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Part 1

NEW BEDFORD ENVIRONMENTAL  
INVESTIGATION--AMBIENT  
MONITORING PROGRAM

Final Report



GCA CORPORATION  
Technology Division

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Bedford, Mass 01730

Prepared for

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Research Triangle Park, N.C. 27711

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NEW BEDFORD ENVIRONMENTAL  
INVESTIGATION--AMBIENT  
MONITORING PROGRAM

Final Report

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SECTION 1  
INTRODUCTION

The Environmental Protection Agency is currently conducting a comprehensive evaluation of the occurrences, distribution, transport, and fate of polychlorinated biphenyls (PCBs) and related organic contaminants within the New Bedford area. An integral part of this program is a complete evaluation of the ambient air in and around the New Bedford Metropolitan area. In response to these requirements, GCA/Technology Division, in conjunction with the Environmental Protection Agency, designed a comprehensive monitoring program to assess ambient levels of PCBs, trace metals, and a variety of organic components within the New Bedford area. The resulting program consisted of sampling at each of 21 stations, encompassing a geographical area which included New Bedford, Fairhaven, Dartmouth, and Acushnet. It was the intent of this program to provide quantitative "real time" measurements over the study region using high-volume air samplers operating simultaneously at each of the 21 stations. As a consequence, samples were collected for a 12-hour period on each of 3 days: August 31, September 3, and September 9, 1982.

The specific site listing, contained in Section 2 of this report, included a number of areas of particular interest to both the Environmental Protection Agency and the Massachusetts Department of Environmental Quality Engineering. Included in the "target" site summary were a number of potentially contaminated (i.e., PCBs) areas, as well as urban New Bedford and Fairhaven background stations.

Sampling protocols as noted in Section 3 consisted of the use of high-volume air samplers fitted with both particulate filters and two tandem polyurethane foam plugs. Samplers were typically operated for 12-hour periods and samples returned to the GCA laboratory for subsequent analysis. Meteorological monitoring, as outlined in Section 3, was conducted at each of eight sites located throughout the study region.

Analyses, as outlined in Section 4, were conducted on Day 2 and Day 3 samples only. PCB measurements were made on the 24 high-volume samples collected on each of the 2 days with subsequent organic analyses provided by GC/MS on samples containing significant quantities of PCBs. Additionally, as outlined in the project test plan, comprehensive analyses were conducted on eight preselected samples collected on each of the 2 days. This consisted of organic and trace metals analyses of the particulate filter as well as GC/MS analyses of the polyurethane foam sample.

Analytical results collected for each of the 2 test days are provided in Section 5 including PCB measurements, trace metal analyses and semivolatile organic constituents. A complete discussion of results is provided in Section 6 including the following:

- Apparent trends in data,
- Comparison of data with existing data from study region,
- Comparison of ambient PCB concentrations with levels noted in other urban and rural North American locations,
- Recommendations for further study.

A complete presentation of all program quality control data is provided in Section 7. This includes results of all-laboratory control spikes, blind spikes, surrogate component recoveries, and results of replicate collocated samples for each of the 2 test days. Results of a PCB collection/trapping efficiency study employing polyurethane foam and a PCB storage stability study are also provided.

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## SECTION 2

### DESCRIPTION OF STUDY REGION AND SITE LOCATIONS

#### OVERVIEW

As specified in the program test plan, high-volume air samplers were placed at each of 21 preselected sites in the defined study region. The site summary listing includes a number of suspected emission sources of PCBs as well as a number of potentially contaminated areas previously uncharacterized. Background stations were located at a number of sites in order to establish baseline values over the study region for subsequent comparison purposes. The siting of samplers around each of the designated locations was based on historical meteorological data which indicated that the seasonal prevailing winds would emanate from the southwest. Ambient samples consisting of a particulate filter and two polyurethane foam plugs contained in a high-volume air sampler were placed at each of the sites noted in Table 1 and operated for approximately 12 hours on each of 3 separate days. More specifically, samples were collected on August 31, September 3, and September 9, 1982. The ambient network is illustrated in Figure 1. To permit adequate characterization of fugitive area sources, samplers were placed as closely as possible to flow vectors in the northeast, northwest, and southeast directions. These locations would assess wind flow from the southwesterly, southeasterly and northwesterly directions, respectively.

Meteorological monitoring measurements to be discussed in more detail later in Section 3 were collected at each of eight sites distributed throughout the study region. Multiple meteorological stations were required to permit both adequate categorization of background conditions and locations of "new" sources of PCB emissions. Per the program design, samples were collected on each of 3 separate days during the calendar period August 31 to September 9, 1982. Each of the 3 test days was selected on the basis of meteorological conditions predicted for that day. Generally, samples were collected over a 12-hour period spanning from midmorning to early evening (i.e., 9:00 a.m. to 9:00 p.m.). The 12-hour sampling period was selected to both encompass the more noteworthy trends of a typical day and provide "real time" measurements over the course of a day. A listing of actual sample start and completion times for each of the 3 test days is provided in Section 3 of this report.

#### AMBIENT SITE SELECTION

As specified in the Test Plan/Quality Assurance Plan (Appendix A), 23 locations were selected to adequately define the study region. Actual

TABLE 1. AMBIENT MONITORING SITE LOCATIONS<sup>a</sup>

Site area	Type	Site No.	Location	Selection criteria
Dartmouth	Background	1	Roof of Town Hall <sup>b,c,d</sup>	Outside affected region
Sullivan's Ledge	Area source	2	Onsite	Suspected area source
New Bedford Landfill	Area source	3	Shawmut St. (NE) <sup>c,d,e</sup>	Prevailing wind direction
		4	Adams Oil (SE) <sup>f</sup>	Offshore flow
		5	Airport (NW)	Onshore flow
Cushman Park, Fairhaven	Urban background, poss. area source	6	Onsite <sup>c</sup>	Suspected area source
		7	Job C. Tripp School <sup>e</sup>	Approximately prevailing wind direction
Aerovox	Area source	8	Acushnet Nursing Home (ENE) <sup>d</sup>	Prevailing wind direction
		9	C&W Welding (N) <sup>c,e</sup>	
		10	Burt School (SE)	Offshore flow
		11	Brooklawn Park (WSW)	Upwind of prevailing wind direction
Marsh Island	Area source	12	Taber St. Sta. onsite	Suspected area source
New Bedford (Urban)	Urban background	13	Roof of Fire Station #2 <sup>c</sup>	Assumed unaffected area
Cornell Dubilier	Area source	14	Hurricane Barrier (NNW)	
		15	St. Anne's Rectory (WNW)	Onshore flow
		16	Fire Station #11 (WSW)	
Fairhaven	Urban background	17	Guy's Pharmacy <sup>g</sup>	Assumed unaffected area

(continued)

TABLE 1 (continued)

Site area	Type	Site No.	Location	Selection criteria
New Bedford Sewage Sludge Incinerator	Point source/ area source	18	Location #3 (NNE) <sup>c,d</sup>	Prevailing wind direction
		19	Location #2 (NE)	Prevailing wind direction
		20	Location #1 (E)	
		21	Location #4 (SW)	Upwind of prevailing wind direction

<sup>a</sup>See Figure 1 for site map.

<sup>b</sup>This monitor provides upwind coverage for Cornell Dubilier.

<sup>c</sup>These sites underwent comprehensive analysis including PCBs, other chlorinated organics and trace metals.

<sup>d</sup>Collocated meteorological monitoring instrumentation.

<sup>e</sup>Collocated high volume samplers.

<sup>f</sup>This monitor served the dual purpose of covering Sullivan's Ledge as well as an upwind sampler, depending upon wind direction.

<sup>g</sup>This site provided data on the impact of Cushman Park and Cornell Dubilier on Fairhaven ambient air.

NOTE: High-Volume sampling apparatus were operated at all of the locations listed above. All samplers initially were subjected to PCB analysis. Subsequent work included analysis for other chlorinated organics on samples containing levels compatible with GC/MS detection limits.

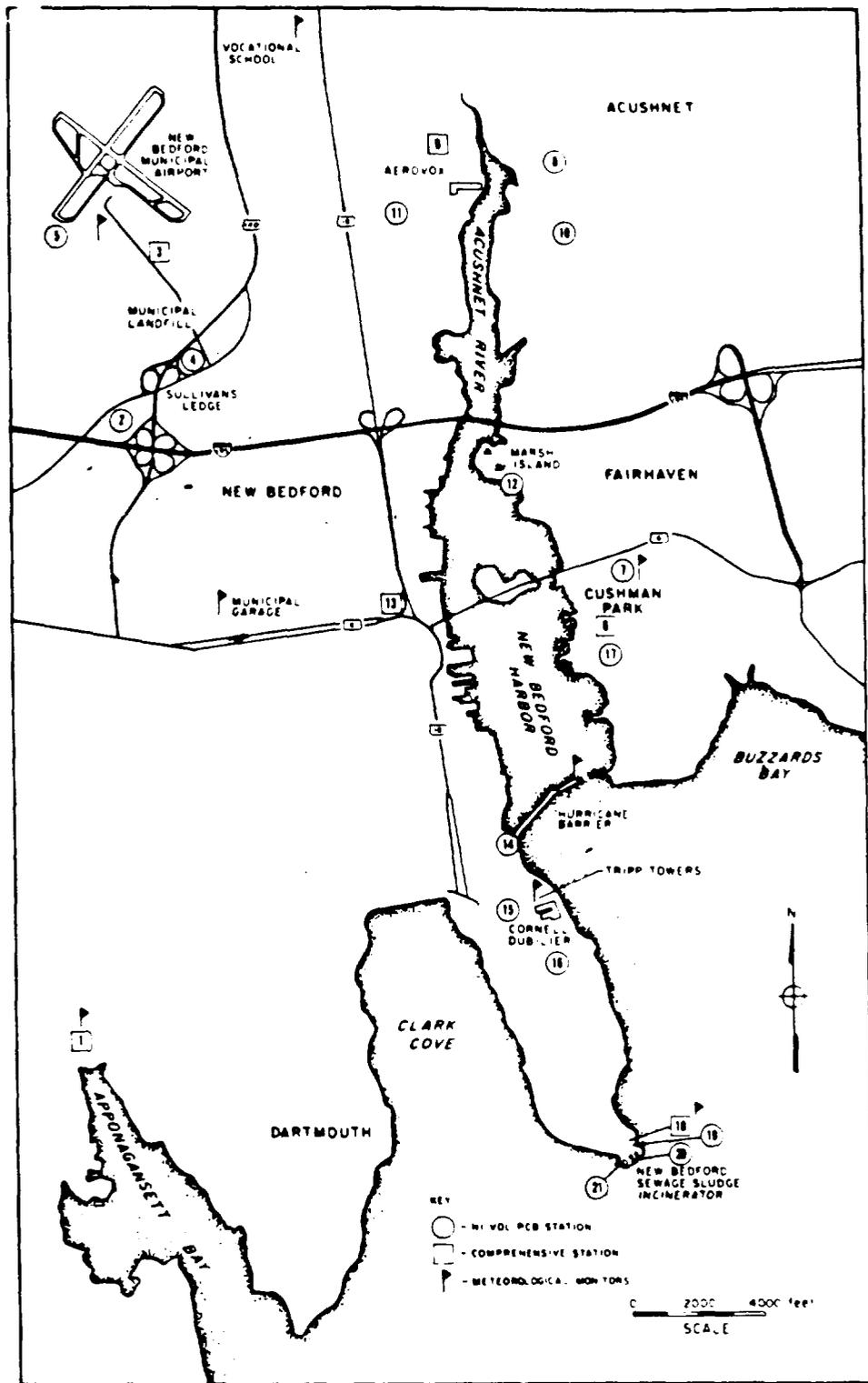


Figure 1. Ambient monitoring stations--site schematic.

sample locations during each of the 3 test days, however, numbered 21, as two stations were deleted prior to the first test date. In accordance with the program objectives outlined earlier, each of the preselected sites was placed in one of the four categories as noted below:

- Background sites--either urban in the impacted region of New Bedford or Fairhaven or suburban background out of the impacted area.
- Fugitive area sources containing onsite contamination as demonstrated in previous monitoring efforts.
- Fugitive area source suspected of contamination and previously uncharacterized.
- Point sources--such as the New Bedford Municipal Sewage Sludge Incinerator.

