11. Figures 12 through 17 show the sediment sample locations at stations located between the Ft. Edward remnant areas and the Troy Dam (Waterford). Collection depths varied between 3 and 30 feet below the water surface.

Water

PCB concentrations were determined in weekly grab samples at all stations. Raw water samples were collected at mid-depth using a Kemmerer water bottle having a stainless steel cylinder and teflon seals at all Stations except GF-4, GF-3, C-2, E-0 and E-1. Due to shallow depths at those stations, grab samples were taken using hexane-rinsed 1L glass jars. All samples were placed in 1L hexane-rinsed glass jars having teflon-lined lids for PCB analyses and in clean 0.5L jars having wax-lined lids for total suspended solids analysis. The samples were chilled in an ice-filled cooler upon collection, then refrigerated and sent to the analytical laboratory within five days of collection.

Dialysis Membrane Bags. Because waterborne PCB concentrations during the 1989 program were below analytical detection limits the water samples were supplemented with solvent-filled dialysis membrane bag monitors (Figure 18). Two dialysis bags (each filled with 4ml of hexane) were suspended at mid-depth at all stations in brass cages so as to have a representative exposure to the water column (Figure 19). The bags from each station were

collected on a biweekly basis, stored in 0.5L hexane-washed jars, and chilled in an ice-filled cooler upon collection.

Aquatic Biota. The major biotic components (periphyton, macroinvertebrates and fish) were monitored. Each of these components represents a trophic level in the aquatic ecosystem. The following aquatic biota sampling programs were conducted:

- Multiplate (Hester-Dendy) composited sampling (replicated) for periphyton, silt and some macroinvertebrate species at all stations (Figure 20). The multiplate samplers were suspended at mid-depth to provide representative exposures in the water column (Figure 19). Exposure periods were nominally five weeks in duration. Samples were obtained by scraping five plates separated by 3mm spacing and five plates separated by 6mm spacing, producing a total of two samples per sampling apparatus. (However, in some cases, composite samples were used to produce an adequate sample size volume of material.) The multiplate sampling procedure followed the methods of Simpson, et al (1986). Multiplate samples were packed in ice and shipped to the laboratory in hexane-rinsed jars.

- Caddisfly larvae samples were obtained in riffle areas above and below the remnant deposit reach (Stations GF-4, C-2, E-5, and E-6). Caddisfly larvae were hand collected (using forceps) from individual rocks located in the respective riffle areas. The samples were placed in hexane-rinsed jars, placed on ice and frozen before shipment to the analytical laboratory.

- Fathead minnow in situ assay monitoring was conducted at six stations (C-1, GF-4, C-2, E-5, E-6 and E-7) using the methodology of Jones and Sloan (1989). Approximately 50 fathead minnows were placed in bioassay containers (Figure 21) and suspended mid-depth in the station water column for a nominal exposure

period of three weeks. Upon removal, the minnows were placed in aluminum foil, stored in plastic bags, and frozen prior to shipment to the laboratory.

2.3.6 Additional Environmental Measurements

The following environmental parameters were measured (or obtained) in association with the aquatic monitoring programs:

- River discharge (cfs at Ft. Edward USGS gage)
- Air and water temperature (°C)
- Dissolved oxygen (mg/L)
- pH (standard units)
- Conductivity (μmhos/cm)

Field measurements of pH, dissolved oxygen, temperature, and conductivity were obtained using portable meters. Dissolved oxygen and temperature were measured using a Yellow Springs Instruments Model 54 dissolved oxygen meter; conductivity was measured using a Yellow Springs Instruments Model 33 S-C-T meter; and pH was measured with an Orion Model 407 pH meter. Calibration of the meters was in accordance with the manufacturer's instructions. Field measurements were obtained every week at each station.

2.3.7 Laboratory Methods

The laboratory analyses of aquatic samples were performed by Hazleton Laboratories America, Inc. (Madison, WI). All of the PCB analyses performed by Hazleton utilized packed column gas chromatography methods capable of identifying PCBs as the commercial Aroclor mixtures. Hazleton also performed the total suspended solids (TSS) analyses on water, and the particle size, total solids (TS), total organic carbon (TOC) and total volatile solids (TVS) analyses on sediments. Full details of the analytical procedures used by

Hazleton are found in the Quality Assurance Project Plan (QAPP) appended to the 1989 monitoring program (Harza/Yates & Auberle 1989b).

Method limits of detection are listed below:

Matrix	Detection Limit	Assumptions
Water	0.10 μg/L	1 L sample
Dialysis bags	0.10 μg/L	
Sediment	50 μg/kg	20 g initial sample
Tissue	50 μg/kg	20 g initial sample

Results of sediment analyses were expressed on a dry weight (μg/g) basis. (The wet weights of the sediments prior to drying are available should wet weight results be desired.) All tissue analysis results are also reported on a dry weight (μg/g) basis. However, because many of the existing analyses of tissues from the project vicinity are expressed on a wet weight basis, the wet weight of the tissues prior to drying are available so that calculation of results on that basis can be conducted.

2.3.8 QA/QC

2.3.8.1 Field Study. Aquatic sample chain of custody (COC) forms were completed by the field crew immediately after sample collection, and were shipped to the analytical laboratories with the samples. The COC forms documented sample shipping and holding times, as well as the personnel involved in collection, handling and analysis of the samples.

Instrument logbooks were maintained with each piece of equipment to document calibrations and maintenance records.

Biological samples were collected using the appropriate procedures for the biota in question (scraping of rocks, or Hester-Dendy multiplate sampler for both periphyton and benthic macroinvertebrates). A sample was retained for taxonomic analysis, while the composited portion for chemical analysis was placed in hexane-washed sample bottles, which were placed in ice chests containing water ice and shipped to the laboratory following the shipment and COC procedures detailed earlier.

For all environmental matrices, 10% field duplicate samples were collected and submitted for chemical analyses.

2.8.3.2 Laboratory. The quality assurance procedures for the laboratory analyses are found in the Quality Assurance Project Plan (QAPP) document (Harza/Yates & Auberle 1989b) prepared prior to the start of the 1989 field program. All chemical analyses of aquatic samples were performed by a NYSDEC certified analytical laboratory. The analytical chemistry procedures utilized by the laboratory are documented in the QAPP. Detection limits in the QAPP were those listed on the Federal Target Compound List (TCL) (0.5 μg/L for water, 0.08 mg/kg for sediment). No TCL detection limits are available for biological tissue; however, a detection limit in this program was approximately 50 μg/kg wet weight for tissues.

2.3.9 Results and Discussion

2.3.9.1 Sediment. A total of 40 sediment samples was collected during 1990 from 16 of the 17 aquatic monitoring stations prior to the start of construction activities at the remnant areas. Sediment PCB concentrations throughout this report are expressed as μg/g dry weight. Particle size distributions were performed on dry sediment. The particle size distribution curves for each sample are found in Appendix 5. Total organic carbon and total volatile solids are expressed as weight percent of the dried sediment. (Total solids is the weight percent of solid material in the wet sediment after the water was evaporated.) The

particle size, TOC, TS and TVS content of the samples are listed in Table 1 of Appendix 2. The Aroclor 1242 and Aroclor 1254 concentrations in sediments collected during preconstruction monitoring are summarized in Tables 3 and 4, respectively. Aroclor 1242 was found in 27 of the 40 preconstruction samples; Aroclor 1254, in 31. The highest PCB concentrations (40.0 μg/g Aroclor 1242; 6.4 μg/g Aroclor 1254) were collected from Stations E-5 and E-5A (Tables 3,4 and Figure 22). Results of the individual stations are described below.

Station C-1

Three samples were collected at C-1 on May 14th. None of the samples contained detectable Aroclor 1242. One sample contained Aroclor 1254 at the low concentration of 0.054 μg/g.

Station GF-1

Three samples were collected from Station GF-1 on May 16th. Two of the samples contained both detectable Aroclor 1242 and Aroclor 1254. The highest concentrations found were from the same sample, which contained 0.22 μg/g Aroclor 1242 and 0.15 μg/g Aroclor 1254. The mean composition of samples during preconstruction monitoring was 59.9% Aroclor 1242 and 40.1% Aroclor 1254.

Station GF-2

Two samples were collected from GF-2 on May 16th. Aroclor 1242 was not found in either sample. Aroclor 1254 was found in both samples, with the maximum concentration being 0.076 μg/g.

Station GF-3

Four preconstruction monitoring sediment samples were collected at Station GF-3. Only one sample contained detectable PCB. This sample contained only Aroclor 1242 at the concentration of 0.100 μg/g.

Station GF-4

No sediment samples were collected at Station GF-4 during preconstruction monitoring.

Station C-2

Two samples were collected at Station C-2 during preconstruction monitoring, with considerably different concentrations of PCB. One sample, which contained 19.5% gravel (the second highest gravel content in all sediment samples collected during 1990, Table 1, Appendix 2) contained only 0.19 μg/g Aroclor 1242. The other preconstruction monitoring sample, which consisted of 95.1% sand, contained 7.60 μg/g Aroclor 1242. No Aroclor 1254 was detected in either preconstruction monitoring sample.

Station E-0

Only one sediment sample was collected at Station E-0 during preconstruction monitoring. This sample contained 3.90 μg/g Aroclor 1242 and 0.38 μg/g Aroclor 1254.

Station E-1

Two samples were collected at Station E-1 on June 13th. These two samples illustrate both the patchy nature of PCB concentrations in the sediments of the upper Hudson River and

the difficulty in correlating PCB content, particle size, and physical and chemical parameters of the sediment.

One sample contained 7.60 μg/g Aroclor 1242 and 1.8 μg/g Aroclor 1254. This was despite the sample containing the third highest gravel content (16.8%) in all samples collected during 1990. This sample did contain 7.3% silt, compared to the 0.8% silt content of the other sample collected at Station E-1 during preconstruction monitoring.

The second sample contained 0.87 μg/g Aroclor 1242 and 0.26 μg/g Aroclor 1254. It consisted of 95.5% sand, with little gravel, silt and clay. The TOC, TS and TVS composition of the two preconstruction monitoring samples from Station E-1 were very similar (Table 1, Appendix 2).

The mean composition of the two preconstruction samples was 78.9% Aroclor 1242 and 21.1% Aroclor 1254.

Station E-2

Only one preconstruction monitoring sample was collected at Station E-2 in 1990. This sample contained 9.30 μg/g Aroclor 1242 and 1.40 μg/g Aroclor 1254.

Station E-3

The single preconstruction monitoring sample from Station E-3 contained the lowest PCB concentrations of the stations in the immediate vicinity of the remnant areas (Figure 22). The sample contained 0.77 μg/g Aroclor 1242 and 0.23 μg/g Aroclor 1254.

Station E-4

Three samples were collected from Station E-4 during preconstruction monitoring on June 13th. All three samples contained both detectable Aroclor 1242 and Aroclor 1254. The highest PCB concentration in a sediment sample collected at Station E-4 in 1990 was found in a preconstruction sample containing 18.00 μg/g Aroclor 1242 and 3.40 μg/g Aroclor 1254.

The proportions of Aroclor 1242 and 1254 were very consistent in the three preconstruction monitoring samples. The mean sample composition was 85.3% Aroclor 1242 and 14.7% Aroclor 1254.

Station E-5

Station E-5 had the highest mean PCB concentration (23.65 μg/g total PCB) in sediments of the stations sampled during the 1990 preconstruction period (Figure 22, Tables 3 and 4). It should be noted that the mean values in Tables 3 and 4 are based on only two samples, having widely divergent PCB concentrations.

One sample, consisting of nearly 50% silt and clay and 50% sand, contained only 0.99 μg/g Aroclor 1242 and 0.16 μg/g Aroclor 1254. The second sample, consisting of 88% sand and 9% silt, contained 40.00 μg/g Aroclor 1242 and 6.10 μg/g Aroclor 1254. The TOC and TS content of the two samples was very similar; however, the TVS of the sample with the higher PCB concentration was nearly twice that of the other sample.

The Aroclor composition of the two samples was similar. Aroclor 1242 averaged 86.4% of the total PCB, with Aroclor 1254 accounting for the remaining 13.6%.

Station E-5A

Three sediment samples were collected during the 1990 preconstruction monitoring; all three contained both Aroclor 1242 and Aroclor 1254. The mean Aroclor 1242 concentration was 17.8 μg/g, while the mean Aroclor 1254 concentration was 2.79 μg/g. Station E-5A had the second highest mean total PCB content during the 1990 preconstruction monitoring period (Figure 22). The highest sediment PCB concentration at E-5A during 1990 was found in a preconstruction monitoring sample containing 40.0 μg/g Aroclor 1242 and 6.40 μg/g Aroclor 1254.

The Aroclor composition of the three samples were similar, averaging 86.9% Aroclor 1242 and 13.1% Aroclor 1254. The sample containing the highest PCB concentration (46.4 μg/g total PCB) also contained the highest TVS, TOC, and lowest TS concentrations collected at Station E-5A during 1990.

Station E-6

Four preconstruction monitoring samples were collected at Station E-6. The samples all contained both Aroclors 1242 and 1254. The mean Aroclor 1242 concentration was 7.18 μg/g, while the mean Aroclor 1254 concentration was 1.52 μg/g. The highest PCB concentration found was 12.0 μg/g Aroclor 1242 and 2.30 μg/g Aroclor 1254.

The proportions of Aroclors 1242 and 1254 were similar to those found at stations in the vicinity of the remnant areas. Aroclor 1242 accounted for an average of 84.4% of the total PCB, while Aroclor 1254 accounted for 15.6% of the total PCB.

Station E-7

Three samples were collected at Station E-7 during the 1990 preconstruction monitoring period. The total PCB concentration in each of the samples was very similar, being between 1.21 μg/g and 1.69 μg/g. The mean Aroclor 1242 composition of the samples was 79.7%, while the mean Aroclor 1254 composition was 20.3%.

Station HR-1

Two samples, containing 1.69 μg/g and 0.90 μg/g total PCB, respectively, were collected at Station HR-1 during the 1990 preconstruction monitoring period. The mean Aroclor composition of the samples was 85.5% Aroclor 1242 and 14.5% Aroclor 1254.

Station MR-1

Station MR-1 is one of two stations at which only Aroclor 1254 was detected in sediment samples during 1990 (Station GF-2 is the other). All (four) preconstruction sediment samples collected at this station contained detectable Aroclor 1254, with concentrations between 0.066 μg/g and 0.130 μg/g that averaged 0.096 μg/g.

2.3.9.2 Water.

2.3.9.2.1 Water Grab Samples. Results of the 1990 preconstruction water monitoring for PCBs at the 17 aquatic stations (Figure 7) are presented in Tables 5 and 6. Of a total 233 water samples collected between March 29 and June 30, 1990, 19 (8.2%) contained PCB above the laboratory detection limit of 0.1 μg/L. Aroclor 1242 was the only Aroclor detected. The maximum observed PCB concentration was 0.49 μg/L, found in two samples; one collected at Station E5 on March 29th, the other collected from Station E4 on April 27th.

Because only Aroclor 1242 was detected, Table 5 also lists the station and respective number of samples containing detectable PCBs during the sampling period. Of the 19 samples with detectable PCBs, 14 were from stations in the vicinity of the Remnant Sites; most (10) from Stations E-4, E-5 and E-5A. These three stations are located within approximately one mile of each other (Figure 23) between the downstream end of Remnant Site 4 and the southern end of Rogers Island.

Two samples with detectable PCBs were collected upstream of the General Electric facility in Hudson Falls. These samples, taken at Stations GF-2 (0.33 μg/L Aroclor 1242) and GF-3 (0.15 μg/L Aroclor 1242) (Figures 31 and 32) were collected on consecutive days, April 25th and 26th (Table 2, Appendix 2). The presence of detectable PCBs upstream of the General Electric plants indicates a PCB source to the Hudson River upstream of Bakers Falls.

Three samples with detectable PCBs were collected from the river reach downstream of Bakers Falls and upstream of the Remnant Sites. Samples from Station C-2 (Figure 33) contained 0.12 μg/L Aroclor 1242 on April 10th, and 0.23 μg/L Aroclor 1242 on April 25th. A sample collected on June 26th from Station E-0 contained 0.20 μg/L Aroclor 1242.

One sample collected at Station E-7, Waterford, had detectable PCBs during the preconstruction monitoring. This sample, collected on April 26th, had an Aroclor 1242 concentration of 0.38 μg/L.