Each of the background stations was selected in areas not suspected of being impacted by "known" sources of PCB emissions. These include the following actual sites as noted in Table 1.

- Dartmouth Town Hall
- New Bedford Fire Station No. 2
- Guy's Pharmacy - Fairhaven
- Job C. Tripp School - Fairhaven

Fugitive area sources containing onsite PCB contamination as evidenced by previous monitoring activities included the following locations:

- New Bedford Municipal Landfill
- Aerovox/Upper Acushnet River
- Cornell Dubilier
- New Bedford Sewage Sludge Incinerator

Potential fugitive area sources of particular interest to the Environmental Protection Agency and previously uncharacterized included the following locations:

- Sullivan's Ledge
- Marsh Island

The single point source in the study area, as shown by earlier monitoring efforts,<sup>1</sup> is the New Bedford Sewage Sludge Incinerator.

Table 1 provides a summary listing of the designated sites, their respective site category as previously discussed and the actual monitoring location chosen for the 3-day testing exercise.

#### METEOROLOGICAL MONITORING SITES

An integral facet of this monitoring program is the availability of a comprehensive set of meteorological data encompassing the entire study region

on each of the 3 test days to accommodate program objectives. Regional surface weather observations from the national "Daily Weather Maps", prepared by the Environmental Data and Information Service of the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce were reviewed, along with local hourly wind observations made in the study area. Hourly wind directions and wind speeds were available from six permanent local sources of data and from two temporary local installations as shown in Figure 1. The permanent sources of data are located at the Hurricane Barrier in New Bedford Harbor and operated by the Army Corps of Engineers, the Greater New Bedford Regional Technical Vocational High School, the Tripp Towers apartment building, the Municipal Sewage Treatment Plant, the Parker Street Municipal Garage, and the New Bedford Airport. The temporary installations were located at the Dartmouth Town Hall and at the Tripp School in Fairhaven. The meteorological data collected during the sampling program were evaluated for each of the 3 sampling days. This evaluation was made in order to determine which of the 3 days had average wind directions (in conjunction with other meteorological conditions such as wind speed and ambient temperature) most approaching the critical southwest vector ( $225^{\circ}$ ) and hence consistent with the program objectives stated earlier.

## SECTION 3

### SAMPLING AND METEOROLOGICAL MONITORING PROCEDURES

#### FIELD WORK SUMMARY

Sampling was conducted in the New Bedford, Dartmouth, Fairhaven and Acushnet areas over a period of 10 days from 8/31/82 to 9/9/82. During this time period, three sampling runs were conducted of approximately 12 hours duration each for the collection of polychlorinated biphenyls (PCBs) and related organics, trace metals, and particulate matter. These days will continue to be referred to as: Day 1 (8/31), Day 2 (9/3) and Day 3 (9/9).

Prior to sampling, micro and macrometeorological conditions were reviewed to determine if desirable conditions (i.e., wind direction, temperature, precipitation potential, etc.) were anticipated. Based on the meteorologist's evaluations, and logistical considerations, a sampling day was approved approximately 24 hours prior to the conduct of sampling. Actual meteorological conditions, as recorded on the day of sampling by existing and temporary monitoring stations, were then evaluated to allow for selection of the "best" set or sets of samples for analysis. Based on this evaluation, Day 2 (9/3) and Day 3 (9/9) were chosen for analysis. Samples from Day 1 have been stored for future analysis, if desired.

As specified in Section 2 of this report, a total of 21 sampling locations were chosen in the study area. In addition, three collocated samplers were placed at preselected locations. All monitoring locations were identified as PCB sampling stations; however, only eight samplers were designated as "comprehensive locations" in which analyses for the previously listed parameters were conducted. Refer to Section 2 and Figure 1 for a detailed explanation of the site selection criteria and a keyed schematic of the ambient monitoring network.

Modified high-volume samplers were used for the collection of PCBs and related organics, trace metals and particulates. The procedure employed was essentially the same as described by Stratton, et al., in "A Method for the Sampling of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA-600/4-78-048, August 1978.

Meteorological conditions were monitored continuously during the course of the sampling effort. Data were obtained from six existing meteorological monitoring stations in the area in addition to two "temporary" installations added by GCA to address specific areas not in the vicinity of an existing station. Data from all stations were used to verify macrometeorological

conditions on the days of sampling and where appropriate to pinpoint microscale conditions in specific monitoring areas. Conditions monitored continuously included wind speed and wind direction, and at one station ambient temperature. Barometric pressure, relative humidity and vapor pressure determinations were also made on the day of sampling at a minimum of twice per day.

#### HIGH-VOLUME SAMPLING

Sampling for PCBs and related organics, trace metals, and particulate matter was performed using high-volume samplers which comply with 40 CFR 50 Appendix B--Reference Method for the Determination of Suspended Particulates in Ambient Atmosphere (High Volume Method) modified as described in "A Method for Sampling and Analyses of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA-600/4-78-048, August 1978. This modification involves an extension of the throat assembly at the filter holder outlet with a piece of cylindrical aluminum. Additional modifications include replacement of rubber gasket material with Teflon and the attachment of flexible duct work to direct electric motor exhaust away from the sampler inlet.

Particulate matter and trace metals were collected on a glass fiber filter, and PCBs and related organics were trapped in two precleaned polyurethane foam plugs housed in the aluminum throat extension located downstream of the filter assembly. With the exception of Day 1 (8/31), flow rates through the samplers were adjusted to approximately  $0.566 \text{ m}^3/\text{min}$  ( $20 \text{ ft}^3/\text{min}$ ) and each sampler was operated for a period of 12 hours to allow for a total collected air volume between 350 and  $450 \text{ m}^3$  (see Tables 2 through 4).

For a detailed description of the sampling procedure and a schematic of the sampling apparatus, refer to Appendix A, Test and Quality Assurance Project Plan.

#### METEOROLOGICAL MONITORING

Six "existing" meteorological monitoring installations and two "temporary" stations were used to determine macro- and micrometeorological conditions in the study area during the specified sampling periods. Refer to Section 2, Figure 1, for a schematic illustrating the location of these stations.

The six "existing" stations are actually temporary installations currently being operated by the University of Massachusetts for an ongoing study concerning the feasibility of wind generation in the New Bedford area. The two temporary stations were set up and monitored by GCA specifically for this project and were located in areas of concern that were not in the vicinity of the existing stations. All stations were equipped to continuously monitor wind speed and wind direction. In addition, barometric pressure and relative humidity data were also recorded on the day of sampling. Ambient temperatures were recorded continuously at the background station in Dartmouth.

TABLE 2. SAMPLE COLLECTION DATA: DAY 1--AUGUST 31, 1982

Site No.	Location	GCA No.		Sample volume <sup>a</sup> (Std. m <sup>3</sup> )	Clock time		Total elapsed time (min)
		PUF	Filter		Start	Stop	
1	Dartmouth Town Hall	25211	25212	890.0	1003	0046	883
2	Sullivan's Ledge	25251	25252	839.2	1238	0104	746
3	Shawmut Pump Station A	25245	25246	726.9	1150	2350	720
3	Shawmut Pump Station B	25213	25214	747.6	1150	2350	720
4	Adams Oil	25207	25208	747.6	1133	2333	720
5	New Bedford Airport	25221	25222	784.0	1333	0038	665
6	Cushman Park	b	b	b	b	b	b
7	Tripp School A	25233	25234	761.8	1305	0105	720
7	Tripp School B	25235	25236	690.2	1305	0105	720
8	Acushnet Nursing	25199	25200	991.3	1055	2259	724
9	C&W Welding A	25227	25228	749.6	1030	2152	682
9	C&W Welding B	25247	25248	759.4	1030	2152	682
10	Burt School	25239	25240	847.4	1107	2350	763
11	Brooklawn Park	25241	25242	844.9	1130	2330	720
12	Taber St. Pump Station	25201	25202	776.5	1925	0125	720
13	Fire Station No. 2	25215	25216	783.5	1118	2318	720
14	Hurricane Barrier	25231	25232	620.9	0906	2100	714
15	St. Anne's Rectory	25209	25210	814.8	0807	2044	757
16	Fire Station No. 11	25205	25206	435.9	0822	2030	728
17	Guy's Pharmacy	25225	25226	103.6	1233	1420	107
18	Incinerator No. 3	25229	25230	864.5	1438	0450	852
19	Incinerator No. 2	25253	25254	779.6	1433	0445	852
20	Incinerator No. 1	25223	25224	1352.2	1411	0839	1108
21	Incinerator No. 4	b	b	b	b	b	b

<sup>a</sup>Values calculated from High-Volume Air Sampler Calibration Data Sheets contained in Appendix B of this report.

<sup>b</sup>Sampler not sited here on 8/31/82. See comments contained in this section for further details.

TABLE 3. SAMPLE COLLECTION DATA: DAY 2--SEPTEMBER 3, 1982

Site No.	Location	GCA No.		Sample volume <sup>a</sup> (Std. m <sup>3</sup> )	Clock time		Total elapsed time (min)
		PUF	Filter		Start	Stop	
1	Dartmouth Town Hall	25429	25430	409.5	0835	2020	705
2	Sullivan's Ledge	25423	25424	366.6	1216	2342	686
3	Shawmut Pump Station A	25435	25436	414.5	0940	2136	716
3	Shawmut Pump Station B	25439	25440	399.3	0940	2136	716
4	Adams Oil	25417	25418	456.9	0938	2307	809
5	New Bedford Airport	25447	25448	396.4	1018	2218	720
6	Cushman Park	25399	25401	444.5	0900	2205	785
7	Tripp School A	25395	25396	461.3	0930	2159	749
7	Tripp School B	25433	25434	434.8	0930	2159	749
8	Acushnet Nursing	25405	25406	408.3	1010	2154	704
9	C&W Welding A	25445	25446	407.0	1028	2228	720
9	C&W Welding B	25443	25444	386.6	1028	2228	720
10	Burt School	25413	25414	428.7	1009	2229	740
11	Brooklawn Park	25459	25460	407.1	1111	2311	720
12	Taber St. Pump Station	25401	25402	507.4	0945	0104	919
13	Fire Station No. 2	25421	25422	299.4	1159	1921	518
14	Hurricane Barrier	25441	25442	416.9	0825	2030	725
15	St. Anne's Rectory	25411	25412	388.0	0754	1956	722
16	Fire Station No. 11	25415	25416	398.2	0750	2011	741
17	Guy's Pharmacy	25403	25404	426.8	0915	2113	718
18	Incinerator No. 3	25431	25432	455.0	0919	2242	803
19	Incinerator No. 2	25397	25398	439.1	0815	2051	756
20	Incinerator No. 1	25407	25408	412.4	0830	2020	710
21	Incinerator No. 4	25425	25426	390.5	0840	2036	716

<sup>a</sup>Values calculated from High-Volume Air Sampler Calibration Data Sheets contained in Appendix B of this report.