Discharge data for the Hudson River at Ft. Edward and from the Hudson River-Black River Regulating District through June 30, 1990, available from the U.S. Geological Survey (USGS), was used to determine if there is a relationship between the detected PCB concentrations in water and river discharge (Figures 24 and 25). Although most of the samples with measurable PCBs were found in three temporal clusters, there was not a discernable relationship between discharge and waterborne PCB during the study period.

Figures 26 through 40 illustrate the relationship between PCB in water and Hudson River discharge at Ft. Edward for each of the aquatic stations at which PCBs were detected during the 1990 preconstruction monitoring. Figures 41 through 50 illustrate the relationship between waterborne PCBs at these stations and precipitation at Glens Falls. Contrary to expectations based on historical data, it is clear from these figures that, for most periods of high discharge, as well as for large precipitation events during the spring of 1990, a concurrent increase in waterborne PCB did not occur.

These observations are confirmed by statistical analysis. During the 1990 preconstruction monitoring period, a statistically significant correlation did not exist between Aroclor 1242 concentrations in water and discharge at Ft. Edward ($r = -0.265$, $P = 0.258$), nor between Aroclor 1242 levels and precipitation at Glens Falls ($r = -0.124$, $P = 0.603$).

Of the 19 grab samples with detectable PCBs collected during the 1990 preconstruction monitoring period (Table 5), 16 were collected during one of three temporal clusters. Five samples with detectable PCBs were collected on March 29th, the first sampling effort of 1990. Seven samples with detectable PCBs were collected between April 20-27th, while four detectable PCB samples were collected between May 18-24th.

During the first temporal cluster, on March 29th, discharge at Ft. Edward was 9560 cubic feet per second (cfs), which was a low point between two flow events with discharge greater than 20,000 cfs. The highest 1990 discharge in the river prior to March 29th was 22,600 cfs, recorded on March 18th. Except for trace amounts, significant precipitation did not occur at the site for eight days prior to March 29th.

Similarly, the water samples with detectable PCBs collected between April 20-27th also were taken during a relatively low flow period between two high flow events (Figure 51). Precipitation was recorded at Glens Falls on four days during this period, with a maximum of 0.67 inches on April 21st.

In contrast to the first two clusters, the cluster of four samples with detectable PCBs between May 18-24th was collected during the period of greatest river discharge during 1990 (Figure 51). Discharge at Ft. Edward during this period was between 19,700 and 26,500 cfs, while precipitation occurred on all but three days between May 4-24th (Table 3, Appendix 2).

Special Samples. Two special samples (samples collected at locations not part of the normal monitoring program) were collected on April 25th from a small (1 to 2-ft wide) stream coming from the cliffs abutting Remnant Site 4. The stream contained a beaver dam (which eventually was removed during the early phases of activities on the site). One sample (Harza ID Number 1985, Table 2, Appendix 2) was collected immediately upstream of the beaver dam, while the second sample (Harza ID Number 1986) was collected downstream of the beaver dam near the Hudson River. The sample taken from the beaver dam pond contained no detectable PCBs, whereas the sample downstream of the dam contained 0.62 μg/L Aroclor 1242.

Five samples, denoted as E5CANAL in Table 2, Appendix 2 were collected on four dates (the fifth sample was a field duplicate) from the backchannel of the Hudson River on the eastern side of Rogers Island at Ft. Edward (Figure 8). The sampling location is adjacent to the sewage treatment facility on Rogers Island. Detectable levels of Aroclor 1242 were found on two of the four dates sampled: March 29th (0.49 μg/L), and on May 22nd (0.19 μg/L in one of the field duplicate samples).

2.3.9.2.2 Dialysis Membrane Bags. Although a total of 65 sets (130 dialysis membrane bags) were deployed during the 1990 preconstruction period, only 53 sets (yielding 97 samples) were retrieved. Of the 12 sets not retrieved, four were vandalized, four were lost due to high flows and four were lost due to leakage. The results of these 97 samples are compiled with the results of all the 1990 samples in Table 4, Appendix 2.

Of the 97 dialysis bag samples analyzed, only five contained detectable levels of PCB (two from Station E-6 and three from Station E-7). Only Aroclor 1242 was found in the samples. The samples from Station E-6 and two of the three samples from Station E-7 were retrieved on June 29th, following an 18-day exposure; each sample contained 0.20 μg/L Aroclor 1242. The remaining sample from Station E-7 having detectable PCBs (Harza ID Number 2047) contained 0.50 μg/L Aroclor 1242 and was retrieved on May 9th following a 238-day exposure. This sample was set at Station E-7 on September 12, 1989, and was reported lost by Harza/Yates & Auberle (1990a).

2.3.9.2.3 Physical Water Quality Parameters. The weekly monitoring results for temperature, dissolved oxygen, pH, conductivity and depth at the aquatic stations during the 1990 preconstruction period are presented in Table 5 of Appendix 2. Total suspended solids (TSS) data are given in Table 2 of Appendix 2. The Hudson River in the vicinity of Ft. Edward during this period had low conductivity, with high levels of dissolved oxygen. The TSS levels in the upper Hudson were also low, generally being less than 10 mg/L. The pH of the river varied from slightly acidic to somewhat alkaline.

The Mohawk River at Station MR-1 was considerably more turbid than the upper Hudson, as shown by the elevated TSS levels. Station HR-1, on the Hudson River below the confluence of the Mohawk and upper Hudson, usually had water quality conditions intermediate between those found in the Mohawk and upper Hudson.

2.3.9.3 Aquatic Biota

2.3.9.3.1 Hester-Dendy Multiplate Samples. One set of Hester-Dendy multiplate samplers (a total of 37 samples) were recovered at each station during the 1990 preconstruction monitoring period. The results of these samples are included in the compilation of results given in Table 6 in Appendix 2. One of the samplers recovered during 1990 (Harza ID Number 2048) at Station E-7 (Waterford) was originally set on September 12, 1989. This

sampler was reported as lost by Harza/Yates & Auberle (1990a). It was recovered on May 9, 1990, after a 238-day exposure, and had an Aroclor 1242 concentration of 1.4 μg/g, with no other Aroclors detected. Samplers set during the 1990 preconstruction monitoring period, but recovered after July 1, 1990 (the beginning of the 1990 construction monitoring period), are discussed in the Construction Monitoring Program portion of this report.

Total PCB concentrations during the 1990 preconstruction monitoring period varied from non-detectable (at Stations C-1, GF-1, GF-2 and GF-3) to 16.2 mg/kg (at Station E-5A). Aroclor 1242 accounted for most (75.7% to 100%) of the total PCB concentration at all Hudson River stations. However, at Station MR-1 (the Mohawk River) only Aroclor 1254 (0.11 mg/kg and 0.12 mg/kg) was found.

2.3.9.3.2 Caddisflies. No caddisfly larvae were collected during the 1990 preconstruction monitoring period.

2.3.9.3.3 Caged Fish. All fathead minnow in-situ samples were recovered after the beginning of the 1990 construction monitoring period and are, therefore, discussed in the Construction Monitoring Program portion of this report.

2.3.9.4 QA/QC. The results of the QA/QC procedures for the 1990 preconstruction monitoring period are given in Appendix 3.

3.0 CONSTRUCTION MONITORING PROGRAM

3.1 Monitoring Strategy

Although the containment construction activities on the Ft. Edward Dam PCB Remnant Sites were performed in such a way as to minimize the short-term impacts to other media, they had the potential to release PCBs to the river and the atmosphere. Such releases (if any) were expected to be first detected in the immediate vicinity of the Sites. To assess these potential impacts, emphasis in the Construction Monitoring Program was placed on determining changes in PCB levels in the air and water adjacent to the construction area(s). To evaluate changes in PCB levels beyond the immediate remnant area construction activities, sediments, water and aquatic biota at the 1990 preconstruction program monitoring sites continued to be sampled.

The 1990 Construction Monitoring Program was thus designed to be a supplement to the 1990 Preconstruction Monitoring Program, which continued in full operation. Monitoring sites in addition to those in the preconstruction program were in the vicinity of the Remnant Sites and the reach of river downstream to the Thompson Island Pool (Figure 52+60). The sampling frequency at the stations adjacent to the Sites was conducted on an intensified schedule concomitant with construction activities. The Construction Monitoring Program was conducted in accordance with the Plan of Study described in Harza/Yates & Auberle (1990d). However, because construction activities on the Remnant Sites continued through December, the sampling procedures and schedule had to be modified for winter conditions. The modifications, described in Harza/Yates & Auberle (1990e), were principally a reduction in the number of aquatic stations due to a lack of access caused by ice conditions.

3.2 Air Quality Monitoring

3.2.1 Study Area

The study area for the Construction Monitoring Program included the area immediately adjacent to the Remnant Sites and the Fort Edward residential vicinity described in the preceding section on preconstruction monitoring. Although the residential areas continued to be monitored to assess increases in airborne PCBs over preconstruction levels, the prime focus of the construction monitoring was on the remnant sites undergoing. Because the principal goal of the site monitoring was the quantification of airborne PCB and metals (lead and cadmium) potentially released by construction activities, the area under study changed so as to monitor those activities.

3.2.2 Station Locations

Two independent sampling networks were operated during the 1990 construction monitoring period. The network of four fixed-location sampling stations, A1, A2, A3, and A5 (shown in Figure 53) continued to operate during this time. In addition, a second sampling network, consisting of Stations B2A, B3A, B4A, B4B and B5A, and designated "the construction monitoring network" was activated. The location, start dates and sampling frequencies of the construction air quality stations are listed below.

1990 Construction Monitoring Air Sampling Station Locations, Start Dates and Frequencies

Site Designation	Location	Sampling Start Date	Sampling Frequency
A1	Bakers Falls	5/11/90	Every 3 Days
A2	May Street	3/30/90	Every 3 Days
A3	McCrea Street	5/11/90	Every 3 Days
A5	Cary Road	3/30/90	Every 3 Days
B2A	Remnant Site 2	9/10/90	Daily
B3A	Remnant Site 3	7/31/90	Daily
B4A	Remnant Site 4	9/18/90	Daily
B4B	Remnant Site 4	9/26/90	Daily
B5A	Remnant Site 5	7/16/90	Daily

With the exception of the construction monitoring station (B5A) adjacent to Remnant Site 5 (formerly designated as Station A4 in the fixed-location sampling network), the construction monitoring samplers were mobile, self-powered units. The purpose of this sampling network was to maintain at least one sampler at each Remnant Site in close proximity to the actual construction activity. Samplers were initially placed adjacent to the Remnant Site and then moved onto the Site when initial sanding was partially completed. Figures 54 and 55 show where the samplers were located on each Site.

3.2.3 Materials and Methods

The materials and methods for the fixed-location air monitoring stations are the same as those given in the preconstruction portion of this report. The materials and methods for the construction monitoring network stations differed from the fixed-location stations in that

sample times were designed to match the construction schedule and additional parameters (metals) were measured.

The construction monitoring network samplers were modified to permit measurement of airborne lead and cadmium. This modification consisted of the addition of a sample line from the vacuum system (Figure 56) to a metals sampling train. Figure 57 illustrates the metals sampling train mounted on a mobil air sampler. The metals sampling line had its own critical orifice to control flow. The sample train consisted of a 37mm filter canister pre-loaded with a 0.8 micrometer Mixed Cellulose Esters (MCE) filter. The filter canister was operated with the upstream plastic face removed to provide a more uniform velocity through the filtration area.

Sampling time and schedules for the construction monitoring samplers were set to match construction activities. At least one sampler operated on each Remnant Site during each day of construction activity. The sample time for that day was designed to match the length of the construction day. When construction was conducted for a single shift, the air sampler operated from eight to twelve hours. When construction activity switched to two, 10-hour shifts, the construction monitoring station operated 16 to 24 hours per day.

Because the initial sampling results for metals showed that all samples were below detection limits (5.0 μg for lead; 0.2 μg for cadmium), lead and cadmium sampling was discontinued at each Remnant Site when the initial sand layer had been installed.

3.2.4 Meteorology

Meteorological information was prepared for the 1990 Construction Monitoring Program. This information is in Appendix 4. There is one wind rose for each day that a sampler was in operation.

3.2.5 Laboratory Methods

The laboratory methods for PCB analysis were the same as those described in the preconstruction portion of this report. Lead and cadmium samples were analyzed by Hudson Environmental Services (a New York State Department of Health certified laboratory) using NIOSH Methods 7048 and 7082.

3.2.6 QA/QC

The QA/QC procedures identified in the preconstruction portion of this report were followed with minor changes for the construction phase. During preconstruction, all collocated samples were analyzed even though the QA/QC procedures only required one analysis per sample day. The additional collocated samples were analyzed to obtain more data points due to the shortened sampling season. For construction monitoring, only one collocated sample was analyzed for each sample event, as specified in the QA/QC procedures.

A collocated sample and field blank were obtained for each sample day for both the fixed-location stations and the construction stations. Separate collocated samples and field blanks were required because the sample times were different.

For the construction monitoring network stations, a minimum sample time was for quality control purposes. These stations used gasoline-powered generators for their electrical supply. Because of mechanical problems, the generators would sporadically shut off prior to completion of the desired sample time. To insure that the sample was representative, a four-hour sample was used as a minimum sampling time criterion.

3.2.7 Results and Discussion

3.2.7.1 Air Quality. Appendix 1, Table 2 presents the air sampling results for the 1990 construction monitoring period. The results indicate that the sampling system preferentially trapped PCBs in the front half of the first florisil tube. Eighty-two percent of the detected PCB concentrations were found in the front half of the first tube. Only two percent of the detectable PCB concentrations were found in the filter. This finding differs from the results expected at the beginning of the program. It was thought that the majority of the airborne PCBs would be in particulate form, resulting from the mechanical attrition of soil particles having PCB adhered on them. The results expressed in Table 2 of Appendix 1 indicate that either the PCB existed almost entirely in vapor form or that the sampling train stripped PCB collected on the filter. This stripping could result by vaporization of the PCB held on the filter by the sample air. It is not known if this phenomenon occurred.

Table 2 in Appendix 1 also indicates that there were no detectable levels of PCB in the back half of the second tube. This result implies that no breakthrough occurred within the sampling train. Only 5.9% of the detectable PCB hits were found in the front half of the second tube.

Table 7 shows PCB concentrations for samples exhibiting detectable levels, by sample location, as well as the construction activity(s) occurring at the site for the sample day. Detectable concentrations of PCB were found in 110 of 759 (14.5%) samples. The highest single concentration was 2.77 $\mu g/m^3$ and occurred at Site 3 on September 6, 1990. The average PCB concentration was 0.5 $\mu g/m^3$.

With one exception, Aroclor 1242 was found in all air samples having detectable PCB levels. One sample, collected at fixed-location air monitoring Station A2 on October 5, 1990, contained Aroclor 1254 in the filter portion of the sample train. No other Aroclors were found in this sample.

Two samples with detectable PCBs listed in Table 7 were rejected using stricter rejection criteria than discussed in the QAPP document. One sample did not have the minimum 4-hour sampling period and was rejected for insufficient sample time. The other sample was rejected because the final flow rate had decreased from the initial flow rate by 73%. Although the final flow rate was measurable, the sample was rejected for excessive flow rate variance. The stricter rejection criteria were employed because samples such as these are not considered to accurately represent the airborne PCB concentration.

Based on the data in Table 7, Figure 58 illustrates, for each site, the number of samples having detectable concentrations vs. the total number of samples taken. At Site 3, 48% of the total samples taken had detectable levels of PCB. At Site 5, 22% of the samples taken had a detectable PCB level. Sites 2 and 4 had very low numbers of detectable PCB samples. As seen in Figure 58, the majority of samples having detectable PCBs were taken from samplers operating on the east side of the Hudson River.

The relationship between PCB concentration and construction activity is shown in Figure 59. Construction activity was separated into five categories: clearing, regrading, subgrading, Claymax placement, and topsoil placement. Clearing represents the initial clearing of brush from the site. Regrading defines the period when the natural contour of the site was levelled by graders and bulldozers. Subgrading refers to the placing of the initial sand layer. Claymax placement covers the time that this liner was placed on the site. Topsoil placement indicates the spreading of topsoil at the site. If no activity was occurring at the site, the inactive designation was used.

For many of the sample days, more than one construction activity occurred at a site. Therefore, a given detectable PCB sample may be counted under more than one construction activity. Figure 59 shows that the majority of samples having detectable PCBs occurred during the placing of the subgrade. This activity involved numerous heavy construction vehicles moving over the exposed soil. To a lesser extent, on Site 3, the clearing operation

also resulted in a sizeable number of detectable PCB concentrations. The figure also shows that, at Site 5, six samples were found to have detectable PCB levels when there was no construction activity at the Site.