TABLE 4. SAMPLE COLLECTION DATA: DAY 3--SEPTEMBER 9, 1982

Site No.	Location	GCA No.		Sample volume <sup>a</sup> (Std. m <sup>3</sup> )	Clock time		Total elapsed time (min)
		PUF	Filter		Start	Stop	
1	Dartmouth Town Hall	25572	25573	461.3	0833	2158	805
2	Sullivan's Ledge	25556	25557	401.9	0928	2148	740
3	Shawmut Pump Station A	25580	25581	433.1	0914	2034	680
3	Shawmut Pump Station B	25578	25579	408.8	0914	2034	680
4	Adams Oil	25586	25587	444.8	0908	2138	750
5	New Bedford Airport	25588	25589	406.7	0945	2214	749
6	Cushman Park	25552	25553	391.2	0830	1948	678
7	Tripp School A	25554	25555	470.9	0843	2223	820
7	Tripp School B	25592	25593	447.5	0843	2223	820
8	Acushnet Nursing	25574	25575	427.4	0925	2150	745
9	C&W Welding A	25606	25607	413.0	0935	2135	720
9	C&W Welding B	25610	25611	423.3	0935	2135	720
10	Burt School	25598	25599	419.5	0916	2146	750
11	Brooklawn Park	25594	25595	413.0	0959	2159	720
12	Taber St. Pump Station	25564	25565	452.3	0856	2126	750
13	Fire Station No. 2	25560	25561	414.3	0856	2219	803
14	Hurricane Barrier	25608	25609	461.4	0756	1951	715
15	St. Anne's Rectory	25576	25577	219.0	0738	2014	756
16	Fire Station No. 11	25600	25601	432.4	0740	2010	750
17	Guy's Pharmacy	25570	25571	368.2	0814	2006	712
18	Incinerator No. 3	25604	25605	398.3	0805	1940	695
19	Incinerator No. 2	25582	25583	401.2	0800	1940	700
20	Incinerator No. 1	25596	25597	464.7	0812	2013	721
21	Incinerator No. 4	25568	25569	426.9	0800	2025	745

<sup>a</sup>Values calculated from High-Volume Air Sampler Calibration Data Sheets contained in Appendix B of this report.

For a detailed description of the equipment used, calibration procedures and operational checks used by GCA at the "temporary" installations, refer to Appendix A, Test and Quality Assurance Project Plan.

#### FIELD COMMENTS/NOTES

With the exception of Day 1 (8/31), all sampling and monitoring activities were as specified in GCA's Test and Quality Assurance Project Plan entitled "Sampling and Analysis Protocols for Ambient Monitoring in Support of the New Bedford Environmental Investigation" (Appendix A). The following is a brief description of the problems encountered and the resulting deviations from specified protocols.

#### Day 1 (8/31)

A number of problems were encountered on the first day of sampling resulting in the following deviations from specified protocols:

- All sample runs were delayed from 1 to 5 hours resulting in sample collection over a nonsynchronous time period.
- The lack of voltage regulators during the first day of sampling resulted in excess collected air volumes at nearly all locations.
- No sampler was located in Cushman Park due to concerns aired by Fairhaven Town Officials of potential vandalism. It was later decided that a sampler in this area was necessary.
- No sampler was located upwind of the sewage sludge incinerator due to power problems. This was later resolved.
- Timer malfunctions at a number of locations allowed a few samplers to shut off prematurely or continue sampling until manually turned off. This problem was later rectified.

#### SAMPLE BANK/CHAIN OF CUSTODY PROCEDURES

Prior to each sampling date, the prepared media (polyurethane foam plugs and glass fiber filters) were submitted to the GCA Sample Bank for entry in the Master Log Book and assignment of GCA Control Numbers. This unique identification was affixed to the respective hi-vol samplers and subsequently used throughout the sampling and analysis procedures for continuous, unambiguous traceability.

Chain of custody procedures were immediately initiated. A page for each sample was entered sequentially by GCA Control Number in the Custody Notebook, and the release of sampling media from the Sample Bank to sampling personnel was documented by the recording of signatures and dates on the appropriate Notebook pages.

At the completion of each day's sampling activities, the collected samples were listed by site location and GCA Control Number on Chain of Custody Record forms and returned to the GCA Laboratory. Upon receipt there, the submitted samples were checked against the accompanying custody forms to verify complete and accurate sample identification. The Chain of Custody Records were then signed by the receiving personnel to document transfer of custody. Tables 5, 6, and 7, respectively, list the samples collected on August 31, September 3, and September 9, 1982.

Chain-of-custody procedures were maintained in the laboratory in the following two ways:

- The transfer of samples or extracts between analysts within the laboratory was recorded on Sample Custody Transfer forms which are entered in the permanent project file.
- The transfer of samples or extracts between an analyst and the Sample Bank was recorded in the Custody Notebook.

TABLE 5. CROSS-REFERENCE LIST OF SAMPLES COLLECTED 31 AUGUST 1982 (DAY 1)  
AND PREASSIGNED GCA CONTROL NUMBERS

Sampling site <sup>a</sup>		Sample medium		GCA Control No.
Location	Site No.	Type	Identification	
Acushnet Nursing Home	8	PUF	Lot 1, #1	25199
		Filter	5163901	25200
Taber St. Station	12	PUF	Lot 1, #2	25201
		Filter	5163902	25202
VOID	-	PUF	Lot 1, #3	25203
		Filter	5163903	25204
Fire Station #11	16	PUF	Lot 1, #4	25205
		Filter	5163904	25206
Adams Oil	4	PUF	Lot 1, #5	25207
		Filter	5163905	25208
St. Anne's Rectory	15	PUF	Lot 1, #6	25209
		Filter	5163906	25210
Dartmouth Town Hall	1	PUF	Lot 1, #7	25211
		Filter	5163907	25212
Shawmut St.	3	PUF	Lot 1, #8	25213
		Filter	5163908	25214
Fire Station #2	13	PUF	Lot 1, #9	25215
		Filter	5163909	25216
Field-biased Blank	-	PUF	Lot 1, #10	25217
		Filter	5163910	25218
Quality Control	-	PUF	Lot 1, #11	25219
		Filter	5163925	25220
Airport	5	PUF	Lot 1, #12	25221
		Filter	5163911	25222
Incinerator Site #1	20	PUF	Lot 2, #13	25223
		Filter	5163912	25224
Guy's Pharmacy	17	PUF	Lot 2, #14	25225
		Filter	5163913	25226

(continued)

TABLE 5 (continued)

Sampling site <sup>a</sup>		Sampling medium		GCA
Location	Site No.	Type	Identification	Control No.
C&W Welding	9	PUF	Lot 2, #15	25227
		Filter	5163914	25228
Incinerator Site #3	18	PUF	Lot 2, #16	25229
		Filter	5163915	25230
Hurricane Barrier	14	PUF	Lot 2, #17	25231
		Filter	5163916	25232
Job C. Tripp School	7	PUF	Lot 2, #18	25233
		Filter	5163917	25234
Job C. Tripp School	7	PUF	Lot 2, #19	25235
		Filter	5163918	25236
Quality Control	-	PUF	Lot 2, #20	25237
		Filter	5163926	25238
Burt School	10	PUF	Lot 2, #21	25239
		Filter	5163919	25240
Brooklawn Park	11	PUF	Lot 2, #22	25241
		Filter	5163920	25242
VOID	-	PUF	Lot 2, #23	25243
		Filter	5163921	25244
Shawmut St.	3	PUF	Lot 2, #24	25245
		Filter	5163922	25246
C&W Welding	9	PUF	Lot 3, #25	25247
		Filter	5163923	25248
Quality Control	-	PUF	Lot 3, #26	25249
		Filter	5163927	25250
Sullivan's Ledge	2	PUF	Lot 3, #27	25251
		Filter	5163924	25252
Incinerator Site #2	19	PUF	Lot 3, #28	25253
		Filter	5163928	25254

<sup>a</sup>Sampling sites correspond to locations and site numbers shown in Figure 1.

TABLE 6. CROSS-REFERENCE LIST OF SAMPLES COLLECTED 3 SEPTEMBER 1982 (DAY 2)  
AND PREASSIGNED GCA CONTROL NUMBERS

Sampling site <sup>a</sup>		Sample medium		GCA Control No.
Location	Site No.	Type	Identification	
Job C. Tripp School	7	PUF	Lot 3, #1	25395
		Filter	5163929	25396
Incinerator Site #2	19	PUF	Lot 3, #2	25397
		Filter	5163930	25398
Cushman Park	6	PUF	Lot 3, #3	25399
		Filter	5163931	25400
Taber St. Station	12	PUF	Lot 3, #4	25401
		Filter	5163933	25402
Guy's Pharmacy	17	PUF	Lot 3, #5	25403
		Filter	5163934	25404
Acushnet Nursing Home	8	PUF	Lot 3, #6	25405
		Filter	5163935	25406
Incinerator Site #1	20	PUF	Lot 3, #7	25407
		Filter	5163937	25408
Quality Control	-	PUF	Lot 3, #8	25409
		Filter	5163942	25410
St. Anne's Rectory	15	PUF	Lot 4, #9	25411
		Filter	5163932	25412
Burt School	10	PUF	Lot 4, #10	25413
		Filter	5163936	25414
Fire Station #11	16	PUF	Lot 4, #11	25415
		Filter	5163938	25416
Adams Oil	4	PUF	Lot 4, #12	25417
		Filter	5163939	25418
VOID	-	PUF	Lot 4, #13	25419
		Filter	5163940	25420
Fire Station #2	13	PUF	Lot 4, #14	25421
		Filter	5163941	25422

(continued)

TABLE 6 (continued)

Sampling site <sup>a</sup>		Sampling medium		GCA
Location	Site No.	Type	Identification	Control No.
Sullivan's Ledge	2	PUF Filter	Lot 4, #15 5163943	25423 25424
Incinerator Site #4	21	PUF Filter	Lot 4, #16 5163944	25425 25426
Quality Control	-	PUF Filter	Lot 4, #17 5163947	25427 25428
Dartmouth Town Hall	1	PUF Filter	Lot 4, #18 5163945	25429 25430
Incinerator Site #3	18	PUF Filter	Lot 4, #19 5163946	25431 25432
Job C. Tripp School	7	PUF Filter	Lot 5, #20 5163948	25433 25434
Shawmut St.	3	PUF Filter	Lot 5, #21 5163949	25435 25436
Quality Control	-	PUF Filter	Lot 5, #22 5163950	25437 25438
Shawmut St.	3	PUF Filter	Lot 5, #23 5163951	25439 25440
Hurricane Barrier	14	PUF Filter	Lot 5, #24 5163952	25441 25442
C&W Welding	9	PUF Filter	Lot 5, #25 5163953	25443 25444
C&W Welding	9	PUF Filter	Lot 5, #26 5163954	25445 25446
Airport	5	PUF Filter	Lot 6, #27 5163955	25447 25448
Field-biased Blank	-	PUF Filter	Lot 6, #28 5163956	25449 25450

(continued)

TABLE 6 (continued)

Sampling site <sup>a</sup>		Sampling medium		GCA Control No.
Location	Site No.	Type	Identification	
Quality Control	-	PUF	Lot 6, #29	25451
		Filter	5163957	25452
VOID	-	PUF	Lot 6, #30	25457
		Filter	5163958	25458
Brooklawn Park	11	PUF	Lot 6, #31	25459
		Filter	5163959	25460

<sup>a</sup>Sampling sites correspond to locations and site numbers shown in Figure 1.

TABLE 7. CROSS-REFERENCE LIST OF SAMPLES COLLECTED 9 SEPTEMBER 1982 (DAY 3)  
AND PREASSIGNED GCA CONTROL NUMBERS

Sampling site <sup>a</sup>		Sample medium		GCA Control No.
Location	Site No.	Type	Identification	
Cushman Park	6	PUF	Lot 6, #1	25552
		Filter	5163960	25553
Job C. Tripp School	7	PUF	Lot 6, #2	25554
		Filter	5163961	25555
Sullivan's Ledge	2	PUF	Lot 6, #3	25556
		Filter	5163962	25557
Field-biased Blank	-	PUF	Lot 6, #4	25558
		Filter	5163963	25559
Fire Station #2	13	PUF	Lot 6, #5	25560
		Filter	5163964	25561
Quality Control	-	PUF	Lot 6, #6	25562
		Filter	5163966	25563
Taber St. Station	12	PUF	Lot 7, #7	25564
		Filter	5163965	25565
Quality Control	-	PUF	Lot 7, #8	25566
		Filter	5163967	25567
Incinerator Site #4	21	PUF	Lot 7, #9	25568
		Filter	5163968	25569
Guy's Pharmacy	17	PUF	Lot 7, #10	25570
		Filter	5163969	25571
Dartmouth Town Hall	1	PUF	Lot 7, #11	25572
		Filter	5163970	25573
Acushnet Nursing Home	8	PUF	Lot 7, #12	25574
		Filter	5163971	25575
St. Anne's Rectory	15	PUF	Lot 7, #13	25576
		Filter	5163972	25577
Shawmut St.	3	PUF	Lot 8, #14	25578
		Filter	5163973	25579

(continued)

TABLE 7 (continued)

Sampling site <sup>a</sup>		Sampling medium		GCA
Location	Site No.	Type	Identification	Control No.
Shawmut St.	3	PUF Filter	Lot 8, #15 5163974	25580 25581
Incinerator Site #2	19	PUF Filter	Lot 8, #16 5163975	25582 25583
VOID	-	PUF Filter	Lot 8, #17 5163982	25584 25585
Adams Oil	4	PUF Filter	Lot 8, #18 5163977	25586 25587
Airport	5	PUF Filter	Lot 8, #19 5163981	25588 25589
Quality Control	-	PUF Filter	Lot 8, #20 5163983	25590 25591
Job C. Tripp School	7	PUF Filter	Lot 8, #21 5163986	25592 25593
Brooklawn Park	11	PUF Filter	Lot 8, #22 5163987	25594 25595
Incinerator Site #1	20	PUF Filter	Lot 8, #23 5163988	25596 25597
Burt School	10	PUF Filter	Lot 8, #24 5163989	25598 25599
Fire Station #11	16	PUF Filter	Lot 8, #25 5163990	25600 25601
Quality Control	-	PUF Filter	Lot 9, #26 5163984	25602 25603
Incinerator Site #3	18	PUF Filter	Lot 9, #27 5163976	25604 25605
C&W Welding	9	PUF Filter	Lot 9, #28 5163978	25606 25607

(continued)

TABLE 7 (continued)

Sampling site <sup>a</sup>		Sampling medium		GCA
Location	Site No.	Type	Identification	Control No.
Hurricane Barrier	14	PUF	Lot 9, #29	25608
		Filter	5163979	25609
C&W Welding	9	PUF	Lot 9, #30	25610
		Filter	5163980	25611
VOID	-	PUF	Lot 9, #31	25612
		Filter	5163985	25613

<sup>a</sup>Sampling sites correspond to locations and site numbers shown in Figure 1.

## SECTION 4

### ANALYTICAL PROTOCOLS

#### INTRODUCTION

As noted previously, high-volume air samples collected at 21 separate locations on each of 3 test days were returned to the GCA laboratory for subsequent analysis. Subsequent review of the meteorological monitoring data (Section 5) in conjunction with other factors indicated that samples from Day 2 (9/3/82) and Day 3 (9/9/82) most clearly satisfied the selection criteria and program objectives defined in Appendix A of this report. As a consequence, the complete set of 24 polyurethane foam samples from each of the 2 test days were analyzed for PCBs using conventional gas chromatographic procedures (GC/ECD). Filters and polyurethane foam extracts from 8 of 24 samples were also designated for comprehensive analysis; i.e., PCBs (GC/MS), semivolatile organics (chlorinated benzenes, chlorinated phenols and other nonchlorinated organics) and trace metals (filters only). Additionally, four samples (PUF only) from the remaining noncomprehensive stations found by GC/ECD to contain significant levels of PCBs were submitted for gas chromatography/mass spectrometry to include analysis of individual PCB positional isomer classes.

#### SAMPLE PREPARATION

##### Polyurethane Foam (PUF) Plugs

All PUF plugs used in field sampling were precleaned in the laboratory to remove potential interferences. Cleanup procedures used are detailed in Appendix A (Section 3.A.3). Lots containing 24 PUF plugs, extracted as a group, were assigned individual Lot Numbers. Two plugs from each lot were chosen at random and re-extracted overnight in 5 percent ethyl ether in hexane. The extracts were concentrated to 10 ml for GC/ECD analysis of organochlorine pesticides and PCBs. The quality control criteria by which the lots were evaluated were that each set contain less than 0.5 ng/m<sup>3</sup> of organochlorine pesticides and less than 2.5 ng/m<sup>3</sup> of PCBs, assuming an eventual air sampling volume of 400 m<sup>3</sup>. Lots of PUF plugs which did not meet the above criteria were re-extracted in ethyl ether/hexane and resubjected to the quality control check until these criteria were met.

PUF plug samples from Days 2 and 3 of testing were prepared for analysis in accordance with procedures detailed in Section 4 of Appendix A with the

singular exception that a sulfuric acid partitioning cleanup was substituted for the alumina column cleanup procedure. Figure 2, presents the revised analytical scheme.

As indicated in Figure 2, the following aliquots were proportioned from each 10.0 ml final extract: 1.0 ml for GC/ECD analysis of PCBs; 4.0 ml for the GC/MS analysis of semivolatile organics; and 5.0 ml as a reserve sample.

The 1.0 ml GC/ECD extract was subjected to the previously mentioned acid cleanup prior to analysis. The 4.0 ml GC/MS aliquot was surrogate-spiked with a predetermined quantity (20 to 50  $\mu\text{g}$ ) of the following deuterated analogues:  $\text{d}_3$ -trichlorobenzene,  $\text{d}_{10}$ -biphenyl,  $\text{d}_6$ -tetrachlorobiphenyl and  $\text{d}_{12}$ -chrysene. Actual surrogate quantities ( $\mu\text{g}$ ) applied and recovered in each sample are provided in Section 7 of this report (Quality Control). The extract was then evaporated to 0.1 ml under a gentle stream of nitrogen and transferred to a 0.1 ml septum-sealed vial for analysis.

### Particulate Filters

Particulate filters from 24 samples collected on each of 3 test days were returned to the GCA laboratory for subsequent analysis. Total (net) particulate weights and concentrations ( $\mu\text{g}/\text{m}^3$ ) for each of the 2 test days were recorded and are provided in Section 5 of this report. After completion of the particulate weight analysis, a 50 percent aliquot of selected filters from Days 2 and 3 was removed for analysis of semivolatile organics. Each filter aliquot was surrogate-spiked with 40 to 50  $\mu\text{g}$  quantities of a variety of deuterated analogues ( $\text{d}_3$ -trichlorobenzene,  $\text{d}_{10}$ -biphenyl,  $\text{d}_6$ -tetrachlorobiphenyl,  $\text{d}_{12}$ -chrysene) and soxhlet-extracted in methylene chloride for a period of 24 hours. Extracts were then reduced using a Kuderna-Danish evaporative concentrator to a final volume of 10.0 ml. A 5.0 ml portion of the final extract was held in reserve while the remaining 5.0 ml was further concentrated, under a gentle stream of nitrogen, to 0.1 ml for GC/MS analysis.

### GC/ECD ANALYSIS

A 1.0 ml aliquot from each 10.0 ml PUF extract was subjected to GC/ECD analysis according to the protocol described in Appendix A. Instrumental conditions for this analysis are shown in Table 8. Aroclor calibration standards were prepared and verified using the procedures outlined in Section 5 of Appendix A.

Calibration curves were prepared from a linear regression analysis of the integrated area response from injection of four standards each of Aroclor 1242 and Aroclor 1254. For Aroclor 1242, calibration points were typically obtained by summing the six peak areas shown in Figure 3. Peak summation procedures such as those applied here are routinely employed in the determination of PCBs in ambient air when using GC/ECD.<sup>2-5</sup> While all of the peaks characteristic of a given Aroclor standard (e.g., for Aroclor 1242, 12 to 15 peaks) were used for initial (screening) qualitative assignments, six peaks were chosen for quantitative purposes as noted in Figure 3. These peaks

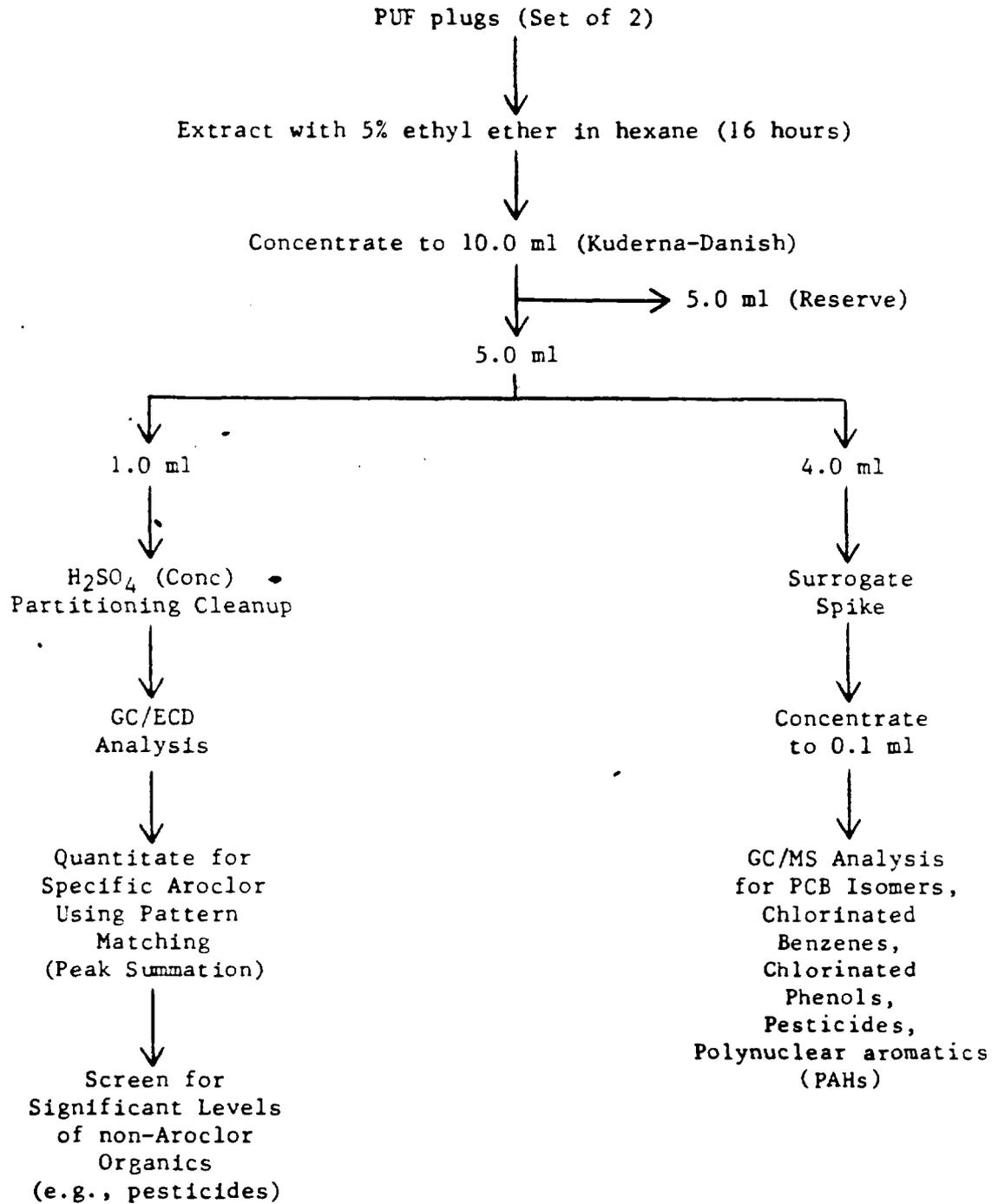


Figure 2. Analysis scheme--polyurethane foam plugs (PUF).



were selected on the following basis: (a) major chromatographic components of both Aroclor and sample (typically, the quantitative peaks selected for Aroclor 1242 [as shown in Figure 3] represent 60 to 70 percent of the total area elicited by the major peaks of an Aroclor 1242 standard reference material in the GCA laboratory); (b) peaks not subject to interferences from coeluting non-Aroclor components; (c) relative peak ratios visually and numerically (area counts in  $\mu\text{V}\cdot\text{sec}$ ) most similar to those noted in standard. This quantitative technique was applied to all program samples except those collected at Sullivan's Ledge (Site 2) where an electron-capturing interference precluded the use of peak No. 6. Aroclor 1254 calibrations are based on the area summation of the five characteristic peaks indicated in Figure 3. It should be noted that calibration curves (GC/ECD) were rejected in all instances if the correlation coefficient of the linear regression analysis was less than 0.999. All samples were quantitated by entering the summed sample area into the appropriate linear regression curve. Sample extracts were diluted as necessary to be bracketed by the response of calibration standards. EPA/EMSL Aroclor (1242 and/or 1254) reference samples were run on each day of quantitative analysis to provide verification of the existing Aroclor calibration curve (GC/ECD). Disparities from the "true" EMSL values were used to correct actual reported sample concentrations. Additionally, during sample extract prescreening analyses, a complete series of Aroclor reference standards (i.e., 1016, 1221, 1232, 1242, 1248, 1254, 1260) were run to qualitatively establish the Aroclor patterns to be selected for subsequent quantitative analyses. As noted here and in Section 5, sample extracts contained predominantly an Aroclor 1016/1242 pattern and in some instances Aroclor 1254.