The sampling for lead and cadmium yielded no detectable levels for either metal. As previously noted, the limit of detection for lead was 5.0 μg and for cadmium was 0.2 μg.

3.2.7.2 QA/QC. A relatively small number of sampling problems were encountered during the construction monitoring period. The problems can be grouped into three categories: loss of power supply, failure to meet flow rate performance criteria and human errors. (No laboratory or QA/QC problems were encountered.) These problems affected 72 samples. The sample sites and sample days where the problems occurred are provided in Table 7.

Power supply problems accounted for the majority of lost samples during this period. Malfunctions of the mobile monitoring station generators resulted in the loss of 50 samples. The permanent air monitoring stations were not affected by power supply problems.

Fourteen samples failed to meet flow rate performance criteria and were subsequently rejected. Three sources of flow rate problems were identified: rain water entering the sampling train, a defective critical orifice and blockages in the sample tubing. The rainwater problem was the most serious.

Human error affected the integrity of eight samples. The increased complexity of air sampling during construction monitoring and extremes in weather from summer to winter created more opportunities for human error. Field personnel were required to adhere to varying sampling schedules depending on construction activity at the remediation areas. At times, samples were not taken according to the study plan schedule because the field personnel were not aware of changes in the construction activities at a Site.

Changes were made during the course of the sampling period to reduce the frequency of the problems. The sampling trains were modified to reduce the intrusion of rain water into the sampler. Increased maintenance of the generators helped minimize the loss of power problem.

3.3 Aquatic Monitoring

3.3.1 Study Area

During the construction period, the major change in the aquatic monitoring effort from that of the 1990 Preconstruction Monitoring Program was the increase in water sampling in the vicinity of construction. The study area for the increased water quality monitoring program included the Hudson River from approximately 100 feet upstream of Remnant Site 2, to the upstream portion of Thompson Island Pool. To evaluate impacts beyond the Remnant Sites, the aquatic sampling sites established in the 1990 Preconstruction Monitoring Program continued in operation.

3.3.2 Water Quality Stations

Nine water sampling stations (six at new locations) were added to the 1990 preconstruction aquatic monitoring stations to assess construction activity impacts on waterborne PCB levels in the Hudson River (Table 8; Figure 60). Eight of these stations were located immediately upstream and downstream of the remnant area on which construction activities would be occurring. The remaining new station was downstream of Remnant Site 5 between the southern edge of the site and existing monitoring Station E5. Additionally, in the event of an unplanned occurrence that created conditions whereby contaminants were released to the river resulting from construction activities, grab water samples were taken at the site of the occurrence. The 17 aquatic stations established for the 1990 Preconstruction Monitoring Program (Table 1, and Figure 7) continued to be sampled for sediment, water and aquatic

biota during the ice-free portion of the construction monitoring program (July-November). Beginning in December, however, ice conditions limited access to those stations listed in Table 9 (Figure 61).

3.3.3 Monitoring Components

The additional aquatic sampling during the Construction Monitoring Program consisted solely of increased water sampling. Sediment and aquatic biota sampling continued as per the 1990 Preconstruction Monitoring Program. Additional sediment and aquatic biota samples were not collected because the continuing 1990 Preconstruction Monitoring Program sampling efforts were expected to be sufficient to assess construction impacts for these parameters. This is because sediment and biotic PCB concentrations will not fluctuate as rapidly as waterborne PCBs due to the length of time required for these components to equilibrate with the waterborne PCBs.

3.3.4 Materials and Methods

3.3.4.1 Sediments. Surficial sediments were collected seasonally. Summer (August) and fall (November) samples were collected during the 1990 construction monitoring period. Multiple (two to four) surface grab samples were taken with the six-inch petite ponar dredge at each of the stations listed in Table 1. The locations of these samples are shown in Figures 62 through 78.

3.3.4.2 Water. Water samples at the eight stations adjacent to the remnant sites (Table 8; Figure 60) were equipped with an ISCO™ automatic water sampler (Figure 79). Because of the design of the ISCO sampler, a 350-mL glass bottle (hexane rinsed) is the maximum sized bottle the sampler could contain. To obtain the minimum sample volume (1000 mL) required for water analysis, and to improve the monitoring coverage during the construction activities at a site, three 350-mL samples were collected each day an ISCO was in operation.

These three samples were collected at 9 am, noon and 3 pm. The three individual samples collected each day were then composited by the field crew into the one daily sample for the station. Because the river currents were expected to confine most precipitation runoff to the downstream river bank, samples were taken adjacent to the bank.

At stations not equipped with an ISCO™ automatic sampler (Tables 1 and 8), water samples for PCB chemical analyses and total suspended solids analysis were collected using a stainless steel Kemmerer water bottle. When air temperatures fell below 32°F, the ISCO™ samplers were removed to prevent sample freezing. Sampling was then conducted using the stainless steel Kemmerer water bottle. Hexane-rinsed 1.0-L glass sample collections bottles with Teflon-lined caps were used for PCB analysis samples; 500-mL glass bottles were used for total suspended solids. (The ISCO sampler was equipped with 350-mL bottles; grab samples were placed in 1.0-L bottles.)

The sampling frequency at stations having an ISCO sampler depended on the construction schedule. At stations on a site scheduled for construction activity, daily water sampling was begun one week prior to that activity, and continued throughout construction and for one month following construction activity. These samples were removed and fresh containers placed in the ISCO sampler every three days. At all other stations, water samples were taken on a weekly basis.

3.3.4.3 **Aquatic Biota.** Multiplate (Hester-Dendy), caddisfly larvae and fathead minnow in-situ assay monitoring samples continued to be collected at the preconstruction aquatic stations listed in Table 2 per the procedures used in the 1990 Preconstruction Monitoring Program. Exposure times and sampling dates for the multiplate samples and fathead minnow monitoring samples are listed in Appendix 2, Tables 6 and 7, respectively. Sampling dates and locations for caddisfly larvae are given in the Results and Discussion.

3.3.5 Additional Environmental Measurements.

River discharge, and air and water temperatures continued to be measured as per the 1990 Preconstruction Monitoring Program. Dissolved oxygen, pH and conductivity were measured until December, when winter conditions interfered with the operation of the meters.

3.3.6 Laboratory Methods

Hazleton Laboratories America, Inc. (Madison, WI) performed the PCB analyses on water, sediment, fish, multiplate samples, caddisflies and solvent bags. All of the PCB analyses performed by Hazleton utilized packed column gas chromatography methods capable of identifying PCBs as the commercial Aroclor mixtures. Hazleton also performed the total suspended solids (TSS) analyses on water, percent lipid analyses on fish, and on the particle size, total solids (TS), total organic carbon (TOC) and total volatile solids (TVS) analyses on sediments. Full details of the analytical procedures used by Hazleton are found in the Quality Assurance Project Plan (QAPP) appended to the 1989 monitoring program (Harza/ Yates & Auberle 1989b).

Method limits of detection are listed below:

Matrix	Detection Limit	Assumptions
Water	0.10 μg/L	1 L sample
Dialysis bags	0.10 μg/L	
Sediment	50 μg/kg	20 g initial sample
Tissue	50 μg/kg	20 g initial sample

The sample volume collected in the field for sediment and tissue samples has an impact on the limit of quantification (LOQ) of sample. Small samples will have LOQ values greater than the detection limits listed above. This happened infrequently, and was a problem only for some tissue (multiplate, fish, caddisfly) samples.

3.3.7 QA/QC

The QA/QC procedures in operation during the 1990 Preconstruction Monitoring Program continued during the 1990 Construction Monitoring Program. Chain of Custody (COC) forms were completed by the field crew immediately after all sample collections, and were shipped to the analytical laboratory with the sample. The COC forms were used to document sample shipping and holding times, as well as the personnel involved with collection, handling and analysis of the samples. The laboratory QA/QC procedures continued in accordance with QAPP. The Quality Assurance Project Plan (QAPP) for the laboratory analyses are found in the QAPP chapter submitted with the 1989 Baseline Monitoring Plan of Study.

3.3.8 Results and Discussion

3.3.8.1 Sediment. A total of 77 sediment samples were collected from all (17) aquatic monitoring stations during the 1990 construction monitoring period. Tables 10 and 11 summarize the Aroclor 1242 and Aroclor 1254 construction monitoring data, respectively, of the 77 samples. Aroclor 1242 was found in 47 of the samples; Aroclor 1254 in 52.

The particle size, TOC, TS and TVS content of the samples are given in Table 1 of Appendix 2. Tables 12 through 18 summarize, respectively, the mean gravel, sand, silt, clay, TOC, TS and TVS content of sediments from each station during 1990.

PCB concentrations throughout this section are expressed as $\mu g/g$ dry weight. Particle size distributions were performed on dry sediment. The particle size distribution curves for each sample are found in Appendix 5. Total organic carbon and total volatile solids are expressed as weight percent of the dried sediment. (Total solids is the weight percent of solid material in the wet sediment after the water was evaporated.)

As can be seen in Figure 80, most sediments collected during 1990 consisted of sand and silt-sized particles. The mean silt content of sediments from Stations C-2, E-0, E-1 and E-2 was lower than that of the other sampling stations. This reflects the higher gradient of the Hudson River at the aforementioned stations, which makes them poor sediment deposition areas compared to the other sampling stations. The field crews specifically searched for the finest particle size sediments at each station, accounting for the low gravel content of the samples.

The total organic carbon content of most samples was lower between Stations GF-4 and E-5A than it was at the stations located both upstream and downstream of the remnant areas (Table 16 and Figure 81). This also reflects the higher gradient of the river in the vicinity of the remnant areas than in the areas upstream and downstream of the construction activities. The upstream and downstream sampling stations are generally located in impoundments of the Hudson River. The total volatile solids content of sediments followed the same trend as the TOC results (Table 18 and Figure 81).

Tables 10 and 11 provide the mean, median, minimum, maximum, and standard error of the mean for each station sampled during construction monitoring. Figure 82 shows the station mean PCB concentrations during construction monitoring. A comparison of Figures 22 and 82 shows that the relative PCB concentrations at the sampling stations was largely unchanged between the 1990 preconstruction and construction monitoring. The highest PCB concentration (61.0 μg/g Aroclor 1242; 15.0 μg/g Aroclor 1254) was again found at Station E-5. Results from the individual stations are described below.

Station C-1

Three samples were collected on August 29th, and three were collected on November 2nd. Two of the samples collected in August had detectable Aroclor 1254, while two samples

collected in November contained both Aroclors 1242 and 1254. The two November samples were the only samples collected at Station C-1 during 1990 with detectable Aroclor 1242.

The maximum PCB concentration in a construction monitoring sediment sample at this station was 0.21 μg/g Aroclor 1242 and 0.14 μg/g Aroclor 1254. The mean construction monitoring Aroclor composition of sediments from Station C-1 was 21.5% Aroclor 1242 and 78.5% Aroclor 1254.

Station GF-1

Three sediment samples were collected at Station GF-1 on August 29th and another three on November 2nd. Detectable Aroclor 1242 was found in one of the samples collected during each sampling period. Detectable Aroclor 1254 was found in all three samples collected in November.

The highest PCB concentrations found at Station GF-1 during 1990 were in a November sample containing 0.33 μg/g Aroclor 1242 and 0.17 μg/g Aroclor 1254. This sample also contained the highest PCB concentration found upstream of Bakers Falls during 1990.

The mean Aroclor composition of sediments collected during construction monitoring at Station GF-1 was 41.5% Aroclor 1242 and 58.5% Aroclor 1254.

Station GF-2

Five sediment samples were collected during construction monitoring. Three were collected on August 29th, and two were collected on November 2nd. Three of these five samples contained Aroclor 1254; none contained Aroclor 1242. Station GF-2 and Station MR-1 are the only stations at which only Aroclor 1254 was detected in sediment samples. The mean

Aroclor 1254 content of those samples with detectable PCB was 0.085 μg/g, with a maximum of 0.13 μg/g.

Station GF-3

Three samples were collected at Station GF-3 on August 28th, and another three samples were collected on October 17th. None of the six samples collected during construction monitoring contained detectable PCBs.

Station GF-4

Two sediment samples were collected at Station GF-4 on September 25th. Neither sample contained detectable PCBs.

Station C-2

Two sediment samples were collected at Station C-2 on August 31st, and a third sample was collected on November 20th. Aroclor 1242 was found in two of the samples, with the maximum concentration being 4.30 μg/g. No Aroclor 1254 was found in the sediment samples from Station C-2 during construction monitoring.

Station E-0

Two sediment samples were collected from Station E-0 during construction monitoring. One sample was collected on August 30th, while the other was collected on October 16th. Both samples contained detectable Aroclor 1242, while one also contained detectable Aroclor 1254. Total PCB concentrations in the two samples were very similar, being between 6.08 μg/g and 6.20 μg/g. The sample with both Aroclor 1242 and 1254 contained 5.10 μg/g Aroclor 1242 and 0.98 μg/g Aroclor 1254. These two samples contained the highest PCB

concentrations in sediment collected upstream of remnant area construction activities during construction monitoring.

Station E-1

Four samples, two collected on August 30th and two on October 16th were obtained at Station E-1 during construction monitoring. All four samples contained both detectable Aroclor 1242 and 1254. Despite a rather large difference in the total PCB concentration of the four samples (0.252 μg/g to 19.90 μg/g), the Aroclor composition was consistent among the four samples, averaging 78.1% Aroclor 1242 and 21.9% Aroclor 1254.

The mean Aroclor 1242 concentration at Station E-1 during construction monitoring was 6.98 μg/g, while the mean Aroclor 1254 content was 2.09 μg/g.

Station E-2

Two samples were collected from Station E-2 during construction monitoring, one each on August 30th and October 16th. Both samples contained nearly identical total PCB concentrations (20.2 μg/g and 20.6 μg/g), and similar proportions of Aroclor 1242 and Aroclor 1254 (a mean 85.8% Aroclor 1242 and 14.2% Aroclor 1254). The construction monitoring mean total PCB concentration of 20.4 μg/g is nearly four times the mean 5.26 μg/g total PCB found in sediments collected at this station during preconstruction monitoring.

Station E-3

Two samples were collected from Station E-3 during construction monitoring, one each on August 30th and October 16th. Both samples contained nearly identical total PCB concentrations (0.370 μg/g and 0.253 μg/g), and similar proportions of Aroclor 1242 and Aroclor 1254 (a mean 81.4% Aroclor 1242 and 18.6% Aroclor 1254). Sediment PCB concentrations

at Station E-3 are much lower than at other stations in the immediate vicinity of the Remnant Sites, which is probably due to the absence of depositional sediments at the site.

Station E-4

Four of five samples collected during construction monitoring at Station E-4 contained both Aroclor 1242 and Aroclor 1254. The fifth sample, with a high gravel (12.6%) and sand (45.8%) content contained no detectable PCBs. Of the samples with detectable PCBs, the mean Aroclor 1242 concentration was 6.325 μg/g, and the mean Aroclor 1254 concentration was 1.453 μg/g. The highest concentration found at this station during construction monitoring contained 10.4 μg/g Aroclor 1242 and 2.30 μg/g Aroclor 1254.

Station E-5

All (four) sediment samples collected at Station E-5 during construction monitoring contained both detectable Aroclor 1242 and Aroclor 1254. The Aroclor composition of the four samples averaged 81.8% Aroclor 1242, and 18.2% Aroclor 1254. Included among these four samples was the sample with the highest Aroclor 1242 (61.0 μg/g) and Aroclor 1254 (15.0 μg/g) concentrations of all sediment samples collected during 1990. The sediment samples with the second and third highest total PCB concentrations (71.0 and 51.0 μg/g) during 1990 were also collected from Station E-5 during construction monitoring. Figure 82 shows that sediment PCB concentrations at Station E-5 are considerably higher than those at any other station.

Station E-5A

All (six) construction monitoring samples collected at Station E-5A contained detectable Aroclor 1242, with five also containing detectable Aroclor 1254. The mean Aroclor 1242 concentration was 11.92 μg/g; the mean Aroclor 1254 concentration was 1.72 μg/g. The

mean proportions of Aroclor 1242 and Aroclor 1254 were 89.8% and 10.2%, respectively. The maximum concentration of Aroclor 1242 observed during construction monitoring was 19.0 μg/g, and the maximum Aroclor 1254 content was 2.30 μg/g. These maxima are slightly less than half of the respective maximum concentrations in one of the E-5A sediment samples collected during preconstruction monitoring. As a result, the construction monitoring mean Aroclor 1242 and 1254 concentrations were somewhat lower than the preconstruction monitoring means.