TABLE 8. GC/ECD CONDITIONS FOR PUF PLUG ANALYSIS

Instrument	Hewlett-Packard 5840A with Ni <sup>63</sup> electron capture detector and HP 7671A automatic sampler
Column	1.5% OV-17/1.95% QF-1 on 100/120 Chromosorb WHP, 6 ft x 2 mm
Temperatures	
Column	185°C
Injector	270°C
Detector	350°C
Injector volume	4.0 $\mu\text{l}$
Run time	30 min
Carrier flow	UHP argon/methane, 35 ml/min

## GC/MS ANALYSIS

Each of the 0.1 ml extracts designated for GC/MS analysis (see Section 5) were spiked with an internal standard solution containing 4 µg each of dg-naphthalene and d<sub>10</sub>-anthracene. Subsequent analyses were conducted using a Hewlett-Packard 5985 quadrupole mass spectrometer operating in the electron impact mode (70 eV). Instrumental operating conditions for these analyses are listed in Table 9. Spectra were acquired in the continuous scan mode over the range of 45 to 450 amu.

Standard reference materials available for all of the components listed in Table 10 were used to establish pertinent chromatographic (RT, RRT) and mass spectral (RF) identification criteria. Typical retention time (RT) data in minutes are provided in Table 10.

Mass spectral response factors relative to the closest eluting internal standard were determined for each of the compounds listed in Table 10. Three serial dilutions of each stock calibration mixture ranging in concentration from 10 ng/µl to 400 ng/µl were used to establish the working calibration curve prior to sample analysis. Individual component response factors (RF) were derived from the following mathematical relationship:

$$RF = \frac{A_x W_{IS}}{A_{IS} W_x}$$

where  $A_x$  is the area of the quantitative ion of compound x,  $W_x$  is the quantity in ng eliciting the area response,  $A_{IS}$  is the area of the quantitative ion of the appropriate internal standard (dg-naphthalene  $m/e = 136$ , d<sub>10</sub>-anthracene  $m/e = 188$ ) and  $W_{IS}$  is the quantity in ng eliciting the area response. Average component response factors are provided in Table 10.

The established three-point calibration curves were verified on each subsequent day of analysis with a single calibration point check for each component. The resulting RF values were compared to the existing average RF values.

Component identification criteria for the chlorobenzenes, chlorophenols, and chlorinated pesticides were generally consistent with criteria specified in the EPA Method 625 GC/MS protocol.<sup>6</sup> More specifically, this included the following identification criteria: (a) retention time (RT) of component spectra falls within a  $\pm 0.2$  minute window established by the corresponding standard reference material; (b) extracted ion profile for the primary ion or base peak is consistent with the corresponding reference material; (c) for positive identification, a minimum of two other characteristic ions for the compound were required to reach a maximum intensity within one scan of that noted for the primary ion and be present at a relative intensity within 10 percent of that noted in the reference spectra. (Representative spectra of standard reference materials and some of the more noteworthy components identified in program samples are provided in Appendices E and D, respectively.)

TABLE 9. GC/MS OPERATING CONDITIONS

Instrument	Hewlett-Packard 5985, quadrupole mass spectrometer
GC Conditions	
Column	DB-5 30M fused silica capillary
Temperature program	50°C held for 2 min then 10°/min to 300°C and held
Injector type	Grob w/0.5 min sweep time
Injector temperature	275°C
Injection volume	1 µl, splitless
Column flow	UHP helium, 0.5 ml/min
MS Conditions	
Emission	300 µA
Electron energy	70 eV
Scan time	1.0 s/scan
Mass interval	45 to 450 amu
Source temperature	200°C

TABLE 10. SEMIVOLATILE ORGANIC ANALYSES--SUMMARY OF GC/MS QUALITATIVE AND QUANTITATIVE DATA FOR STANDARD REFERENCE COMPOUNDS

Compound	Quantitative ion	Internal standard <sup>a</sup>	Typical RT (minutes)	Average RF <sup>b</sup>
<u>Chlorinated phenols</u>				
3-chlorophenol	128	d <sub>8</sub>	10.1	0.588
4-chlorophenol	128	d <sub>8</sub>	10.1	0.436
2,3-dichlorophenol	162	d <sub>8</sub>	9.7	0.237
2,4-dichlorophenol	162	d <sub>8</sub>	9.6	0.272
2,6-dichlorophenol	162	d <sub>8</sub>	10.2	0.245
3,4-dichlorophenol	162	d <sub>8</sub>	14.0	0.173
3,5-dichlorophenol	162	d <sub>8</sub>	13.6	0.283
2,3,4-trichlorophenol	196	d <sub>8</sub>	13.3	0.140
2,3,5-trichlorophenol	196	d <sub>8</sub>	12.6	0.147
2,4,5-trichlorophenol	198	d <sub>8</sub>	13.0	0.121
2,4,6-trichlorophenol	196	d <sub>8</sub>	13.0	0.199
3,4,5-trichlorophenol	196	d <sub>10</sub>	17.3	0.275
2,3,4,5-tetrachlorophenol	232	d <sub>10</sub>	16.3	0.230
2,3,4,6-tetrachlorophenol	232	d <sub>10</sub>	16.4	0.197
2,3,5,6-tetrachlorophenol	232	d <sub>10</sub>	16.2	0.229
pentachlorophenol	266	d <sub>10</sub>	19.3	0.085

(continued)

TABLE 10 (continued)

Compound	Quantitative ion	Internal standard <sup>a</sup>	Typical RT (minutes)	Average RF <sup>b</sup>
<u>Chlorinated benzenes</u>				
1,2,3-trichlorobenzene	180	d <sub>8</sub>	10.4	0.305
1,3,5-trichlorobenzene	180	d <sub>8</sub>	8.8	0.260
1,2,3,4-tetrachlorobenzene	216	d <sub>8</sub>	13.5	0.217
1,2,3,5-tetrachlorobenzene	216	d <sub>8</sub>	12.6	0.197
pentachlorobenzene	250	d <sub>10</sub>	15.9	0.417
hexachlorobenzene	284	d <sub>10</sub>	18.8	0.199
<u>Chlorinated biphenyls</u>				
2-chlorobiphenyl	188	d <sub>10</sub>	15.5	1.22
4-chlorobiphenyl	188	d <sub>10</sub>	16.7	0.904
2,5-dichlorobiphenyl	222	d <sub>10</sub>	18.1	0.505
3,3'-dichlorobiphenyl	222	d <sub>10</sub>	19.5	0.495
2,3',5-trichlorobiphenyl	256	d <sub>10</sub>	20.7	0.222
2,4,5-trichlorobiphenyl	256	d <sub>10</sub>	20.6	0.229
2,3',4',5-tetrachlorobiphenyl	292	d <sub>10</sub>	23.4	0.103
2,2',4,5,5'-pentachlorobiphenyl	326	d <sub>10</sub>	24.1	0.046

(continued)

TABLE 10 (continued)

Compound	Quantitative ion	Internal standard <sup>a</sup>	Typical RT (minutes)	Average RF <sup>b</sup>
<u>Chlorinated biphenyls (continued)</u>				
2,2',4,4',6,6'-hexachlorobiphenyl	360	d <sub>10</sub>	23.8	0.039
2,2',3,4,5,5',6-heptachlorobiphenyl	394	d <sub>10</sub>	27.5	0.013
2,2',3,3',4,4',5,5'-octachlorobiphenyl	179	d <sub>10</sub>	30.4	0.015
2,2',3,3',4,5,5',6,6'-nonchlorobiphenyl	197 <sup>d</sup>	d <sub>10</sub>	30.0	0.017
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl	214	d <sub>10</sub>	31.9	0.021
<u>Polynuclear aromatics (PAHs)</u>				
Naphthalene	128	d <sub>8</sub>	9.8	1.38
Biphenyl	154	d <sub>8</sub>	13.5	0.654
2-Chloronaphthalene	162	d <sub>8</sub>	13.4	0.456
Acenaphthylene	152	d <sub>10</sub>	14.6	1.05
Acenaphthene	154	d <sub>10</sub>	15.2	0.592
Fluorene	166	d <sub>10</sub>	16.8	1.95
Phenanthrene/Anthracene <sup>c</sup>	178	d <sub>10</sub>	19.8	0.890
Fluoranthene	202	d <sub>10</sub>	23.4	0.814
Pyrene	202	d <sub>10</sub>	24.0	0.685

(continued)

TABLE 10 (continued)

Compound	Quantitative ion	Internal standard <sup>a</sup>	Typical RT (minutes)	Average RF <sup>b</sup>
<u>Polynuclear aromatics (PAHs) (continued)</u>				
Chrysene	228	d <sub>10</sub>	27.9	0.144
Benzo(a)anthracene	228	d <sub>10</sub>	27.8	0.236
Benzo(b)fluoranthene	252	d <sub>10</sub>	30.9	0.043
Benzo(k)fluoranthene	252	d <sub>10</sub>	31.0	0.115
Benzo(a)pyrene	252	d <sub>10</sub>	31.7	0.094
Dibenzo(a,h)anthracene	278	d <sub>10</sub>	35.1	0.053
Benzo(g,h,i)perylene	276	d <sub>10</sub>	35.0	0.047
Indeno(1,2,3-cd)pyrene	276	d <sub>10</sub>	35.2	0.010
<u>Pesticides</u>				
γ-BHC	109	d <sub>10</sub>	19.5	0.224
α-BHC	109	d <sub>10</sub>	18.6	0.167
Aldrin	66	d <sub>10</sub>	22.2	0.185
Heptachlor	100	d <sub>10</sub>	21.4	0.265
p,p'-DDT	235	d <sub>10</sub>	26.7	0.162

(continued)

TABLE 10 (continued)

Compound	Quantitative ion	Internal standard <sup>a</sup>	Typical RT (minutes)	Average RF <sup>b</sup>
<u>Surrogates</u>				
d <sub>3</sub> -Trichlorobenzene	185	d <sub>8</sub>	8.8	0.250
d <sub>10</sub> -Biphenyl	164	d <sub>8</sub>	13.3	0.589
d <sub>6</sub> -Tetrachlorobiphenyl	298	d <sub>10</sub>	24.9	0.064
d <sub>12</sub> -Chrysene	240	d <sub>10</sub>	27.8	0.070

<sup>a</sup>Response factors calculated relative to most closely eluting internal standard, either d<sub>8</sub>-naphthalene or d<sub>10</sub>-anthracene.

<sup>b</sup>Response factor of component calculated versus the appropriate internal standard according to the following equation:

$$RF = \frac{A_x W_{IS}}{A_{IS} W_x}$$

where, RF = response factor  
 A<sub>x</sub> = area of the quantitative ion of compound x  
 W<sub>x</sub> = quantity in nanograms eliciting this area response  
 A<sub>IS</sub> = area of the quantitative ion of the internal standard  
 W<sub>IS</sub> = quantity in nanograms eliciting the area response.

The values shown here represent average component response factors.

<sup>c</sup>Phenanthrene and anthracene cannot be differentiated under GC/MS conditions employed here.

Spectral identification and quantitation criteria for the polynuclear aromatic hydrocarbons (PAHs) listed in Table 10 were again consistent with EPA Method 625.6. Components not listed here for which results are provided in Section 5 were identified on the basis of spectral data alone. Criteria were identical to those for additional organic components as noted later in this section.

Due to the complexity of the PCB Aroclor mixtures in each of the program samples, the qualitative and quantitative criteria for this class of compounds could not follow the GC/MS criteria established for the other component classes.

The identification and quantitation of polychlorinated biphenyls (i.e., Aroclor mixtures) were based upon the analysis of a series of representative positional isomers as listed in Table 10. These isomers, representing unit increments in chlorine substitution from mono- to decachlorobiphenyl were used to establish a retention time window of approximately +3 minutes for each isomer group. The characteristic ions for each isomer group were determined from the mass spectral data obtained during the analysis of standard reference materials. Data obtained for each sample were then reviewed for the presence of the chlorine isotope clusters typical of PCB compounds. The extracted ion profiles for the primary ions of all PCBs were obtained. All peaks noted on the extracted ion profile for a given isomer group falling within the assigned retention time window for that isomer group were then examined.

Assignments to a specific isomer group were made upon satisfying the following criteria: (a) the primary ion (e.g., tetrachlorobiphenyl  $m/e = 292$ ) was present as part of a chlorine isotope cluster, (b) a minimum of two additional ions characteristic of the isomer group were present in the component spectra at the expected relative intensities, (c) an absence of ions indicative of higher molecular weight chlorinated fragments, (d) balance of the spectra was consistent with chlorine substitution on a biphenyl molecule. Peaks satisfying these criteria were assigned to the appropriate positional isomer group and quantitated using the response factor (RF) generated for the reference material with the same molecular mass as the component peak. Accordingly, results in Section 5 are provided in  $ng/m^3$  for each of the 10 positional isomer groups. Total concentrations resulting from the sum of the positional isomer groups are also presented.

Spectral identification criteria for additional components not listed in Table 10 for which results are provided in Section 5 followed the criteria noted below. A background-corrected spectrum of the component was first obtained by computer subtraction. A probability-based library search (PBS) was then conducted by computer routine, comparing the unknown spectra with those of the EPA/NIH libraries. The computer search provided up to 10 possible matches. The spectra of library matches were compared directly to the unknown spectrum by the operator. For positive identification, the following conditions were required:

- The intensity, relative to the base peak, of all major peaks (greater than 50 percent of base peak) agreed within 20 percent.

- All peaks present in the library spectrum at more than 20 percent of the base peak were present in the unknown spectrum.
- The unknown spectrum must not have any peaks present more than 30 percent of the base peak that are not seen in the library spectrum or are not clearly attributable to coeluting compounds.

If the library search did not provide a positive match, the unknown spectra were reviewed for major peaks and fragmentation patterns. Tentative identifications were made by the operator and verified by comparison of available reference spectra (EPA/NIH libraries) to the background corrected component spectra. Component concentrations were calculated relative to the closest eluting internal standard. All values represent approximations due to inherent variabilities in component response factors in the absence of reference materials.

#### TRACE METAL ANALYSIS

Analysis for trace metals was conducted on particulate filters from the comprehensive stations from Days 2 and 3 of testing. The 50 percent filter aliquot, remaining after GC/MS analysis, was prepared for trace metals analysis of collected particulate matter using the digestion procedures detailed in Appendix A. Trace metal concentrations were determined by means of Inductively Coupled Argon Plasma Emission Spectroscopy (ICAP) using a Jarrell Ash 855 Atom Comp managed by a PDP-8 minicomputer.

Instrument calibration was accomplished by analyzing a blank and a 10 mg/l solution of each element. Response intensities of standard solutions were compared to those of samples in order to provide a quantitative measurement. Detection limits and appropriate wavelengths for this analysis are listed in Table 11.

TABLE 11. DETECTION LIMITS AND WAVELENGTHS FOR ICAP ANALYSIS

Element	Derection limits <sup>a</sup> (ng/m <sup>3</sup> )	Wavelength used for analysis (nm)
Ag	0.3	328.0
Al	2	308.2
As	8	197.2
B	1	249.6 (second order)
Ba	0.3	493.4
Be	0.3	234.8
Ca	3	317.9
Cd	0.3	228.8 (second order)
Co	0.8	228.6
Cr	0.8	205.5 (second order)
Cu	0.5	324.7
Fe	1	259.9
Mg	5	279.0
Mn	0.3	257.6
Mo	0.5	202.0
Na	3	589.0
Ni	1	231.6 (second order)
Pb	5	220.3
Sb	5	206.8
Se	5	196.0 (second order)
Si	1	251.6
Sn	8	189.9
Sr	0.3	421.5
Ti	0.3	334.9
Tl	10	190.8 (second order)
V	1	292.4
Zn	0.3	213.8

<sup>a</sup>These values were calculated assuming an air volume of 400 m<sup>3</sup>.

## SECTION 5

### RESULTS

#### METEOROLOGICAL MEASUREMENTS

Meteorological data were collected in the effective study region on each of three sampling days. Pertinent monitoring parameters as noted earlier included wind direction, speed, ambient temperature and atmospheric stability. The primary criteria for the selection of sampling sets for subsequent analyses were days on which the average wind direction most approximated the critical wind direction of 225°(SW). Additional criteria included a review of the ambient temperature and general atmospheric stability during each of the sampling sessions in order to define periods of stability commensurate with the program objectives outlined in Section 2. A brief summary of pertinent meteorological trends indicative of each of the 3 sampling days is provided below. A complete listing of wind speed and directional data for each of the sampling days is provided in Tables 12 through 14. Ambient temperature data are provided in Tables 15 and 16.

#### Day 1--August 31, 1982

The national weather map for 0700 EST showed that higher pressure was evident to the south and southeast of the study area. Wind directions over the region averaged WSW to S, well within the critical range. In general, the local sources of meteorological data showed winds from the SSW to WSW with some slight indication of a W to NW blow late in the day. Speeds were moderate (10 to 12 mph) throughout the region for this day. Relative humidity readings for the 8/31/82 sampling period ranged from 75 to 85 percent. It should be noted that some periods of light rain began around 2100 hours on 8/31/82 but no substantial precipitation took place until approximately 0100 hours on 9/1/82. Most of the samplers were shut off by 0130 and were unaffected by the direct impact of rainfall. Further, the polyurethane foam collection media were housed in sampler shelters designed to minimize the effects of rainfall.

TABLE 12. HOURLY WIND DIRECTION (Degrees) AND WIND SPEED (MPH) OBSERVATIONS  
FOR SAMPLING DAY 1--AUGUST 31, 1982

Time (Hour Ending)	Hurricane Barrier		Tripp Towers		Technical School		Municipal Garage		Sewage Plant		New Bedford Airport		Dartmouth Town Hall		Tripp School	
	Dir.	Speed	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd
0800	225	9.9	225	N/A	203	8.1	270	9.7	225	1.6	225	13.4	250	N/A	250	5
0900	248	13.7	225	N/A	225	11.3	270	11.3	225	14.2	248	14.3	240	N/A	250	7
1000	248	17.0	248	N/A	270	13.2	248	12.0	248	22.9	248	15.0	250	N/A	250	8
1100	225	19.6	203	N/A	248	14.6	270	12.2	248	20.7	248	14.1	260	N/A	250	8
1200	225	18.9	203	N/A	225	14.7	270	15.0	225	24.0	248	14.6	260	N/A	250	8
1300	225	18.6	248	N/A	225	13.6	270	15.5	248	21.8	248	12.9	250	N/A	240	8
1400	225	18.5	225	N/A	270	13.3	293	16.3	248	20.8	248	12.5	250	N/A	240	7
1500	248	16.2	248	N/A	248	12.2	270	16.9	248	22.6	248	11.0	250	N/A	240	7
1600	225	17.8	225	N/A	225	13.2	293	15.1	248	21.3	203	10.6	250	N/A	240	8
1700	225	16.3	248	N/A	225	12.9	293	13.9	225	23.4	248	14.0	250	N/A	240	8
1800	225	13.0	225	N/A	225	11.0	270	11.9	248	21.5	248	11.0	250	N/A	240	7
1900	248	14.4	248	N/A	225	8.6	270	12.5	225	18.7	248	7.9	250	N/A	230	6
2000	225	12.6	248	N/A	225	7.7	315	10.3	248	17.3	248	6.8	260	N/A	240	5
2100	225	12.3	225	N/A	225	6.5	270	8.0	248	17.8	248	6.1	270	N/A	250	4
2200	248	11.0	248	N/A	248	6.7	270	8.6	248	16.4	248	7.2	250	N/A	240	4
2300	248	10.0	225	N/A	225	6.1	293	9.6	248	14.7	248	7.7	260	N/A	230	3
2400	225	9.7	203	N/A	225	7.9	293	8.7	248	14.3	293	8.2	260	N/A	230	4
0100	203	10.6	225	N/A	203	6.8	293	9.3	225	16.6	248	7.8	260	N/A	230	4
0200	248	9.8	225	N/A	225	6.1	270	9.8	248	15.3	270	11.2	250	N/A	220	3

N/A - Data not available.

TABLE 13. HOURLY WIND DIRECTION (Degrees) AND WIND SPEED (MPH) OBSERVATIONS  
FOR SAMPLING DAY 2--SEPTEMBER 3, 1982

Time (Hour Ending)	Hurricane Barrier		Tripp Towers		Technical School		Municipal Garage		Sewage Plant		New Bed. Airport		Dartmouth Town Hall		Tripp School	
	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd
0800	225	15.2	203	NA	225	12.1	270	12.1	225	23.2	203	9.1	260	2	230	7
0900	225	15.9	225	NA	270	12.6	270	13.0	248	21.6	225	11.6	260	2	240	8
1000	225	15.9	225	NA	203	11.4	270	11.9	225	21.4	225	13.8	260	3	240	8
1100	225	17.6	225	NA	225	10.0	293	12.1	248	22.3	248	15.9	270	2	250	7
1200	248	16.0	248	NA	225	9.1	270	12.6	248	19.2	248	16.0	270	1	250	6
1300	248	14.0	248	NA	293	9.4	315	12.9	248	16.1	248	17.7	270	1	260	5
1400	270	10.4	270	NA	248	10.1	315	10.8	248	14.6	248	17.1	260	5	240	5
1500	203	17.4	180	NA	248	10.9	293	10.0	225	21.0	248	14.7	260	6	220	5
1600	203	14.0	158	NA	225	10.6	293	12.2	225	18.9	248	15.3	260	5	230	7
1700	225	16.6	225	NA	225	11.7	270	12.8	225	20.1	248	14.0	250	6	230	8
1800	225	15.5	203	NA	248	9.3	270	12.8	248	22.1	248	12.6	260	5	230	7
1900	225	11.9	248	NA	225	7.0	270	11.3	248	18.5	203	10.4	260	1	240	4
2000	248	9.4	248	NA	270	5.7	270	8.5	248	13.2	248	9.6	260	NA	240	3
2100	270	9.2	248	NA	270	5.1	293	7.2	248	11.7	225	8.6	290	NA	255	3
2200	248	9.1	248	NA	270	5.7	293	7.8	248	12.9	225	7.5	290	NA	260	4
2300	270	9.3	270	NA	270	6.4	315	8.0	270	12.8	248	6.8	290	NA	270	4
2400	248	9.5	270	NA	293	5.1	315	8.8	293	9.6	203	8.8	290	NA	315	3

NA - Data not available.