Station E-6

All (seven) sediment samples collected at this station during construction monitoring contained detectable Aroclor 1242; four of the samples also contained detectable Aroclor 1254. Included among the four is a sample with the highest total PCB concentration at Station E-6 since monitoring began in 1989. This sample, collected November 2nd, contained 28.0 μg/g Aroclor 1242 and 5.30 μg/g Aroclor 1254.

The mean Aroclor 1242 concentration during construction monitoring was 12.5 μg/g; the mean Aroclor 1254 concentration was 2.65 μg/g. No sample contained less than 80% Aroclor 1242. The mean composition of sediments collected at Station E-6 during construction monitoring was 91.1% Aroclor 1242, and 8.9% Aroclor 1254.

Station E-7

Construction monitoring results for sediments collected at Station E-7 were similar to the results of the preconstruction monitoring. The mean concentrations of the six construction monitoring samples were 1.318 μg/g Aroclor 1242 and 0.282 μg/g Aroclor 1254. The relative proportions of the two Aroclors were 81.8% Aroclor 1242 and 18.2% Aroclor 1254. The maximum PCB concentration found in Station E-7 sediments during 1990 was collected

during construction monitoring, and contained 3.30 μg/g Aroclor 1242 and 0.61 μg/g Aroclor 1254.

Station HR-1

All (four) sediment samples collected at Station HR-1 during construction monitoring contained detectable concentrations of both Aroclor 1242 and Aroclor 1254. The mean Aroclor 1242 concentration was 0.863 μg/g, while the mean Aroclor 1254 concentration was 0.251 μg/g. These values are similar to the mean Aroclor 1242 concentration of 1.12 μg/g and mean Aroclor 1254 concentration of 0.175 μg/g found in sediments collected at this station during the 1990 Preconstruction Monitoring Program. The sample containing the highest total PCB levels at this station during 1990 was collected during construction monitoring. This sample contained 1.40 μg/g Aroclor 1242 and 0.47 μg/g Aroclor 1254.

The Aroclor composition of samples from Station HR-1 varied as much as 20% from sample to sample. Mean composition of sediments collected during construction monitoring was 77.8% Aroclor 1242 and 22.2% Aroclor 1254.

Station MR-1

Six of seven construction monitoring samples from Station MR-1 contained detectable Aroclor 1254. No detectable Aroclor 1242 was found in any of the samples taken at Station MR-1 during 1990. The mean Aroclor 1254 content of the six samples with detectable levels was 0.10 μg/g, with a maximum of 0.15 μg/g. Station MR-1 is the only aquatic monitoring station where the particle size distribution of sediments was consistently dominated by the silt fraction (Table 1, Appendix 2).

3.3.8.2 Water. Numerous samples during the 1990 construction monitoring period (July-December) contained PCBs in concentrations greater than the 0.10 μg/L limit of detection

(LOD). Aroclors 1242 and 1254 were the only two Aroclors detected, with Aroclor 1242 detected in much greater frequency than Aroclor 1254. Detectable concentrations of Aroclor 1242 were found in 13 (2.9%) of the 448 grab samples collected weekly during construction (Table 19), and in 230 (27.8%) of 827 samples collected daily by the automated (ISCO) water samplers (Table 20). Aroclor 1254 was found in 3 (0.7%) of 448 grab samples (Table 21), and in 30 (3.6%) of 827 ISCO samples (Table 22). No PCB was detected in field blanks analyzed during 1990.

Summaries of the 1990 construction grab sample station Aroclor 1242 results are given in Table 19; Aroclor 1254 grab sample results are summarized in Table 21. Tables 20 and 22 provide summaries of the automated water sampler results for Aroclors 1242 and 1254, respectively. Appendix 2, Table 2 provides the complete listing of results for each individual sample analyzed during 1990, grouped by sampling station. Five other Aroclor quantifications were evaluated in the 1990 water samples: Aroclors 1016, 1221, 1232, 1248 and 1260. No detectable levels of these Aroclors were found in any water sample.

Detectable concentrations of Aroclor 1242 in the grab samples were between 0.10 μg/L and 0.49 μg/L, while detectable Aroclor 1254 concentrations were between 0.14 μg/L and 0.35 μg/L. PCB levels in the water samples collected by automated samplers occasionally contained much higher concentrations, being between 0.10 μg/L and 25.1 μg/L Aroclor 1242, and 0.11 μg/L and 1.65 μg/L Aroclor 1254. These concentrations are all reported as total waterborne PCB because only a few samples were fractioned to separate dissolved and suspended PCBs.

3.3.8.2.1 **Mid-water grab samples.** Three samples with detectable PCB concentrations were collected upstream of remnant area construction activities. All three, which contained only Aroclor 1242, were collected from Station E-0, on August 10th (0.34 μg/L), October 27th (0.49 μg/L), and November 8th (0.30 μg/L).

There were three samples that contained only Aroclor 1254. All were collected within one day of each other. These samples were collected from Station E-3 (0.17 μg/L), on November 1st; Station E-6, on November 2nd (0.35 μg/L); and from Station E-7 (0.14 μg/L), also on November 2nd.

Construction and remediation activities at the Remnant Sites had little discernable impact on the level of PCB measured weekly at the grab sample stations. Table 23 summarizes the schedule of construction activities at each of the four Remnant Sites, as well as activities related to the installation and removal of the bridge from the west bank of the river to Remnant Site 3. Because of the overlap in activities, most of the 16 samples with detectable PCB cannot be tied conclusively to specific construction activity.

One grab sample result that can possibly be tied to a specific construction event is the detection of O.10 μgL Aroclor 1242 in a sample from Station E-3, collected July 24th, the first day of construction of the bridge connecting the west bank of the river to Remnant Site 3. Station E-3 is immediately downstream of the bridge location, near the west bank of the river. The 0.10 μg/L Aroclor 1242 measured in the July 24th E-3 sample collected may be the result of construction activities on the bridge, which commenced on the west bank of the river.

As was the case during the 1990 preconstruction monitoring, most of the detectable PCB samples during construction monitoring were collected in temporal clusters. Twelve of the 16 grab samples with detectable PCBs were collected in the 15 days between October 25th and November 8th. Of these 12, six samples were collected between October 25-27th (Table 2, Appendix 2). (A seventh sample from this period, the field duplicate of the sample from Station E-5A, also had detectable PCB. However, this field duplicate sample is not considered one of the aforementioned 16 samples having detectable PCB.) Of the remaining six samples with detectable PCBs, three were collected on November 1 or 2, and three

were collected on November 8th. With the exception of Station E-1, at least one sample with detectable PCB was collected from each sampling station between E-0 and E-7.

Construction activities were occurring at all four Remnant Sites in late October and early November. Eleven of the 16 grab samples with detectable PCB were collected in the immediate vicinity of the remnant area (Stations E-1 to E-5A). Five samples with detectable PCB levels were collected on October 25th, at Stations E-2, E-4, DS-1, E-5 and E-5A. Construction activities occurring on October 25th included subgrade sand layer placement at Site 2; channel work, placement of claymax, sand and topsoil at Site 3; subgrade sand layer placement at Site 4; and topsoil placement at Site 5 (Table 23).

Discharge of the Hudson River at Ft. Edward between October 22nd and November 12th ranged between 4540 cfs and 16,000 cfs, with a median discharge of 8565 cfs. Measurable precipitation occurred on 12 of the 22 days during this period. Nonetheless, the samples having detectable PCBs do not appear to be related to Hudson River discharge or to precipitation at Glens Falls. Figures 83 through 93 illustrate the relationship between PCB in water and Hudson River discharge at Ft. Edward for each of the grab sample stations where PCBs were detected during the construction monitoring period. The data are illustrated on a quarterly basis for each station to provide greater clarity in the figures. Figures 94 through 104 illustrate the relationship between precipitation and PCB concentrations in water at these stations. As was the case during the 1990 preconstruction monitoring, no statistically significant correlation was noted between either Aroclor 1242 and discharge at Ft. Edward ($r = -0.206$, $P = 0.480$), or Aroclor 1242 and precipitation ($r = 0.353$, $P = 0.216$).

3.3.8.2.2 **Special Samples.** As requested by the agencies in the Construction Monitoring POS (Harza/Yates & Auberle 1990d), special samples were taken when construction activities caused accidental potential releases of PCBs to the river. On September 21, construction activities accidentally ruptured a pipeline on Remnant Site 5. The effluent ran

across PCB-exposed soil. Two special samples were collected from the effluent immediately downstream of the pipeline. The samples contained 1.2 μg/L and 1.0 μg/L Aroclor 1242, respectively.

3.3.8.2.3 Waterford Treated Drinking Water Supply Samples. In accordance with the Administrative Consent Order, the Waterford drinking water supply was monitored during the 1990 construction monitoring period. Starting on October 26th, and continuing weekly thereafter, samples of the untreated and treated water obtained at the Waterford municipal drinking water supply facility were analyzed for PCBs. These samples were taken on the same day the samples of Hudson River water were collected from Station E-7, which is located near the intake structure of the Waterford treatment facility (Figure 105). Hudson River water is the source for the Waterford municipal drinking water supply.

Table 2 of Appendix 2 gives the complete listing of PCB analyses performed on the Waterford facility samples. Untreated (raw) water samples are denoted as Station E7R and treated samples are denoted as Station E7T (for treated) in Table 2, Appendix 2. As shown in Appendix 2, Table 2, no detectable PCBs were found in the Waterford facility samples.

3.3.8.2.4 Automated (ISCO) Sampler Water Samples. Of the 827 samples collected at the automated water sampling stations, 233 (slightly over 28%) contained detectable Aroclor 1242 and/or Aroclor 1254. Table 20 summarizes the Aroclor 1242 results of the samples for each of the eight automated stations; Table 22 summarizes the results of the Aroclor 1254 analyses. Most of the detectable samples contained Aroclor 1242. Of the 827 samples collected, 230 (28%) contained Aroclor 1242 and 30 (4%) contained Aroclor 1254. Only three of the 30 samples with detectable Aroclor 1254 did not also contain Aroclor 1242. These three samples were collected on October 25th from Station RS4W1 (0.11 μg/L Aroclor 1254), and from Station RS5W1 on October 27th (0.19 μg/L) and October 30th (0.20 μg/L). These collections were within nine days of the three aforementioned grab samples at Stations E-3, E-6 and E-7 that also contained only Aroclor 1254. Of the 30

ISCO samples with detectable Aroclor 1254, nine were collected between October 25th and November 3rd. Aroclor 1254 was collected from five of the eight ISCO samplers during this time (Table 2, Appendix 2).

Many of the samples having detectable Aroclor 1254 were collected at Station RS3W1 during the month of November and early December. Eleven samples with detectable Aroclor 1254 were collected at this station between November 8th and December 3rd, including a sample on November 9th with 1.65 μg/L, the highest level of Aroclor 1254 detected in a water sample during 1990 (Table 22).

Figures 106 through 119 illustrate the trends in PCB concentrations at each automated sampling station. The figures are separated into two three-month long segments for each of the eight automated stations to improve clarity. It can be seen that a wide range of concentrations were encountered throughout the 1990 Construction Monitoring Program, varying between 0.10 μg/L and 25.1 μg/L Aroclor 1242 (Table 20), and from 0.11 μg/L to 1.65 μg/L Aroclor 1254 (Table 22).

An unexpected result of the 1990 monitoring program is the large number of water samples from Station RS3W1 having elevated concentrations of PCB. Although more samples with detectable PCBs were collected at Station RS3W2, the water samples having the highest PCB concentrations during 1990 were all collected at Station RS3W1. This finding is unexpected because Station RS3W1 is located upstream of all construction activities on the east bank of the Hudson River, and should be unaffected by construction activities on the eastern shoreline of the river.

Three of the stations on the eastern shore of the river, Stations RS3W1, RS3W2 and RS5W1 (Figure 120), accounted for 178 of the 230 (77.4%) water samples having detectable Aroclor 1242 and 25 of the 30 (83.3%) water samples having detectable Aroclor 1254. Figures 121 to 126 provide a daily comparison by month of PCB in water at Stations

RS3W1, RS3W2 and RS5W1. Although samples from Stations RS3W1, RS3W2 and RS5W1 were those which most often contained detectable PCBs, Figures 121 to 126 indicate that these three stations were not consistently detecting PCBs at the same time.

Pairwise nominal scale correlations (Zar 1974) were used to determine the statistical relationship of the dates on which PCBs were detected at the various sites. This procedure correlates the presence (or absence) of PCB in water on each date that samples were collected at a pair of stations. Although not proving cause and effect, a statistically significant ($P=0.05$) correlation provides an indication of whether detectable PCB episodes are due to one upstream event affecting all sites. Alternatively, the presence of detectable PCBs at the sites on different dates may be due to independent events, such as the various construction activities at each site. The normal approximation to the binomial test (Zar 1974) was used to test the significance of the nominal scale correlations.

Table 24 contains the results of the nominal scale correlations. For Stations RS3W1 and RS3W2, a significant ($P \leq 0.05$) correlation was noted between the dates on which samples did (and did not) contain detectable PCBs. For Stations RS3W1 and RS5W1, as well as for Stations RS3W2 and RS5W1, no significant ($P=0.05$) correlation between date and presence/absence of detectable PCBs was found.

Figure 127 provides a chart showing the time and duration of construction activities on each Remnant Site. As seen in the figure, usually more than one construction activity occurred concurrently on a site. Additionally, construction activities occurred concurrently on several Sites. Consequently, it is not possible to identify the impact of a specific construction activity on a Site. Nonetheless, generalizations about the impact of several types of construction activities on PCB levels in water can be drawn by pooling data from all eight automated stations.

Table 25 lists the total number of samples collected from all eight automated stations during 1990, the number of water samples with detectable levels of PCB (hits), and the percentage of the total samples having hits. (Because more than one construction activity occurred concurrently, the samples listed for one construction activity in Table 25 can also be listed for another activity, resulting in the sum of the number of hits in Table 25 being larger than the total number of samples collected with detectable PCBs.) Because it is not possible to isolate the individual construction activity responsible for PCB in water, no statistical tests to determine differences in the impacts of the various construction activities were attempted. Nevertheless, it is clear from Table 25 that some activities had relatively little impact on PCB concentrations in water.

Figure 128 plots the percentage of samples with detectable PCBs (Table 25) by construction activity. It appears that clearing, shoreline protection, the temporary bridge abutment installation and bridge removal had considerably less effect on PCB concentrations in water than did regrading, bridge installation, subgrade placement and channel work (improving the drainage of water from the Sites), which are activities that require considerable movement of construction equipment. Such movement creates the potential for disturbing the contaminated deposits, or for sloughing into the river.

The remaining discussion of the automated sample results are described on a site-by- site basis. The results for each individual sample collected by the automated samplers are given in Appendix 2, Table 2.

Remnant Site 2

Construction monitoring activities at Remnant Site 2 commenced on July 12th, ran through July 18th, then were suspended until September 10th. A total of 86 samples was collected at RS2W1, and 84 samples were collected at RS2W2 during 1990. Table 20 summarizes the RS2W1 samples (11) and the RS2W2 samples (13) with detectable Aroclor 1242 levels.

When only those samples above the 0.10 μg/L limit of detection are considered, Station RS2W1 had the second highest mean (0.53 μg/L) and the highest median (0.45 μg/L) Aroclor 1242 concentrations of the eight automated stations. (Station RS3W1 had the highest mean Aroclor 1242 concentration: 1.85 μg/L.) By contrast, Station RS2W2 had the second lowest mean (0.26 μg/L) and third lowest median (0.20 μg/L) Aroclor 1242 concentrations of the eight automated stations (Table 20).

Aroclor 1254 was found in only two samples collected by the Remnant Site 2 samplers during 1990. A concentration of 0.77 μg/L Aroclor 1254 was found in the sample collected at RS2W1 on October 29th. A sample with 0.36 μg/L Aroclor 1254 was collected at Station RS2W2 on October 9th.

The maximum Aroclor 1242 concentration at RS2W1 was 2.26 μg/L, collected on October 29th (the date when the only RS2W1 sample with detectable Aroclor 1254 was collected). Two days later, the maximum Aroclor 1242 concentration (0.52 μg/L) at Station RS2W2 was noted. Figures 106 and 107 illustrate the temporal trends of detectable PCBs in water at Station RS2W1. Figures 108 and 109 show the PCB temporal trends at Station RS2W2. Detectable PCBs in water at both RS2W1 and RS2W2 were found in three temporal clusters, although the clusters did not occur simultaneously at the two stations.