TABLE 14. HOURLY WIND DIRECTION (Degrees) AND WIND SPEED (MPH) OBSERVATIONS  
FOR SAMPLING DAY 3--SEPTEMBER 9, 1982

Time (Hour Ending)	Hurricane Barrier		Tripp Towers		Technical School		Municipal Garage		Sewage Plant		New Bed. Airport		Dartmouth Town Hall		Tripp School	
	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd
0800	248	6.0	248	NA	225	4.0	315	5.9	248	7.1	203	1.6	250	NA	180	2
0900	248	8.7	225	NA	248	5.1	270	8.3	248	9.8	338	1.6	270	2	240	3
1000	248	11.7	225	NA	270	7.8	315	8.6	248	13.0	203	2.0	270	4	270	4
1100	248	12.3	248	NA	270	10.1	315	10.7	248	14.5	225	1.7	270	4	265	5
1200	225	12.4	203	NA	NA	NA	NA	NA	248	18.0	158	2.6	260	6	260	5
1300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	203	5.1	250	10	240	6
1400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	113	7.7	240	10	250	6
1500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	135	7.1	250	10	250	7
1600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	248	5.3	250	10	250	8
1700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	225	5.6	250	10	250	9
1800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	203	4.4	260	9	250	8
1900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	203	4.1	260	6	250	6
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	203	NA	260	5	250	5
2100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	203	NA	270	5	250	5
2200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	225	NA	270	3	260	4
2300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	248	NA	270	3	270	3
2400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	248	NA	270	3	240	3

NA - Data not available.

TABLE 15. AMBIENT TEMPERATURE MEASUREMENTS: DAY 2--  
SEPTEMBER 3, 1982

Site No.	Location	Temp (°C)	Clock time	Temp (°C)	Clock time
1	Dartmouth Town Hall	22	0835	24	2020
2	Sullivan's Ledge	31	1216	24	2342
3	Shawmut Pump Station A	25	0940	24	2136
3	Shawmut Pump Station B	25	0940	24	2136
4	Adams Oil	25	0938	24	2307
5	New Bedford Airport	25	1018	24	2218
6	Cushman Park	23	0900	24	2205
7	Tripp School A	27	0930	24	2159
7	Tripp School B	27	0930	24	2159
8	Acushnet Nursing	28	1010	24	2154
9	C&W Welding A	25	1028	24	2228
9	C&W Welding B	25	1028	24	2228
10	Burt School	25	1009	24	2229
11	Brooklawn Park	25	1111	24	2211
12	Taber St. Pump Station	27	0945	24	0104
13	Fire Station No. 2	28	1159	24	1921
14	Hurricane Barrier	23	0825	24	2030
15	St. Anne's Rectory	24	0754	24	1956
16	Fire Station No. 11	24	0750	24	2010
17	Guy's Pharmacy	23	0915	24	2113
18	Incinerator No. 3	22	0919	24	2242
19	Incinerator No. 2	22	0815	24	2051
20	Incinerator No. 1	22	0830	24	2020
21	Incinerator No. 4	22	0840	24	2036

TABLE 16. AMBIENT TEMPERATURE MEASUREMENTS: DAY 3--  
SEPTEMBER 9, 1982

Site No.	Location	Temp (°C)	Clock time	Temp (°C)	Clock time
1	Dartmouth Town Hall	21	0833	23	2158
2	Sullivan's Ledge	24	0928	23	2148
3	Shawmut Pump Station A	22	0914	23	2034
3	Shawmut Pump Station B	22	0914	23	2034
4	Adams Oil	21	0908	23	2138
5	New Bedford Airport	24	0945	23	2214
6	Cushman Park	20	0830	23	1948
7	Tripp School A	20	0843	23	2223
7	Tripp School B	20	0843	23	2223
8	Acushnet Nursing	22	0925	23	2150
9	C&W Welding A	22	0935	23	2135
9	C&W Welding B	22	0935	23	2135
10	Burt School	22	0916	23	2146
11	Brooklawn Park	22	0959	23	2159
12	Taber St. Pump Station	20	0856	23	2126
13	Fire Station No. 2	21	0856	23	2219
14	Hurricane Barrier	20	0756	23	1951
15	St. Anne's Rectory	16	0738	23	2014
16	Fire Station No. 11	14	0740	23	2010
17	Guy's Pharmacy	20	0814	23	2006
18	Incinerator No. 3	21	0805	23	1940
19	Incinerator No. 2	21	0800	23	1940
20	Incinerator No. 1	21	0812	23	2013
21	Incinerator No. 4	21	0800	23	2025

Further information on rainfall (inches) pertinent to the effective sampling period as provided by the National Weather Service (Warwick, R.I., station) is shown as follows.

<u>Date</u>	<u>Time</u>	<u>Amount (inches)</u>
8/31/82	-	Trace
9/01/82	0105 to 1822 2117 to midnight	2.15
9/02/82	Midnight to 0830	0.5

#### Day 2--September 3, 1982

The national weather map for 0700 EST showed that a low pressure center was located to the NW of the region, bringing SSW to W winds to the study area. The local sources of meteorological data showed winds from the SSW to W with a tendency toward WSW to W directions prevailing. Speeds were moderate (10 to 12 mph) for most of the day. Ambient temperature data collected at each test site at the start and conclusion of each Day 2 sampling period are provided in Table 15.

#### Day 3--September 9, 1982

The national weather map for 0700 EST showed a high pressure center located to the south of the study area, causing generally SW to W winds. The local meteorological data showed the wind to be much more definitely from the west. However, data were missing from five of the eight sites from noon until the end of the day. Wind speeds were light to moderate (3 to 10 mph) throughout the day. Ambient temperature data collected at each test site at the start and conclusion of each Day 3 sampling period are provided in Table 16.

Based on the foregoing discussion, the data indicated that the optimum day for analysis would be Day 2 (September 3, 1982).

#### TRACE METAL MEASUREMENTS

Test results for trace metals collected on Days 2 and 3 at each of six comprehensive stations are shown in Table 17. All results are provided in  $\mu\text{g}/\text{m}^3$  for each of 27 metals (aluminum-zinc) contained in the particulate filter portion of each of the high-volume samplers. Results are also provided for collocated monitors placed at C&W Welding (Site 9) and Shawmut Station (Site 3) on each of the test days. Please note that all measurements represent blank corrected values.

TABLE 17. TRACE METAL RESULTS<sup>a</sup>--COMPREHENSIVE STATIONS<sup>b</sup>

Element	Concentration (ug/m <sup>3</sup> )															
	C&W Welding (Site 9) <sup>c</sup>				Shawmut Station (Site 3) <sup>c</sup>				Incinerator #3 (Site 18)		Dartmouth Town Hall (Site 1)		New Bedford Fire Station (Site 13)		Cushman Park #1 Fairhaven (Site 6)	
	Day 2		Day 3		Day 2		Day 3		Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3
	A	B	A	B	A	B	A	B	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3
Aluminum	0.184	0.352	0.467	0.220	ND	0.083	0.099	ND	0.112	0.884	0.100	0.399	0.007	0.263	ND	0.574
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	0.0068	0.0114	0.0118	0.0072	0.0044	0.0040	0.0076	ND	0.0060	0.093	0.0042	0.0041	0.0016	0.0046	0.0026	0.0134
Beryllium	0.0002	0.0001	0.0002	0.0002	ND	ND	ND	ND	0.0001	0.0005	ND	ND	ND	0.0002	ND	ND
Boron	ND	ND	0.030	ND	ND	0.0095	0.008	ND	ND	0.005	ND	0.043	ND	ND	ND	0.007
Cadmium	0.0005	0.0003	0.0003	0.0006	ND	ND	ND	ND	0.0004	0.0054	ND	ND	ND	0.0002	ND	ND
Calcium	0.614	0.864	0.765	0.373	ND	0.143	0.159	ND	ND	2.48	0.291	0.698	0.016	0.403	ND	0.652
Chromium	0.0025	0.0033	0.0042	0.0039	0.0011	0.0080	0.0036	0.0008	0.0071	0.0540	0.0042	0.0016	0.0007	ND	0.0016	0.0024
Cobalt	0.0007	0.0014	0.0016	0.0020	ND	0.0018	0.0013	ND	0.0011	0.0029	0.0021	0.0007	0.0005	ND	0.0108	0.0033
Copper	0.0489	0.0773	0.0278	0.0319	0.0579	0.0656	0.0135	0.0411	0.0270	0.183	0.0347	0.0518	0.0121	0.0364	0.0203	0.0294
Iron	0.3810	0.5460	0.605	0.489	0.157	0.160	0.219	0.239	0.358	1.94	0.174	0.271	0.159	0.536	0.376	0.498
Lead	0.327	0.445	0.158	0.207	0.109	0.115	0.044	0.037	0.116	0.067	0.110	0.054	0.148	0.228	0.161	0.048
Magnesium	0.246	0.458	0.450	0.283	ND	0.103	0.145	0.005	0.105	0.818	0.210	0.366	0.025	0.227	0.056	0.311
Manganese	0.0063	0.0105	0.0095	0.0078	0.0028	0.0035	0.0031	0.0022	0.0038	0.0169	0.0042	0.0041	0.0027	0.0062	0.0054	0.0081
Molybdenum	ND	ND	ND	0.0005	ND	ND	ND	ND	0.0006	0.0028	ND	ND	ND	ND	ND	ND
Nickel	0.055	0.015	0.144	0.069	0.027	0.029	0.233	ND	0.002	0.196	0.004	ND	ND	ND	ND	0.008
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silicon	ND	0.150	0.811	0.534	ND	ND	0.403	0.653	ND	0.299	ND	0.353	ND	ND	ND	1.26
Silver	0.0011	ND	ND	0.0006	ND	ND	ND	ND	ND	0.0096	ND	ND	ND	ND	0.0008	ND
Sodium	54.1	66.0	20.8	15.4	44.1	51.8	12.2	4.89	40.2	22.6	59.8	25.8	28.2	10.9	38.2	28.4
Strontium	0.0034	0.0052	0.0041	0.0025	ND	ND	0.0014	ND	0.0011	0.0122	0.0018	0.0039	0.0002	0.0020	0.0005	0.0033
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(continued)

TABLE 17 (continued)

Element	Concentration ( $\mu\text{g}/\text{m}^3$ )															
	C&W Welding (Site 9) <sup>c</sup>				Shawmut Station (Site 3) <sup>c</sup>				Incinerator #3 (Site 18)		Dartmouth Town Hall (Site 1)		New Bedford Fire Station (Site 13)		Cushman Park #1 Fairhaven (Site 6)	
	Day 2		Day 3		Day 2		Day 3		Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3
	A	B	A	B	A	B	A	B								
Tin	0.021	ND	ND	0.015	ND	ND	0.015	ND	ND	0.011	ND	ND	ND	0.008	ND	ND
Titanium	ND	0.0110	0.0031	ND	ND	ND	ND	ND	0.0392	ND	ND	ND	ND	ND	ND	0.0053
Vanadium	0.0082	0.0143	0.017	0.017	0.0046	0.0050	0.006	0.005	0.0055	0.011	0.0074	0.006	0.0053	0.009	0.0074	0.007
Zinc	0.275	0.445	0.443	0.439	0.0314	0.0681	0.0210	0.0264	0.0530	0.131	0.0425	0.0225	0.0185	0.0323	0.0353	0.0386

<sup>a</sup>All data points represent blank corrected values. For individual detection limits, see site specific data sheets provided in Appendix C of this report.