At Station RS2W1, two samples with detectable PCBs were collected the second week of September, during regrading activities at the Site (Figure 106). A cluster of five samples with detectable PCB, including the sample with the highest concentrations measured during 1990, was collected during the last ten days of October (Figure 107). Construction activities at the Site during this time were shoreline protection and subgrade sand layer placement (Table 26). Three samples with detectable PCBs were collected the second week of December (Figure 107). Construction activities at this time were Claymax placement, topsoil placement and channel work (Table 26). However, because of its upstream location, it is doubtful that construction activities were responsible for the detectable levels of PCB

at Station RS2W1. The presence of detectable PCBs in samples at this station is indicative of upstream PCB sources.

Three temporal clusters of detectable PCBs in water were found at Station RS2W2. However, these clusters occurred at different times than the clusters at Station RS2W1. A cluster of five samples at RS2W2 was noted between September 24th and October 1st (Figures 108 and 109). Regrading of the Site was proceeding at this time and shoreline protection had just begun (Table 26). A second cluster (four samples) was noted the second week of October (Figure 109), during which time regrading, shoreline protection and subgrade sand layer placement were occurring. The third cluster (four samples) was noted between October 29th and November 5th (Figure 109). Shoreline protection was being completed and subgrade sand layer placement was occurring during this time. The differences in timing of the temporal clusters of detectable PCBs at Stations RS2W1 and RS2W2 indicates a different source for the clusters at the two stations.

The clusters of samples with detectable PCBs at Stations RS2W1 and RS2W2 are not correlated to either river discharge at Ft. Edward or to precipitation at Glens Falls. At Station RS2W1, the correlation (r) between Aroclor 1242 concentrations and discharge was $r = 0.359$ ($P = 0.278$), whereas the correlation between Aroclor 1242 and precipitation was $r = -0.041$ ($P = 0.904$). At Station RS2W2, the correlation between Aroclor 1242 and discharge was $r = -0.053$ ($P = 0.864$), and the correlation between Aroclor 1242 and precipitation was $r = 0.272$ ($P = 0.369$).

Table 26 lists the number of incidences of detectable PCB (hits) in water occurring during each construction activity at Remnant Site 2. No hits were recorded during clearing of the Site. No trends were noted at Station RS2W1, as the frequency of hits was relatively consistent during all other construction activities. Table 26 also shows that all PCB hits in water at Station RS2W2 occurred only during three construction activities: regrading, shoreline protection and subgrade sand layer placement. All of the PCB hits in water at

RS2W2 took place between September 24th and November 5th. Although regrading, shoreline protection and subgrade sand placement took place concurrently throughout this period, the timing of the hits coincides almost exactly with shoreline protection activities at the Site (Table 26), which took place between September 22nd and November 6th.

Remnant Site 3

The largest numbers of samples having detectable PCBs were collected at Stations RS3W1 and RS3W2. The number of samples having PCB concentrations above the 0.10 μg/L LOD was approximately equal at these stations (69 from RS3W1; 74 from RS3W2). Stations RS3W1 and RS3W2 were the only automated monitoring stations at which over 50% of the samples contained detectable PCBs (Table 20). Additionally, the 10 highest Aroclor 1242 concentrations and four highest Aroclor 1254 concentrations were found in samples collected from Station RS3W1 (Appendix 2, Table 2).

The mean detectable Aroclor 1242 concentration (1.85 μg/L) at Station RS3W1 was by far the highest mean Aroclor 1242 concentration of the eight automated stations (Table 20). The median detectable Aroclor 1242 concentration of 0.32 μg/L at Station RS3W1 was exceeded only by the median from Station RS2W1. The large discrepancy between the mean and median values of Aroclor 1242 at Station RS3W1 is due to the high concentrations found in several of the samples.

Station RS3W2's mean detectable Aroclor 1242 concentration of 0.40 μg/L and median detectable Aroclor 1242 level of 0.24 μg/L were the fourth highest of the eight automated sampling stations. The highest PCB concentration detected at Station RS3W2 was 2.80 μg/L Aroclor 1242, found on August 2nd. Only four samples from RS3W2 were above 1.0 μg/L Aroclor 1242.

Of the four samples at Station RS3W2 above 1.0μg/L Aroclor 1242, only the sample collected November 29th was obtained on the same date that a sample from Station RS3W1 also contained in excess of 1.0 μg/L Aroclor 1242 (Appendix 2, Table 2). Although there is a statistically significant (P=0.05) correlation between the dates on which PCBs were detected at Stations RS3W1 and RS3W2 (Table 24), an examination of Figures 121 through 126 shows that the relationship is by no means consistent.

Table 22 shows that 20 of the 30 samples containing Aroclor 1254 collected by automated samplers were obtained at Stations RS3W1 and RS3W2. Sixteen of these samples were collected at Station RS3W1, including the sample collected November 9th, which had the highest Aroclor 1254 content (1.65 μg/L) obtained during 1990. Two other samples from RS3W1 contained in excess of 1.0 μg/L Aroclor 1254, and were collected on October 26th (1.30 μg/L) and November 8th (1.12 μg/L). All three samples in which the Aroclor 1254 concentration was above 1.0 μg/L also contained Aroclor 1242 levels higher than the concentration of Aroclor 1254. The presence of Aroclor 1254 in samples from Station RS3W1, located upstream of all construction activities on the east bank of the Hudson (Figure 120), indicates the potential presence of one or more Aroclor 1254 sources upstream of Remnant Site 3. The sampler at Station RS3W2 collected four samples with detectable Aroclor 1254, but none higher than 0.32 μg/L (Table 22).

Remnant Site 3 was the only construction site having statistically significant ($P \geq 0.05$) relationships between PCBs in water and river discharge at Ft. Edward. At Station RS3W1, a highly significant correlation was noted between Aroclor 1242 in water and discharge ($r = 0.382$; $P = 0.001$). However, no significant (P=0.05) relationship was noted at Station RS3W1 between Aroclor 1242 and precipitation ($r = 0.123$; $P = 0.313$). Similar relationships were found at Station RS3W2, in that a significant correlation was observed between Aroclor 1242 and discharge ($r = 0.234$, $P = 0.045$), but no significant correlation was found between Aroclor 1242 and precipitation ($r = 0.035$, $P = 0.764$). Figures 110 and 111 show the relationship between discharge and PCB in water at Station RS3W1, while Figures 112

and 113 illustrate the discharge and PCB relationship at Station RS3W2. Figures 129 and 130 show the relationship between precipitation and PCB in water at Stations RS3W1 and RS3W2, respectively.

Construction monitoring activities at Stations RS3W1 and RS3W2 started on July 12th. With the exception of an 8-day period in late July and a 5-day period at Thanksgiving, monitoring at these two stations was essentially continuous throughout 1990. The stations at Remnant Site 3 (and the stations at Remnant Site 5) provide the most comprehensive monitoring records at the Remnant Sites. This occurs because construction activities commenced earlier on Remnant Sites 3 and 5 than on Remnant Sites 2 and 4.

In addition to the relationship between discharge and PCBs in water, Figures 110 and 111 indicate that the period of highest PCB concentrations in water at Station RS3W1 was during the second half of October and the first half of November. As shown in Table 27, channel work, clearing, subgrade sand layer placement, Claymax placement and topsoil placement took place at portions of Remnant Site 3 during October and November. However, because Station RS3W1 is located upstream of remedial activities on Remnant Site 3 (Figure 120), it should be unaffected by construction activities on the Site. As noted previously, this indicates a potential upstream source.

With the exceptions of late July, late August, early September, and most of December, PCBs were detected in water samples collected at Station RS3W1 throughout the construction monitoring period. PCBs were detected in all (52) water samples at RS3W1 between October 1st and December 3rd (Appendix 2, Table 2); 19 contained total PCB in excess of 1 μg/L, and three contained total PCB in excess of 10 μg/L.

All but one of the 19 samples containing total PCB in excess of 1 μg/L were collected in three temporal clusters. No samples containing in excess of 1 μg/L were collected prior to October 13th. Between October 13th and 29th, a cluster of 10 samples above 1 μg/L were

collected. The two samples having the highest Aroclor 1242 concentration in water during 1990 were collected at RS3W1 on October 22nd (22.4 μg/L) and October 24th (25.1 μg/L). These two samples were collected just prior to the highest discharge in the Hudson River during the fall of 1990 (Figure 111). A second cluster, consisting of all (four) samples collected between November 8th and 12th, contained in excess of 1 μg/L Aroclor 1242, with a maximum of 16.3 μg/L on November 12th. Four of six samples (the third cluster) collected between November 27th and December 3rd contained in excess of 1 μg/L total PCB.

The 74 samples with detectable PCBs collected at Station RS3W2 are the largest number of detectable samples collected at a station. The range of concentrations observed at RS3W2 (0.10 μg/L to 2.80 μg/L) is more similar to the concentration ranges observed at Stations RS2W1 and RS5W1 (Table 20) than to the extreme range of concentrations observed at Station RS3W1. As was the case with samples from Station RS3W1, samples with detectable PCBs were generally found throughout the construction monitoring period, with only a few time periods when no detectable PCBs were found. No detectable PCBs were found during the second half of August, mid-November, and (as at Station RS3W1) after December 3rd (Table 2, Appendix 2).

At least one sequence of samples with detectable PCBs can be attributed to a specific construction activity. A series of 11 samples with detectable PCBs collected between July 28th and August 13th at stations immediately downstream of the temporary bridge from the west bank of the river to the southern end of Remnant Site 3 corresponds well to the construction of that bridge (Table 27). Only four samples from Station RS3W1 had detectable PCBs during this time, so it appears that the installation of the bridge piers may have had a localized effect on the PCB concentrations in the water column immediately downstream.

However, removal of the temporary bridge had no discernable impact on PCB levels in water at Station RS3W2. Placement of riprap for shoreline protection at the Site also had no measurable impact on PCBs in water. No PCBs were detected in water samples collected at Station RS3W2 during that activity.

The schedule of the remaining construction activities at Remnant Site 3 are described in Table 27. Due to the overlap in activities at the Site, it is not possible to separate the impacts of regrading, clearing, channel work, subgrade sand placement, Claymax placement and topsoil placement. During each of these activities, the percentages of Station RS3W2 samples having detectable PCBs were from 59% to 100% (Table 27). Even if the activity schedules had not overlapped, the significant (P=0.05) correlation between the PCB detection patterns at Stations RS3W1 and RS3W2 (Table 27) confounds efforts to identify the impacts of specific construction activities.

Remnant Site 4

Because construction activities on Remnant Site 4 started later than on the other sites, the number of samples collected at this Site is less than at other remnant areas. Sampling at both RS4W1 and RS4W2 started on September 12th. Technical difficulties with the ISCO sampler at RS4W2 during late October resulted in only 66 samples being collected at that station, compared with 75 samples collected at Station RS4W1.

Twelve samples from Station RS4W1, and 11 samples from Station RS4W2 had detectable Aroclor 1242 during 1990. The mean (0.263 μg/L) and median (0.25 μg/L) detectable Aroclor 1242 concentrations at Station RS4W1 were similar to the mean (0.271 μg/L) and median (0.20 μg/L) concentrations at Station RS4W2 (Table 20). Both stations ranked in the middle of the eight automated stations with respect to their mean and median detectable concentrations.

Two samples from Station RS4W1 had detectable Aroclor 1254 levels (October 25th, 0.11 μg/L; and December 3rd, 0.14 μg/L). One sample from Station RS4W2, collected on November 10th, had detectable Aroclor 1254 at a concentration of 0.34 μg/L.

No statistically significant correlations were noted between Aroclor 1242 concentrations and Hudson River discharge at either Station RS4W1 ($r = 0.175$, $P = 0.586$) or Station RS4W2 ($r = 0.239$, $P = 0.478$). No statistically significant correlation ($r = 0.268$, $P = 0.399$) was noted between precipitation and Aroclor 1242 levels at Station RS4W1 (Figure 131). Station RS4W2 is unique among the eight automated sampling stations in having a highly significant correlation ($r = 0.867$, $P = 0.001$) between precipitation and detectable Aroclor 1242 concentrations (Figure 132).

Figure 131 illustrates the scattered temporal nature of the samples with detectable PCBs collected at Station RS4W1. No PCBs were detected in samples collected during the month of September. After the first of October, the only cluster of samples with detectable PCBs occurred during the third and fourth weeks of October. The highest PCB concentrations at Station RS4W1 (0.61 μg/L Aroclor 1242, and 0.14 μg/L Aroclor 1254) were observed in the last 1990 sample having detectable PCB. As was the case for the other automated sampling stations, no detectable PCBs were collected at RS4W1 after early December.

Table 28 indicates that one third of the RS4W1 samples collected during regrading activities at Remnant Site 4 had detectable PCBs. Lower percentages of samples having detectable PCBs were associated with other Site 4 construction activities. No PCBs were detected in water samples at Station RS4W1 during removal of the temporary bridge to Remnant Site 3. As is the case for all other automated samplers at the upstream end of a remnant area, construction activities at that remnant area should have no impact on water quality at the sampler. The samples with detectable PCBs at Station RS4W1 are thus due to construction or other events taking place upstream of the station.

Two small temporal clusters of samples with detectable PCBs were noted at Station RS4W2. Most samples with detectable PCBs at this station were collected either the first week of October or the second week of November (Figure 115). The distribution of clusters at RS4W2 differs from the pattern of detectable samples collected at Station RS4W1, shown in Figure 114, possibly indicating a different PCB source for the two groups of samples. Regrading was the only construction activity during the first week of October at Remnant Site 4 (Table 28). Forty percent of the samples collected at Station RS4W2 during regrading contained detectable PCBs. Subgrade sand layer placement was the only construction activity at Remnant Site 4 during the temporal cluster of detectable PCB samples in November. However, only 11% of the samples collected at RS4W2 during subgrade sand placement contained detectable PCBs. Shoreline protection activities and removal of the temporary bridge had little discernable impact on PCB levels at Station RS4W2 (Table 28).

Remnant Site 5

Stations RS5W1 and RS5W2 operated continuously from July 5th to the end of 1990, and presented an interesting contrast in the numbers of samples having detectable PCBs. At Station RS5W1, located upstream of Remnant Site 5 around a very sharp bend in the Hudson River (Figure 120), 35 samples with detectable Aroclor 1242, and five samples with detectable Aroclor 1254 (Tables 20 and 22) were collected. This is the third highest number of detectable samples at an automated station; only the two automated samplers at Remnant Site 3 were higher. Station RS5W1 is undoubtedly detecting events occurring upstream of Remnant Site 5. By contrast, only five samples with detectable PCBs were collected at Station RS5W2, the downstream station designed to measure construction impacts at Remnant Site 5. This was the smallest number of samples with detectable PCBs collected by the automated samplers.

Although Station RS5W1 had the third highest mean Aroclor 1242 concentration (0.419 μg/L) of the eight automated stations, it had the second lowest median detectable Aroclor

1242 concentration (0.19 μg/L). This is caused by several samples having high PCB concentrations that skew the mean higher than the median. The maximum Aroclor 1242 concentration at Station RS5W1 was 3.70 μg/L, the second highest maxima of the eight automated stations (Table 20). However, only one other sample from RS5W1 had in excess of 1 μg/L Aroclor 1242, although three other samples had a total PCB concentration (sum of Aroclors 1242 and 1254) greater than 1 μg/L (Tables 2, Appendix 2).

Station RS5W1, in conjunction with the Remnant Site 3 stations, collected over 77% of the detectable PCB samples obtained by the ISCO samplers. However, no statistically significant (P=0.05) correlation exists between the dates on which these samples were collected at Station RS5W1 and at either Station RS3W1 or RS3W2 (Table 24). This lack of correlation can be seen in Figures 121 through 126.

Five samples with detectable Aroclor 1254 were collected at Station RS5W1 (Table 22). Three of these were collected within two weeks of each other in late October and early November. Two samples with detectable Aroclor 1254, collected in late October, were among the relatively few water samples containing only Aroclor 1254. No Aroclor 1254 was detected at Station RS5W2.

No statistically significant (P=0.05) correlations between detectable PCB concentrations and Hudson River discharge nor between detectable PCB concentrations and precipitation were found at either Station RS5W1 ($r = 0.101$, $P = 0.564$ for discharge; $r = 0.031$, $P = 0.858$ for precipitation) or at Station RS5W2 ($r = -0.564$, $P = 0.600$ for discharge; $r = -0.026$, $P = 0.689$ for precipitation).

The most noticeable temporal trend in the distribution of water samples with detectable PCB at Station RS5W1 (Figures 116 and 117) is the absence of detectable PCBs after November 10th. This is approximately 3½ weeks before the cessation of detectable PCBs at Stations RS3W1 and RS3W2, but is comparable to the time at which detectable PCBs

also ceased to be detected at Station RS4W2 (the station closest to Station RS5W1; Figure 120), and at Stations RS2W1, RS2W2 and RS4W1 (Table 2, Appendix 2).

PCBs were detected shortly after sampling commenced (July 5th) at Station RS5W1, again during installation of the temporary bridge (July 24th to August 13th), and then fairly continuously between the first of September and November 10th. The highest Aroclor 1242 concentrations at RS5W1 were collected on September 8th (3.70 μg/L) and October 24th (1.47 μg/L). (October 24th was also the day 25.1 μg/L Aroclor 1242 was detected at Station RS3W1, the highest PCB concentration detected in water during 1990.) However, no PCB was detected at either Station RS3W1 or RS3W2 on September 8th, the date when Station RS5W1 recorded its highest level of PCB.

Because Station RS5W1 is upstream of the construction activities at Remnant Site 5, those activities should have had no impact on the samples collected at that station. Consistent with the relatively even distribution of samples having detectable PCB at RS5W1 (Figures 116 and 117), no single construction activity on Remnant Site 5 (Table 29), nor on the neighboring upstream Remnant Site 3 (Table 30), appears to be responsible for the major proportion of the detectable PCB samples at RS5W1. The lack of a statistically significant ($P=0.05$) correlation between dates on which PCBs were detected at Stations RS3W2 and RS5W1 provides additional evidence that the activities at Remnant Site 3 do not account for the large number of samples having detectable PCBs at Station RS5W1.

Figures 118 and 119 indicate that the five samples with detectable Aroclor 1242 collected at Station RS5W2 occurred in two groups. Two detectable samples were collected the third week of September, while three detectable samples were collected during the fourth week of October. Table 29 lists the construction activities occurring at Remnant Site 5 during the times detectable PCBs were noted at Station RS5W2. The small number of samples with detectable PCBs from RS5W2, and the low Aroclor 1242 levels (a maximum of 0.24 μg/L)

in those few samples having detectable levels, suggest that remediation activities on Remnant Site 5 had little impact on PCB concentrations in the Hudson River.

3.3.8.2.5 **Dialysis Bags.** During the construction monitoring phase of the study, nine sets of dialysis bags were placed at accessible stations. Data were not obtained for every sampling period, nor for every station, due to vandalism of the sampling sets or to inaccessibility of the site. No data are available from Station GF-1 because sampling at this station was suspended after repeated vandalism. Exposure times for the bags ranged from 12 to 31 days. Table 4 of Appendix 2 gives bag deployment dates, retrieval dates, and exposure times for dialysis bags emplaced during the 1990 Construction Monitoring Program.

Detectable levels of Aroclor 1242 were found at seven of the 17 stations sampled. No Aroclor 1254 was detected at any station. Table 4 of Appendix 2 provides a compilation of the results. A statistical summary of the detectable PCB sample results is found in Table 31. Analytical PCB results are expressed as $\mu g/L$. The results for individual stations follow. With the exception of the installation of the bridge from the west bank of the river to Remnant Site 3, the dialysis bag results could not be correlated with specific construction activities.

Station C-1

Sixteen bags were recovered and analyzed (July-November). No detectable PCBs were found at this station.

Station C-2

Thirteen bags were recovered and analyzed (July-October). No detectable PCBs were found at this station.

Station GF-2

Sixteen bags were recovered and analyzed (July-November). No detectable PCBs were found at this station.

Station GF-3

Two bags were recovered and analyzed. These bags were obtained during the first sampling period in the construction monitoring period (June 28 - July 11). No detectable PCBs were found at this station.

Station GF-4

Twelve bags were recovered and analyzed (July-November). No detectable PCBs were found at this station.

Station E-0

Eleven bags were recovered and analyzed (July-November). No detectable PCBs were found at this station.

Station E-1

Sixteen bags were recovered and analyzed (July-November). No detectable PCBs were found at this station.

Station E-2

Sixteen bags were recovered and analyzed (July-November). There were five bags that had detectable levels of PCB. The level of PCB in all five samples was 0.10 μg/L.

Station E-3

Fifteen bags were recovered and analyzed (July-November). Of these samples, two had detectable levels of PCB. One sample had 0.10 μg/L of PCB, while the level in the other sample was 0.20 μg/L. Both of these samples were obtained August 10th, following an exposure period that corresponded to the installation period of the bridge from the west bank of the river to Remnant Site 3. Because Station E-3 is located just downstream of the bridge, the detectable PCB samples may have been related to its installation.

Station E-4

Eleven bags were recovered and analyzed (July-October). A single bag yielded a detectable level of PCB. The level of PCB in the sample was 0.10 μg/L. This sample was obtained in July.

Station E-5

Sixteen bags were recovered and analyzed (July-November). PCB was detected in six of these samples during July, August and late October. The level of PCB in all these was 0.10 μg/L.

Station E-5A

Two bags were recovered and analyzed during July. Both of these samples had PCB levels of 0.10 μg/L.

Station E-6

Eighteen bags were recovered and analyzed (July-November). PCB was detected in 11 of these samples throughout the monitoring period. Six of these samples yielded PCB levels of 0.01 μg/L, while the other five samples held 0.20 μg/L.

Station E-7

Fifteen bags were recovered and analyzed (July-November). There were five bags (all collected in July and August) that had detectable levels of PCB. One sample contained 0.10 μg/L of PCB. The remaining samples contained 0.20 μg/L of PCB.

Station MR-1

Fourteen bags were recovered and analyzed (July-November). No detectable PCBs were found at this station.

Station HR-1

All (18) bags placed at this station were recovered and analyzed (July-November). No detectable PCBs were found at this station.

3.3.8.2.6 Physical Water Quality Parameters. The results of weekly monitoring of temperature, dissolved oxygen, pH, conductivity and depth at the aquatic stations during the 1990

construction period are presented in Table 8 of Appendix 2. Total suspended solids (TSS) data are given in Table 2 of Appendix 2. The Hudson River in the vicinity of Ft. Edward generally had higher conductivity and lower levels of dissolved oxygen than during the 1990 preconstruction period. However, by late September, the level of dissolved oxygen in the Hudson River began to increase. The TSS levels in the upper Hudson were also low, being less than 10 mg/L. The pH of the river was slightly alkaline for most of the monitoring period.

3.3.8.3 Aquatic Biota

3.3.8.3.1 Hester-Dendy Multiplate Samples. A total of 80 Hester-Dendy multiplate samplers (Figure 19) were recovered during the 1990 construction monitoring period. Table 6 in Appendix 2 provides the complete compilation of the results, expressed as $\mu g/g$ dry weight. Exposure times were nominally 5-weeks, but the actual exposure times varied somewhat due to other sampling efforts and weather-related effects on the monitoring program.

When possible, the 3-mm and 6-mm spacing portions of the samplers were analyzed separately. However, luxuriant growth of periphyton during the summer and early fall often made it impossible to distinguish the spacing portion of the sampler on which the growth was attached. In these cases, no effort was made to separate the plates by spacing size, and results in Table 6 of Appendix 2 are reported as composite samples. The composites are denoted as "3 + 6" in the GAPSIZE column of Table 6, Appendix 2.

No significant differences in total PCB concentration were found between the samplers that were split into 3-mm and 6-mm portions and those composited of both 3-mm and 6-mm sections (Kruskal-Wallis test, H = 0.714, P = 0.700). This finding means that the 1990 data may be pooled for statistical purposes, rather than performing individual statistical analyses on the composite, 3-mm and 6-mm sections of the samplers.

Table 32 provides the 1990 mean PCB concentrations for each station where multiplate samplers were set. Only Aroclors 1242 and 1254 were detected in the Hester-Dendy samples, with Aroclor 1242 being the most abundant of the two Aroclors. Based on the pooled data from the composite, 3-and 6-mm fractions of the samplers, Tables 33 and 34 provide the mean, standard error of the mean, median, minimum and maximum Aroclor 1242 and 1254 concentrations, respectively, at each station during 1990.

The 1990 construction monitoring Hester-Dendy Aroclor 1242 and 1254 concentrations are summarized in Table 35. Total PCB concentrations are summarized in Table 36. Stations E-0, E-4 and E-5A had the highest concentrations of Aroclor 1242 and total PCB during construction monitoring . In the case of Stations E-0 and E-4, the mean values were elevated because of one high concentration sample at each station (Table 6, Appendix 2). Stations E-4, E-2 and E-0 contained the highest Aroclor 1254 concentrations during construction monitoring (Table 35).

Stations C-1, GF-1, GF-2, GF-3

These four stations, all located upstream of the remnant area construction activities (Figure 7), were the only stations at which no detectable PCBs were found in any of the Hester-Dendy samples during 1990 (Table 6, Appendix 2). Five sets of samplers were placed at each of these stations during 1990. All were recovered from Stations C-1 and GF-3, although the original sampler set at Station C-1 on April 26th was vandalized, and reset on May 9th. Two of the five samplers set at Station GF-1 were vandalized, those initially placed on June 6th and July 19th. Four of the five samplers set at Station GF-2 were recovered. The sampler set on June 6th at Station GF-2 was vandalized.

Station GF-4

This station was the farthest upstream station to record detectable PCBs during 1990. Only four of the five samplers set at the station during 1990 were recovered; the sampler set on April 25th was not recovered. As discussed in the methodology section of this report, the location of Station GF-4 was moved from its original location due to loss of access to the river at the original location of the station.

Two of the recovered four samplers provided samples with detectable PCBs (Figure 133). One sampler, found after a 40-day exposure between June 28th and August 7th, had 5.30 μg/g Aroclor 1242 and 1.60 μg/g Aroclor 1254. This sample contained the highest PCB concentrations in a silt and periphyton sample collected upstream of Bakers Falls since the beginning of the monitoring program in 1989. The second sample yielded a low level of 0.08 μg/g Aroclor 1242, following a 35-day exposure between August 7th and September 11th. The other two samplers set later in the year provided samples with no detectable PCBs.

Station C-2

All (five) samplers placed at Station C-2 during 1990 were successfully recovered. Four of the samplers contained silt and periphyton with detectable PCBs. The highest concentrations were noted from samplers exposed to the river between August and November (Figure 134). The highest total PCB concentration (8.50μg/g) was found in a sampler exposed 28 days between October 31st and November 28th. This composite sample consisted of 7.20 μg/g Aroclor 1242 and 1.30 μg/g Aroclor 1254.

Three of the four samplers containing detectable PCBs contained both Aroclors 1242 and 1254. The 1990 mean percentage of Aroclor 1242 was 89.2%, with Aroclor 1254 comprising the remaining 10.8%. The 1990 mean total PCB concentration from samplers at Station C-2

was 4.77 μg/g, which was only exceeded by the mean values from Stations E-0, E-4 and E-5A.

Station E-0

All (five) samplers set at Station E-0 during 1990 were successfully recovered. The sampler exposed for 49 days between October 11th and November 29th contained the highest PCB concentration in a Hester-Dendy sample during 1990. This sample contained 20.00 μg/g Aroclor 1242 and 3.60 μg/g Aroclor 1254. The 6-mm spacing portion of the sampler exposed for 41 days between April 27th and June 7th also contained in excess of 10 μg/g total PCB, having 10.50 μg/g Aroclor 1242 and 1.30 μg/g Aroclor 1254. The remaining three samples from Station E-0 contained between 4 and 7 μg/g total PCB (Figure 135).

Station E-1

All (seven) samples collected from Station E-1 during 1990 contained both detectable Aroclor 1242 and Aroclor 1254 (Figure 136). The mean Aroclor 1242 content was 75%; the remaining 25% was Aroclor 1254. The mean total PCB concentration at Station E-1 during 1990 was 4.17 μg/g, making Station E-1 one of seven stations whose 1990 mean detectable total PCB concentration was between 3 μg/g and 5 μg/g.

Station E-2

All seven Hester-Dendy samples collected at Station E-2 during 1990 contained both Aroclors 1242 and 1254 in detectable quantities. The station mean Aroclor 1242 content was 74.1%, with the remaining 25.9% being Aroclor 1254 (Tables 33 and 34).

During construction monitoring, the highest PCB levels found at Station E-2 were from

the sampler retrieved on July 12th (Figure 137). This sampler was set during the preconstruction monitoring, but was retrieved during construction monitoring. The 3-mm fraction of this sampler contained 3.80 μg/g Aroclor 1242 and 1.60 μg/g Aroclor 1254. The 6-mm portion of the sampler contained 6.40 μg/g Aroclor 1242 and 4.20 μg/g Aroclor 1254, the highest Aroclor 1254 concentration found in a Hester-Dendy sample in 1990.

The remaining samplers set during construction monitoring contained between 4.28 μg/g and 6.80 μg/g total PCB (Table 6, Appendix 2).

Station E-3

Three samplers were placed at Station E-3 during the construction monitoring period. All were successfully recovered. A fourth sampler, placed during the preconstruction monitoring, was recovered during construction monitoring (Table 6, Appendix 2). All samplers recovered during construction monitoring contained both Aroclors 1242 and 1254.

The highest PCB concentrations at this station during construction monitoring were obtained in two samplers; one following a 35-day exposure between June 7th and July 12 and the other following a 49-day exposure between October 11th and November 29th. The sampler retrieved on July 12th contained 4.70 μg/g Aroclor 1242 and 2.30 μg/g Aroclor 1254 in the 6-mm section of the sampler. The composited sample, collected November 29th, contained 6.10 μg/g Aroclor 1242 and 0.53 μg/g Aroclor 1254. No discernable seasonal pattern was noted in the PCB uptake by Hester-Dendy samplers at Station E-3 (Figure 138).

The mean Aroclor 1242 content of samples collected at Station E-3 during 1990 was 79.0% (Table 33), while 21% of the total PCB was Aroclor 1254, (Table 34). The relatively high concentrations of PCB in the silt and periphyton during late October and November corresponds to the period of high waterborne PCBs at Station RS3W1, and may be reflective of those levels.

Station E-4

Three of the four samplers exposed during all (or a portion) of the construction monitoring period were recovered. The fourth sampler, set on October 11th, was not recovered. The 6-mm portion of the sampler recovered on July 12th, after a 35-day exposure, contained elevated levels of Aroclor 1242 (6.70 μg/g) and Aroclor 1254 (2.80 μg/g). However, a composite sample, exposed for 42 days between August 30th and October 11th, contained the second highest total PCB (22.0 μg/g), Aroclor 1242 (18.0 μg/g) and Aroclor 1254 (4.0 μg/g) concentrations in a Hester-Dendy sample collected during 1990. The elevated PCB concentrations in this sample were largely responsible for the station mean Aroclor 1242 (5.50 μg/g) and total PCB (6.91 μg/g) concentrations being the third highest of the stations having Hester-Dendy samplers (Tables 33 and 34). The remaining construction monitoring samples from Station E-4 all contained detectable PCBs, with total PCB concentrations being between 1.87 μg/g and 3.47 μg/g.

The mean Aroclor 1242 content of samples collected at Station E-4 during 1990 was 80.5%, with Aroclor 1254 accounting for the remaining 19.5%. Table 6 of Appendix 2 shows that the Aroclor composition of samples from Station E-4 (and the stations downstream of E-4) were somewhat more variable than that of samples at upstream stations. Aroclor 1254 content varied from 7.8-31.0%. Except for the sample recovered on October 11th being high in PCBs, no unusual occurrences nor readily discernable trends were noted in the seasonal pattern of PCB concentrations in samples from Station E-4 (Figure 139).

Station E-5

As shown in Figure 140, all (four) construction monitoring samples from Station E-5 contained considerably higher PCB concentrations than that in the single sample recovered during preconstruction monitoring (May 31). Total PCB levels in silt and periphyton at Station E-5 during construction were between 3.82 μg/g and 7.30 μg/g, with all samples

containing both Aroclor 1242 and 1254. The mean Aroclor 1242 content of samples from Station E-5 was 81.3% (Table 33), while Aroclor 1254 accounted for 18.7% of the total PCB (Table 34).

The highest PCB levels at Station E-5 were found in the 3-mm section of a sampler exposed for 42 days between May 31st and July 12th (4.50 μg/g Aroclor 1242, 2.20 μg/g Aroclor 1254), and in a composite sample recovered on November 29th after a 49-day exposure (6.10 μg/g Aroclor 1242, 1.20 μg/g Aroclor 1254). The other three samples collected during construction monitoring contained between 3.82 μg/g and 4.94 μg/g total PCB (Table 6, Appendix 2). The latter sampler was exposed during the period when water samples at the remnant areas also contained the highest PCB concentrations.

Stations E-5A

Of four Hester-Dendy samplers set at this station during construction monitoring, only two were recovered (Table 6, Appendix 2). The samplers set on July 5th and November 1st at Station E-5A were vandalized and not recovered. Both of the recovered samplers contained Aroclor 1242 and Aroclor 1254.

One sampler, recovered on November 1st after a 49-day exposure, was among the eight samplers with a total PCB concentration in excess of 10 μg/g (Table 6, Appendix 2). Because the sampler exposed during preconstruction monitoring contained over 10 μg/g total PCB, Station E-5A contained the highest overall mean Aroclor 1242 (Table 33), highest mean total PCB (Table 36), and second highest mean Aroclor 1254 concentrations (Table 34) in Hester-Dendy samples during 1990. However, for the construction monitoring period, the mean Aroclor 1242 and mean total PCB concentrations in at Station E-5A were only the third highest of the monitoring stations, being behind Stations E-0 and E-4.

As was the case for Stations E-3, E-4 and E-5 (Figures 138 to 140), the highest PCB concentrations at Station E-5A (Figure 141) were noted during late June and early July, and during October and November. Although the October and November samples correspond with the period of highest PCB concentration in water, and may reflect construction impacts, the June and early July concentrations are likely unrelated to construction activities.

Station E-5A samples had one of the highest average Aroclor 1242 contents of all the stations, averaging 87.3% Aroclor 1242 throughout 1990 (Table 33). On average, only 12.7% of the total PCB in silt and periphyton from Station E-5A was Aroclor 1254 (Table 34).

Station E-6

Only three of the four samplers set at Station E-6 during construction monitoring were successfully recovered. The sampler placed on July 19th was not recovered. Aroclors 1242 and 1254 were detected in all three samplers recovered during construction monitoring. The mean 1990 Aroclor 1242 content of samples from Station E-6 was 76.8%, with the remaining 23.2% being Aroclor 1254 (Tables 33 and 34). A total PCB content of the silt and periphyton samples from Station E-6 were between 2.75 μg/g and 4.70 μg/g (Table 6, Appendix 2) during construction monitoring, a rather narrow range compared to other stations. As was the case for several other stations in the immediate vicinity of the remnant areas, the highest concentrations were found during late June and early July, and during October and November (Figure 142).

The overall 1990 site means, 2.54 μg/g Aroclor 1242 and 0.83 μg/g Aroclor 1254, appear lower than the other stations in the vicinity of the remnant areas (Stations E-0 to E-5A), but are statistically indistinguishable from most of those stations. This was also true for the construction monitoring period mean Aroclor 1242 and 1254 concentrations (Table 35).

Station E-7

Silt and periphyton total PCB concentrations at Station E-7 during 1990 were substantially lower than those at stations in the vicinity of the remnant areas. Both Aroclors 1242 and 1254 were detected in all samples collected during construction monitoring. The mean 1990 Aroclor 1242 content of samples from Station E-7 was 82.7% with 17.3% of the total PCB being Aroclor 1254 (Tables 33 and 34). The mean construction monitoring Aroclor 1242 concentration was 1.40 μg/g, while the mean construction monitoring Aroclor 1254 concentration was 0.64 μg/g (Table 35).

The highest PCB concentration at Station E-7 during 1990 was from a sampler exposed for 37 days between June 12th and July 19th (Figure 143). This composite sample contained 3.50 μg/g Aroclor 1242 and 2.30 μg/g Aroclor 1254. No other construction monitoring sample contained more than 1.79 μg/g total PCB (Table 6, Appendix 2). A consistent downward trend in PCB concentrations in silt and periphyton was noted at Station E-7 over the duration of the construction monitoring period (Figure 143). No changes in PCB concentrations that were attributable to construction activities at the Remnant Sites were noted in the Hester-Dendy samples from Station E-7.

Station HR-1

All (four) samplers placed at Station HR-1 during construction monitoring were successfully recovered. All samples contained both Aroclors 1242 and 1254. The mean Aroclor 1242 content of samples was 75.4%, with the remaining 24.6% consisting of Aroclor 1254 (Tables 33 and 34).

No obvious trend in PCB content of silt and periphyton was noted at Station HR-1 during construction monitoring (Figure 144). The total PCB content of samples from Station HR-1 is lower than any other Hudson River station monitored during 1990, with mean construc-

tion monitoring concentrations of 0.40 μg/g Aroclor 1242, and 0.19 μg/g Aroclor 1254 (Table 35).

No appreciable construction activity impacts on silt and periphyton concentrations at Station HR-1 were detected. The highest concentrations noted were in the 3-mm section of a sampler exposed for 43 days between July 11th and August 23rd (0.52 μg/g Aroclor 1242, 0.25 μg/g Aroclor 1254).

Station MR-1

All (four) samplers exposed during all (or part) of the construction monitoring program were recovered. Only one of the construction monitoring samples contained detectable PCBs (Figure 145). After a 43-day exposure between October 2nd and November 14th, a composite sample contained 0.07 μg/g Aroclor 1254. Station MR-1 is the only sampling station having Hester-Dendy samples containing only Aroclor 1254 (Table 6, Appendix 2; Figure 145).

3.3.8.3.2 Caddisflies. All caddisfly larvae samples were collected during the 1990 Construction Monitoring Program. All collections occurred at four stations (GF-4, C-2, E-5 and E-6). A single collection of larvae occurred during late August and September. This is the time of year immediately before emergence, when the larvae are at their maximum size. Larvae collected were mostly Hydropsyche spp. and Cheumatopsyche spp. Table 37 lists the Aroclor 1242 and 1254 concentrations detected in the larvae. No other Aroclors were detected in the caddisfly samples.

3.3.8.3.3 Caged Fish. Results of the 1990 caged fish (fathead minnow) bioaccumulation studies are compiled in Table 7 of Appendix 2 and summarized in Table 38. In-situ tests were conducted at Stations C-1, C-2 and E-6 during four periods; tests were conducted at Stations GF-4, E-5 and E-7 during five periods. A subset of each group of fish used in the

tests was analyzed at the beginning of each exposure period. These samples are denoted as STOCK in Table 7 of Appendix 2. All analytical PCB results are expressed as $\mu g/g$ dry weight. Table 7 of Appendix 2 also reports the percent lipid content of the fish samples.

Three groups of the stock fish showed highly elevated concentrations (6.0, 3.7 and 2.3 $\mu g/g$ dry weight) of Aroclor 1254 (Table 7, Appendix 2). This prior contamination unfortunately rendered Aroclor 1254 values unusable for the in-situ fish tests conducted between August 7-17th, September 6-12th, and September 25th to October 12th. Although no Aroclor 1242 was detected in the stock fish, the Aroclor 1242 results for the field-exposed fish during these three periods are considered suspect for analytical reasons. The prior contamination poses a potential source of error in the gas chromatograms because the PCB homologs in Aroclor 1254 could be included as part of the Aroclor 1242 concentration; additionally, the fish could metabolize Aroclor 1254 in such a way that the Aroclor 1254 peaks in the chromatogram are mistaken for Aroclor 1242.

In the in-situ tests not compromised by contamination of the stock fish, PCB concentrations were highest at most stations during October and November. This was especially true for the three stations (C-1, GF-4 and C-2) located upstream of the remnant areas. These results indicate that PCB contamination exists in the Hudson River upstream of the remnant areas and the General Electric facilities in Hudson Falls and Ft. Edward.

Although 31 in-situ tests were attempted during the 1990 construction monitoring period, total mortality of the exposed fish occurred in the first test at Stations E-5, E-6 and E-7 (during late June) and in the test at Station C-1 (early September), reducing the number of completed tests to 27. The reasons for these mortalities are unknown.

Station C-1. Of the four in-situ tests conducted at the most upstream control station, Station C-1, only the fish set on October 27th and retrieved on November 16th (the last set of 1990) had detectable PCBs that could not be attributed to contaminated stock fish. These fish

contained 0.73 μg/g Aroclor 1242 and 0.12 μg/g Aroclor 1254. No detectable PCBs, attributable to exposure to the river, were found in the other in-situ assayed fish at Station C-1 during 1990.

Total mortality of the group of fish placed at Station C-1 on September 12th was noted when the fish were recovered on October 5th. This was the only occurrence of mortality in the in-situ tests during early September.

Station GF-4. The first and last groups of fish placed at Station GF-4 during 1990 were the only groups at this station whose PCB body burdens could not be attributed to contamination of the stock fish. Fish set at Station GF-4 between June 28th and July 20th accumulated no detectable PCBs in the 22-day exposure. However, although fish exposed for 24 days between October 17th and November 9th accumulated no Aroclor 1242, they did accumulate 3.80 μg/g Aroclor 1254. This group of fish contained the highest PCB concentration found in the in-situ tests upstream of Bakers Falls since the environmental monitoring program began in 1989. No detectable Aroclor 1242 was found in any of the five groups of fish placed at Station GF-4 during 1990 (Table 38).

Station C-2. Four in-situ tests were conducted at Station C-2 during 1990. Detectable PCBs not due to stock contamination were found in the first group of test fish. Exposed for 22 days between June 28th and July 20th, the fish contained 0.84 μg/L Aroclor 1242 and 0.66 μg/L Aroclor 1254.

The highest PCB concentrations bioaccumulated by test fish at Station C-2 during 1990 were found during a 21-day exposure between September 27th and October 17th. The Aroclor 1242 concentration found in these fish was 4.50 μg/g. However, the Aroclor 1254 concentration (2.40 μg/g) in the fish is nearly identical to the 2.30 μg/g Aroclor 1254 in the stock fish and is likely the residue of prior contamination.

In the remaining (two) tests at Station C-2, PCB concentrations in the caged fish, set on August 7th and September 4th, respectively, contained total PCB concentrations within 0.10 μg/g of the total PCB levels in the stock fish (Table 7, Appendix 2). The results of these tests are, thus, considered to be unusable, and are not discussed further.

Station E-5. Six in-situ tests were conducted at Station E-5 during 1990. As noted previously, total mortality occurred in the first group of fish set on June 26th. The fish in the remaining five tests contained detectable PCBs, with Aroclor 1242 being found in two tests and Aroclor 1254 found in all five. However, only one of the five tests is considered to have reliable concentrations of both Aroclor 1242 and Aroclor 1254. The fish in this test, conducted over a 24-day exposure period between October 16th and November 8th, contained 5.50 μg/g Aroclor 1242, the highest concentration of Aroclor 1242 found in the in-situ tests during 1990, and 0.60 μg/g Aroclor 1254. The Aroclor 1242 results for the other test in which that Aroclor was detected are also considered reliable. The fish in this test, conducted for a 21-day exposure between September 26th and October 16th, contained 5.00 μg/g Aroclor 1242. However, the 2.10 μg/g Aroclor 1254 in this sample is only 0.20 μg/g less than the 2.30 μg/g Aroclor 1254 found in the stock fish, and is considered to be the residue originally present in the stock fish.

No Aroclor 1242 was detected in the groups of fish set at Station E-5 on August 16th and September 5th, respectively. Because the Aroclor 1254 levels found in the test fish during these two exposure periods were within 0.70 μg/g of the levels in the stock fish (Table 7, Appendix 2), the Aroclor 1254 concentrations in the test fish during these two periods are not considered reliable.

Station E-6. Five in-situ tests were conducted at Station E-6 during 1990. Complete mortality of the group of fish placed on June 29th was observed after 11 days of exposure. Of the remaining four tests, the only test having results considered reliable for both Aroclor 1242 and Aroclor 1254 was conducted for 22 days between October 26th and November

16th. No detectable Aroclors were found in this group of fish. The remaining three sets at Station E-6 during 1990 contained no detectable Aroclor 1242, while the Aroclor 1254 concentrations in all three test fish samples was within 1.00 μg/g of the levels found in the contaminated stock fish (Table 7, Appendix 2). Thus, the Aroclor 1254 results for the tests begun August 15th, September 6th and September 28th are believed to reflect the Aroclor 1254 concentration originally present in the stock fish.

Station E-7. During 1990, five in-situ tests were conducted at Station E-7. Total mortality occurred in the initial group of test fish. The absence of detectable Aroclor 1242 and the presence of Aroclor 1254 at concentrations within 1.10 μg/g of the levels in the stock fish in the subsequent three tests leads to the conclusion that results of the tests begun August 15th, September 6th and September 28th reflect the Aroclor 1254 concentrations originally present in the stock fish. Only the group of fish tested between October 26th and November 16th provided reliable concentrations of both Aroclor 1242 and Aroclor 1254. The Aroclor 1242 concentration in these test fish was 0.60 μg/g; no Aroclor 1254 was detected.

3.3.8.4 QA/QC. The results of the QA/QC procedures for the 1990 construction monitoring period are given in Appendix 3.

4.0 SUMMARY AND CONCLUSIONS

The 1990 Preconstruction Monitoring and Construction Monitoring Programs resulted in a substantial amount of data (consisting of over 3500 samples) on airborne PCBs in the vicinity of the Remnant Sites, and on PCBs in upper Hudson River sediments, water and aquatic biota. During the 1990 preconstruction program, 370 air quality samples, 40 sediment samples, 233 water samples, 97 dialysis bags and 37 Hester-Dendy samples were collected. During the 1990 Construction Monitoring Program, 827 air quality samples, 77 sediment samples, 1508 water samples, 215 dialysis bags, 80 periphyton (Hester-Dendy) samples, four caddisfly samples and 27 caged fish samples were collected. Because construction activities on the Remnant Sites continued beyond December 1990, only limited conclusions can be drawn at this time regarding the overall impact of the construction

activities on the levels of PCB in the air and water in the vicinity of the Remnant Areas Sites and downstream. However, the results are sufficient to compare stations and trends for the monitored parameters, and to indicate the presence of sources of PCB upstream of the Remnant Sites.

4.1 Construction Impacts

Because diverse construction activities were occurring simultaneously on the same Remnant Site (as well as on adjacent Remnant Sites), specific construction activities generally cannot be identified as having a particular impact. An exception to this generalization is the impact of the construction of the temporary bridge from the west bank of the river to Remnant Site 3. This activity can reasonably be concluded to have caused elevated PCB levels in water at stations immediately downstream. Activities requiring considerable movement of construction equipment (such as regrading, subgrade placement and channel work) also resulted in an increase in PCB detections in air and water.

4.2 Station Comparisons and Trends in Monitored Parameters

4.2.1 Air Quality. The following summarizes the trend in the 1990 air quality data. During the 1990 preconstruction period, there were no detectable airborne concentrations of PCB. Detectable airborne PCB concentrations were measured during the early phases of construction, particularly during clearing, regrading and placement of the initial sand layer. As construction progressed beyond placement of the initial sand layer, the PCB concentrations decreased. No detectable PCB concentrations were found after November 28, 1990. At that point, the initial sand layer was completely in place on Sites 2, 3 and 5 and partially in place on Site 4.

The preconstruction monitoring documented that the Remnant Sites were not measurably impacting the air, with respect to PCB, in the Fort Edward vicinity. Construction monitoring

indicated that the construction activities resulted in low concentrations of airborne PCB in the vicinity of the Remnant Sites. These detectable PCB concentrations were confined principally to the Remnant Sites themselves. Relatively few, measurable PCB concentrations were detected near populated areas. No PCB concentrations were detected after the Remnant Sites were covered with sand.

4.2.2 **Sediment.** A total of 117 sediment samples was collected during 1990. Forty were collected during preconstruction monitoring, while 77 were collected during construction monitoring. Of these 117 samples, 94 contained detectable PCBs. Aroclor 1242 was detected in 74 samples; Aroclor 1254, in 83. Tables 39 and 40 provide the mean Aroclor 1242 and Aroclor 1254 composition, respectively, of all sediments collected from each station during 1990.

No significant differences (Analysis of Variance, $F = 0.254$, $P = 0.615$) were found between the total PCB concentration of sediments for the 1990 preconstruction and construction monitoring periods (Table 41). This implies that construction activities had no discernable impact on sediment PCB concentrations during 1990.

For the individual stations, where a sufficient number of samples were collected during both preconstruction and construction monitoring to allow determination of within sampling period variation, no significant differences ($P = 0.05$) in total PCB concentrations were noted. However, significant differences ($P = 0.05$) were noted among the total PCB concentrations at groups of the individual sampling stations. Contrast analyses and Tukey's HSD test provided the following relationships among PCB concentrations at the various stations:

E5 > E0 = E1 = E2 = E4 = E5A = E6 > C2 = E3 = E7 = HR1 > C1 = GF1 = GF2 = GF3 = MR1 > GF4

The above relationship was based on pooling the results of all 1990 samples. Figure 146 illustrates the station mean Aroclor 1242 and Aroclor 1254 content of all samples collected from each station during 1990.

As shown in Figure 146, Station E-5 sediments contained significantly higher PCB concentrations than sediments at other stations. Six stations, five of which are in the immediate vicinity of the remnant areas, formed the next cluster of stations with elevated PCB concentrations. Station E-6, located just downstream of the Thompson Island Dam, also fell into this cluster.

A third cluster, including Stations E-7 and HR-1, the two most downstream stations, formed another group of stations with similar PCB concentrations. Stations C-2 and E-3, two of the stations with the lowest silt and TOC content, also fell within this cluster of samples with low PCB concentrations.

The final two groups of stations with very low PCB concentrations consisted of either stations upstream of the remnant areas (control stations) or the Mohawk River. These stations should not be affected by construction activities.

The relationship among stations during 1990 is somewhat different than that found in 1989 (Harza / Yates and Auberle 1990a). Figure 147 provides a comparison of the station 1989 and 1990 mean total PCB concentrations for those stations sampled during both years.

Table 42 provides a correlation matrix showing relationships among the Aroclor and total PCB concentrations, sediment particle sizes, total solids, TOC and TVS. As would be expected, the Aroclor 1242, Aroclor 1254 and total PCB concentrations are highly correlated. The particle size distributions and TS, TVS and TOC results also show a high degree of autocorrelation. However, a statistically significant ($P = 0.05$) negative correlation is shown between Aroclor 1254 concentrations and the clay content of the samples.

4.2.3 Water

4.2.3.1 Water Samples. At one time or another during 1990, detectable PCB concentrations were found in water samples from 13 of the 18 stations where grab samples were collected on a weekly basis. Only stations C-1, GF-1, GF-4, HR-1 and MR-1 (Figure 7) had no detectable PCBs during 1990. Stations C-1, GF-1 and GF-4 are upstream of the General Electric plants in Hudson Falls and Ft. Edward, and would not be influenced by either construction activities at the Remnant Sites or the former PCB discharges from the two GE plants. Station MR-1, which is on the Mohawk River, would also not be influenced by construction activities at the Remnant Sites or discharges from the two GE plants.

During 1990, most of the detectable PCBs in grab samples was noted during the spring quarter (March to June) and during the fall quarter (October to December). Of the 35 grab samples with detectable PCBs, 23 were collected from stations upstream of construction activities (all stations between C-1 and E-0, inclusive) or were collected prior to the start of construction. After construction activities commenced, only two of the grab samples with detectable PCBs were collected between July 1 and September 30, whereas 14 such samples were collected between October 1 and December 31.

When all 1990 water data are pooled, only a weak correlation was noted between PCB in water and Hudson River discharge at Ft. Edward or at Spier Falls (Table 43, Figures 148 and 149). No significant ($P=0.05$) correlation was noted between PCB concentrations in water and precipitation at Glens Falls (Table 43). The precipitation and discharge data are presented in Table 3 of Appendix 2. Figures 150 to 153 illustrate discharge and precipitation data for each quarter of 1990. A significant negative correlation between Aroclor 1242 and total suspended solids ($r = -0.379$, $P = 0.047$) was noted for the grab samples. An insufficient number of total suspended solids samples were collected by the ISCO samplers to allow determination of any relationship between TSS and PCB levels.

An attempt was made to estimate the mean concentration of Aroclors 1242 and 1254 in the Hudson River in the vicinity of the remnant areas. Although most of the statistical analysis in this report has involved those water samples with detectable PCBs, samples with no detectable PCBs must also be considered. Summarizing results from a censored data set (in this instance, concentration values below the LOD are unknown and unavailable) poses statistical difficulties. But if the statistical distribution of a censored set of data can be determined, procedures described by Gilbert (1987) can be used to estimate the mean of the entire censored data set. This is especially true if the data fit a lognormal distribution.

Water quality data are often assumed to fit a lognormal distribution (Helsel 1990, Travis and Land 1990). The distribution of Aroclor 1254 concentrations in Hudson River water samples was found to fit a lognormal distribution of concentration values based on a probability plot (Figure 154), but the distribution of Aroclor 1242 concentrations did not (Figure 155). Using a maximum likelihood estimator (Gilbert 1987), the 1990 mean Aroclor 1254 concentration in the Hudson River near Ft. Edward was estimated to be 1.1 ng/L (parts per trillion). The failure of the Aroclor 1242 data to fit a quantifiable statistical distribution rendered unreliable any maximum likelihood estimates of mean PCB concentrations in the Hudson River for 1990.

4.2.3.2 **Dialysis Bags.** During 1990, 32 (approximately 10%) of the total 312 dialysis bag samples contained detectable PCBs. This compares to 19 (31%) of 69 bag samples that were found to contain detectable PCBs in the 1989 studies (Harza/Yates & Auberle 1990a). Aroclor 1242 was the only Aroclor identified in both the 1989 and 1990 studies. However, whereas no level of PCB exceeded 0.1 μg/L in the 1989 studies, concentrations reached 0.2 μg/L in 12 samples (one at E-3, seven at E-6 and four at E-7) during 1990.

The number of bags with detectable PCBs (16) was the same at stations downstream of Ft. Miller (Stations E-6 and E-7) as the number above Station E-6 (Station E-2, E-3, E-4, E-5 and E-5A) during 1990. Station E-6 had the highest number of bags with detectable PCBs

and highest PCB concentrations (Figure 156). During 1989, Station E-6 also had the highest percentage of bags with detectable PCBs.

4.2.4 Aquatic Biota

4.2.4.1 Hester-Dendy Samples. A total of 117 Hester-Dendy multiplate samplers set at all (17) aquatic monitoring stations were recovered during 1990. PCBs (principally Aroclor 1242) were detected at 13 stations, with total PCB concentrations varying from non-detectable to 23.6 mg/kg (dry weight).

Statistically significant differences were found between stations in the total PCB concentrations (Analysis of Variance or ANOVA, $N = 110$, $F = 6.843$, $P < 0.001$), Aroclor 1242 concentrations (ANOVA, $N = 110$, $F = 6.941$, $P < 0.001$) and Aroclor 1254 (ANOVA, $N = 110$, $F = 4.892$, $P < 0.001$) concentrations. The coefficients of determination (proportion of the variation between PCB concentrations accounted for solely by changes in sampling location) were 0.541 for total PCB, 0.544 for Aroclor 1242, and 0.457 for Aroclor 1254.

Further analysis of the 1990 mean total PCB concentrations using contrasts and Tukey's HSD multiple comparison tests indicated the following relationship among the various sampling stations (upstream to downstream when more than one station has statistically indistinguishable mean total PCB concentrations):

E5A > GF4 = C2 = E0 = E1 = E2 = E3 = E4 = E5 = E6 > E7 > HR1 > MR1 > C1 = GF1 = GF2 = GF3

Stations C-1, GF-1, GF-2 and GF-3, with no detectable PCBs during 1990, form a group of four stations. The lack of a variance at these stations, caused by the absence of detectable PCBs, resulted in the formation of a statistical cluster of stations having the least PCB. Station E-5A has the largest mean total PCB concentrations in silt and periphyton. Station

E-0, located upstream of the construction activities at the Remnant Sites, has the second highest mean total PCB concentrations.

Figure 157 compares the mean total PCB concentrations of stations where Hester-Dendy samplers were deployed during both 1989 and 1990. As can be seen in the figure, the trends in PCB concentrations at the various stations during 1989 and 1990 were similar. Stations E-0 and E-5 had the highest overall PCB concentrations during 1989, while Stations E-0 and E-5A had the highest total PCB concentrations during 1990.

4.2.4.2 Caddisflies. Figure 158 compares the Aroclor and total PCB concentrations in caddisflies collected during 1989 and 1990. For the three stations at which comparisons are possible, Figure 158 shows that the total PCB concentrations are comparable for the two years. Caddisfly larvae from Station E-5 contained the highest PCB concentrations, followed by larvae from Station C-2. Larvae from Station E-6 contained less than half of the PCB content of larvae from Station E-5. No detectable PCBs were found in the caddisfly sample from Station GF-4.

Figure 158 shows that the same trends in PCB concentrations and composition occurred at Stations C-2, E-5 and E-6 in 1989 and 1990. In all three cases, total PCB concentrations went up slightly during 1990. A slight decrease in Aroclor 1242 concentrations at all three stations during 1990 was offset by an increase in Aroclor 1254.

As was the case for the 1989 caddisfly samples (Harza / Yates & Auberle 1990a), the downstream stations contained a larger proportion of Aroclor 1254 than did the upstream stations. It cannot be determined at this time whether these trends are part of a larger long term trend or are just random variation in the results.

4.2.4.3 Caged Fish. Although 31 in-situ tests with caged fathead minnow were attempted during 1990, the prior Aroclor 1254 contamination of the fathead minnow stock and

mortalities of the test fish reduced the number of useable tests for Aroclor 1242 concentrations to 24 and the number useable for Aroclor 1254 to seven. Aroclor 1242 was detected in only six of the 24 useable samples (one sample each at Stations C-1 and E-7, and two samples each at Stations C-2 and E-5). All but one of these samples (the July 20th sample at C-2) occurred in the fall (and had only about 18% of the Aroclor 1242 concentration found in the fall sample). Aroclor 1254 was detected in only four samples (one each at Stations C-1, GF-4, C-2 and E-5). Except for the July 20th sample at C-2, these detections also occurred during the fall. This is in contrast to the 1989 caged fish studies, in which PCB concentrations declined in the fall (Harza / Yates & Auberle 1990a).

The PCB levels in the 1990 studies exceeded those in the 1989 studies at Stations C-1, C-2 and E-5, but were lower than those in the 1989 studies at Stations E-6 and E-7. However, whereas no total PCB concentration in the 1989 caged fish samples exceeded the USFDA action level of 2.0 μg/g, three samples (one at C-2 and two at E-5) exceeded this action level in 1990.

4.3 Correlations Among Parameters

PCB concentrations in six Hudson River environmental matrices were monitored during 1990: waterborne PCB (grab and automatic ISCO samples); PCB fugacity (PCB partial pressure in water) as measured by dialysis bags; periphyton and silt-borne PCB (Hester-Dendy samples); PCB in caddisflies; PCB in fish; and PCB in sediments. Temporal and spatial correlations among these variables reflect times or locations of PCB water and PCB uptake or exchanges by components of the ecosystem. Correlations will depend on the partitioning of waterborne PCB between dissolved and suspended fractions, and on the rates of movement of PCB from one component of the system to another during absorption, volatilization, sedimentation and other environmental processes. Those processes interact with physical dispersion to create spatial and temporal patterns of association that may, or

may not, be identified by correlations, based on samples which reflect concentrations at specific points in time.

Among the six parameters monitored, a correlation in detectable waterborne PCBs was found between the grab water samples and Hester-Dendy samples. This spatial correlation between mean PCB level in 1990 Hester-Dendy samples and the proportion of grab water samples showing detectable PCBs was statistically significant ($r = 0.75$, $n = 16$, $P < 0.001$). Correlation among other parameters were not assessed because sufficient data were not available (caddisflies and fish) or because short term temporal correlations were not appropriate (sediments).

4.4 Sources of PCB Upstream of the Remnant Areas

The design of the construction monitoring program was based on the premise that construction impacts would be observed in water samples collected downstream of a given remnant area, but not upstream of that remnant area. Although it was known from the beginning of monitoring in 1989 that construction activities on the two upstream Remnant Sites (Sites 2 and 3) might be detected at the downstream Remnant Sites (Sites 4 and 5), it was not initially thought that the construction impacts from the Remnant Sites would be observed any appreciable extent downstream.

As shown by the detectable PCBs in water at Stations GF2, GF3, E0, RS2W1 and RS3W1, as well as occasionally elevated PCB levels in sediments and biota upstream of the remnant areas, PCB sources in the Hudson River exist upstream of the remnant areas. The presence of one or more PCB sources located upstream of the remnant areas complicate the determination of construction impacts. Although the identity of the upstream sources are unknown at this time, their continued presence impacts the demonstration of the benefits of the remnant area remediation.

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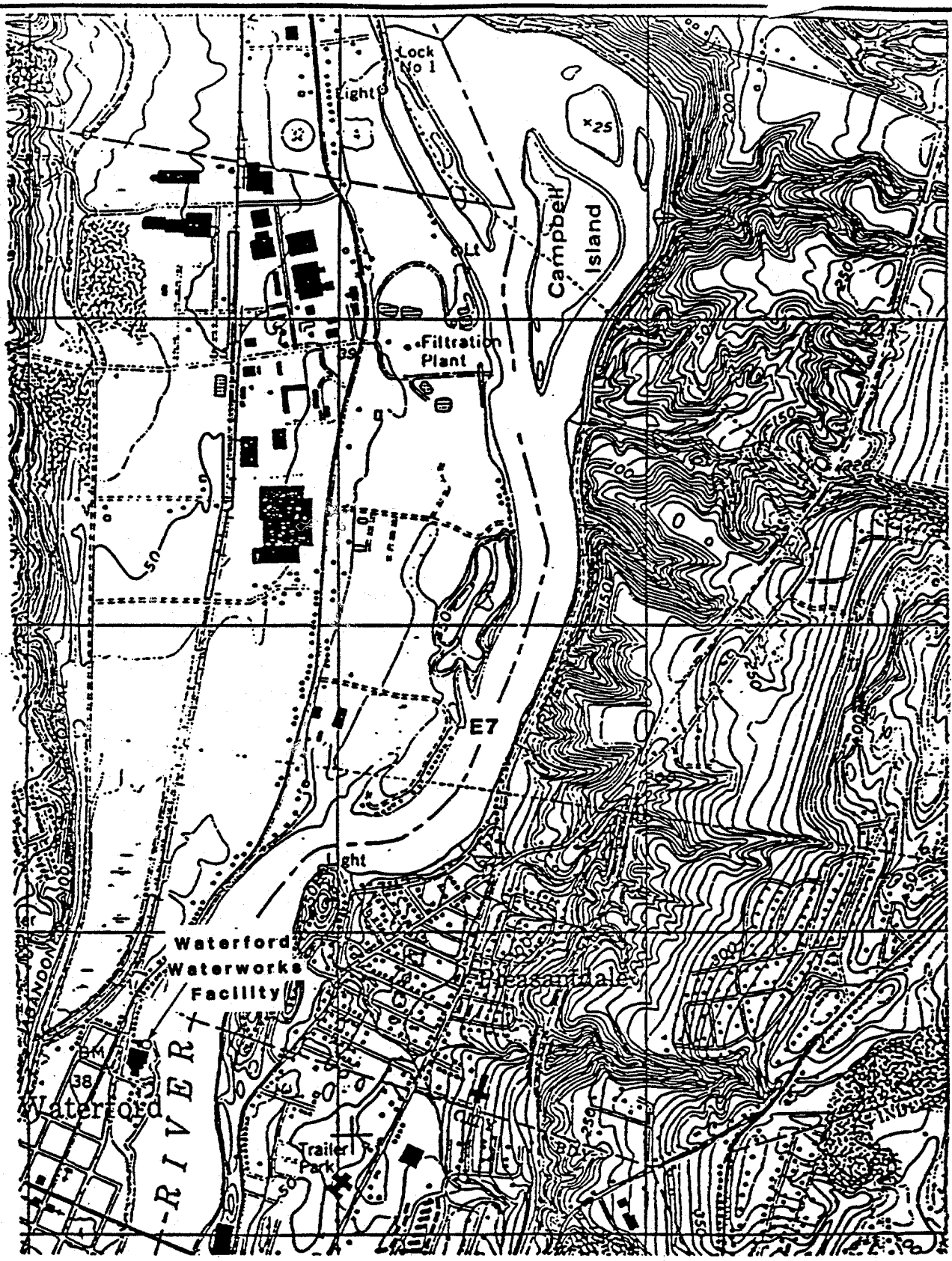

FIGURE 105

SITE E7

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