<sup>b</sup>Each of six stations were selected for comprehensive analyses, including trace metals. The geographical location of each of the stations is noted with a  in Figure 1. Site numbers (in parentheses) and locations are shown in Table 1 and Figure 1.

<sup>c</sup>Collocated monitors at this location; values shown for both samples A and B.

## POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS (GC/ECD)

PCB results are tabulated for each of 2 test days (Days 2 and 3) in Tables 18 and 19, respectively. Results are provided in  $\text{ng}/\text{m}^3$  for each of the aroclor mixtures noted. All values have been corrected using appropriate field and method blanks. Cumulative test results indicative of both test days are listed by site area and category type of Tables 20 through 25. As noted earlier, each of the 10 sites can be further categorized as background, known area source or suspected area source. Classification of the cumulative test data in this manner will assist in illustrating some of the more noteworthy trends in the general discussion (Section 6) to follow.

## POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS (GC/MS)

As noted earlier in Section 4, GC/MS analyses were conducted on polyurethane foam and filter samples from each of six comprehensive stations and on polyurethane foam extracts from each of four stations noted as having elevated PCB levels during GC/ECD analyses (Tables 18 and 19). A complete listing of all samples investigated using the GC/MS protocols described in Section 4 is provided in Table 26. PCB results as determined by GC/MS for each of these samples are provided in Table 27. Results are again provided in  $\text{ng}/\text{m}^3$  for each of 10 PCB positional isomer categories. Total PCB results are also provided in  $\text{ng}/\text{m}^3$  by summing the values from each of the positional isomer groups.

The isomeric distribution patterns for the majority of samples exhibiting measurable PCB concentrations are consistent with the pattern of an Aroclor 1242 or 1016 mixture with the exception of the Sullivan's Ledge samples. The latter samples on both Days 2 and 3 exhibit a noticeable shift to higher boiling, higher molecular weight chlorobiphenyl groups more exemplary of an Aroclor 1254 mixture. (Note the predominance of the di, tri, and tetra groups in stations 8, 9, 12, 18 and 19.) These patterns are in direct contrast to the abundance of tetra, penta, and hexa isomers observed in each of the Sullivan's Ledge samples. (See Appendices D and E for spectra and Section 7 for GC/MS positional isomer group concentrations for an Aroclor 1254 spike sample.) The remainder of the samples listed in Table 27, including stations 1, 3 and 13, contained nondetectable levels of PCBs and were consistent with the much lower levels reported for these stations (GC/ECD) earlier in Tables 18 and 19. Please note that all values have been corrected using appropriate field and method blanks. Representative total ion chromatograms and component and reference spectra for chlorobiphenyl isomers are provided in Appendices D and E of this report.

It should be noted that polyurethane foam and filter extracts from each sample set were analyzed separately, although results are provided for the sum of the two media. In all cases, analysis of the filter samples resulted in ND values for each of the positional isomer categories noted in Table 27. These observations are consistent with the behavior of polychlorinated biphenyls in the ambient atmosphere as noted by other investigators.<sup>7-10</sup> More specifically, PCBs are generally partitioned in the vapor phase in ambient air and not typically associated with airborne particulate matter. Even if

TABLE 18. POLYCHLORINATED BIPHENYL (PCB) CONCENTRATIONS: RESULTS OF DAY 2  
(9/3/82) SAMPLE SET

Site area <sup>a</sup>	Site <sup>a</sup> No.	Location <sup>a</sup>	Concentration (ng/m <sup>3</sup> )	
			Aroclor 1242/1016 <sup>b</sup>	Aroclor 1254
Dartmouth	1	Roof of Town Hall	4.9	<2
Sullivan's Ledge	2	Onsite	180	110
New Bedford Landfill	3	(NE) Shawmut St. <sup>c</sup>	2.9	<2
		(NE) Shawmut St. <sup>c</sup>	1.6	<2
	4	(SE) Adams Oil	7.8	<2
	5	(NW) Airport	2.9	<2
Cushman Park, Fairhaven	6	Onsite	16	<2
	7	Job C. Tripp School <sup>c</sup>	14	<2
		Job C. Tripp School <sup>c</sup>	15	<2
Aerovox	8	(ENE) Acushnet Nursing Home	84	3.7
	9	(N) C&W Welding <sup>c</sup>	99	4.4
		(N) C&W Welding <sup>c</sup>	62	<2
	10	(SE) Burt School	13	<2
	11	(WSW) Brooklawn Park	<1 <sup>d</sup>	<2
Marsh Island	12	Taber St. Station	52	2.3
New Bedford	13	Roof of Fire Station #2	5.1	<2

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(continued)

TABLE 18 (continued)

Site area <sup>a</sup>	Site <sup>a</sup> No.	Location <sup>a</sup>	Concentration (ng/m <sup>3</sup> )	
			Aroclor 1242/1016 <sup>b</sup>	Aroclor 1254
Cornell Dubilier	14	(NNW) Hurricane Barrier	5.4	<2
	15	(WNW) St. Anne's Rectory	9.8	<2
	16	(WSW) Fire Station #11	10	<2
Fairhaven	17	Guy's Pharmacy	18	<2
New Bedford Sewage Sludge Incinerator	18	(NNE) Location #3	33	<2
	19	(NE) Location #2	83	4.0
	20	(E) Location #1	4.9	<2
	21	(SW) Location #4	9.8	<2

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<sup>a</sup>Site area, number and location are as specified in "Sampling and Analysis Protocols for Ambient Monitoring in Support of the New Bedford Environmental Investigation" Test and Quality Assurance Project Plan. Figure 1 of this report is to be substituted for Figure 2-1 in the above document.

<sup>b</sup>Concentration shown was quantitated as Aroclor 1242 only.

<sup>c</sup>Indicates collocated monitors at this location.

<sup>d</sup>This sample (GCA 25459) may have been inadvertently exchanged with one of the field blanks (GCA 25449) during sample handling. The field blank in question yields a value of 8.6 ng/m<sup>3</sup> assuming the 407 m<sup>3</sup> volume collected at the Brooklawn Park Site. The sample in question (GCA 25449) yields a <1 ng/m<sup>3</sup> value as shown in the above table.

TABLE 19. POLYCHLORINATED BIPHENYL (PCB) CONCENTRATIONS: RESULTS OF DAY 3  
(9/9/82) SAMPLE SET

Site area <sup>a</sup>	Site <sup>a</sup> No.	Location <sup>a</sup>	Concentration (ng/m <sup>3</sup> )	
			Aroclor 1242/1016 <sup>b</sup>	Aroclor 1254
Dartmouth	1	Roof of Town Hall	3.6	< 2
Sullivan's Ledge	2	Onsite	140	94
New Bedford Landfill	3	(NE) Shawmut St. <sup>c</sup>	2.4	< 2
		(NE) Shawmut St. <sup>c</sup>	8.2	< 2
	4	(SE) Adams Oil	6.4	< 2
	5	(NW) Airport	6.0	2.1
Cushman Park, Fairhaven	6	Onsite	15	< 2
	7	Job C. Tripp School <sup>c</sup>	7	< 2
		Job C. Tripp School <sup>c</sup>	12	< 2
Aerovox	8	(ENE) Acushnet Nursing Home	48	3.0
	9	(N) C&W Welding <sup>c</sup>	86	4.6
		(N) C&W Welding <sup>c</sup>	90	3.7
	10	(SE) Burt School	9.4	< 2
	11	(WSW) Brooklawn Park	10	< 2
Marsh Island	12	Taber St. Station	60	3.7
New Bedford	13	Roof of Fire Station #2	4.4	< 2

(continued)

TABLE 19 (continued)

Site area <sup>a</sup>	Site <sup>a</sup> No.	Location <sup>a</sup>	Concentration (ng/m <sup>3</sup> )		
			Aroclor 1242/1016 <sup>b</sup>	Aroclor 1254	
Cornell Dubilier	14	(NNW) Hurricane Barrier	5.0	< 2	
	15	(WNW) St. Anne's Rectory	4 <sup>d</sup>	< 2	
	16	(WSW) Fire Station #11	11	2.5	
Fairhaven	17	Guy's Pharmacy	11	< 2	
New Bedford	18	(NNE) Location #3	42	2.2	
	Sewage Sludge	19	(NE) Location #2	66	4.3
	Incinerator	20	(E) Location #1	11	< 2
		21	(SW) Location #4	8.0	< 2

<sup>a</sup>Site area, number and location are as specified in "Sampling and Analysis Protocols for Ambient Monitoring in Support of the New Bedford Environmental Investigation" Test and Quality Assurance Project Plan. Figure 1 of this report is to be substituted for Figure 2-1 in the above document.

<sup>b</sup>Concentration shown was quantitated as Aroclor 1242 only.

<sup>c</sup>Indicates collocated monitors at this location.

<sup>d</sup>Accurate volume measurement was not possible due to HiVol sampler malfunction; an assumed value of 400 m<sup>3</sup> was used to calculate PCB concentration.

TABLE 20. POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS: CUMULATIVE TEST RESULTS--  
BACKGROUND LOCATIONS<sup>a</sup>

Site area	Site No.	Concentration (ng/m <sup>3</sup> )					
		Aroclor 1242/1016 <sup>c</sup>			Aroclor 1254		
		Day 2	Day 3	$\bar{X}$	Day 2	Day 3	$\bar{X}$
Dartmouth Town Hall	1	4.9	3.6	4.3	<2	<2	-
Fairhaven-- Job C. Tripp School <sup>b</sup>	7	14 15	7 12	11 14	<2	<2	-
New Bedford Fire Station #2	13	5.1	4.4	4.8	<2	<2	-
Fairhaven--Guy's Pharmacy	17	18	11	15	<2	<2	-
Cumulative All Stations ( $\bar{X} \pm S_x$ )		11 $\pm$ 6.0	7.6 $\pm$ 3.8	9.5 $\pm$ 5.2	-	-	-

<sup>a</sup>Background stations as defined for the present investigation are discussed in more detail in Section 2.

<sup>b</sup>Collocated monitors at this station. Values shown for both samples A and B.

TABLE 21. POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS: CUMULATIVE TEST RESULTS--AREA SOURCE NEW BEDFORD MUNICIPAL LANDFILL<sup>a</sup>

Site area	Site No.	Concentration (ng/m <sup>3</sup> )					
		Aroclor 1242/1016			Aroclor 1254		
		Day 2	Day 3	$\bar{X}$	Day 2	Day 3	$\bar{X}$
Shawmut Street Station <sup>b</sup> (NE)	3	2.4	2.4	2.4	<2	<2	-
		1.6	8.2	4.9	<2	<2	-
Adams Oil (SE)	4	7.8	6.4	7.1	<2	<2	-
Airport (NW)	5	2.9	6.0	4.5	<2	2.1	-
Cumulative Data ( $\bar{X} \pm S_x$ )		3.7 $\pm$ 2.8	5.8 $\pm$ 2.4	4.7 $\pm$ 2.7	-	-	-
Cumulative Background <sup>c</sup> ( $\bar{X} \pm S_x$ )		11 $\pm$ 6.0	7.6 $\pm$ 3.8	9.5 $\pm$ 5.2	-	-	-

<sup>a</sup>New Bedford Municipal Landfill has historically been considered a fugitive source of PCBs as demonstrated by existing test data.

<sup>b</sup>Collocated monitors at this station. Values shown for both samples A and B.

<sup>c</sup>Reflects cumulative values from all background stations as shown in Table 20.

TABLE 22. POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS: CUMULATIVE TEST RESULTS--  
POTENTIAL AREA SOURCES<sup>a</sup>

Site area	Site No.	Concentration (ng/m <sup>3</sup> )					
		Aroclor 1242/1016			Aroclor 1254		
		Day 2	Day 3	$\bar{X}$	Day 2	Day 3	$\bar{X}$
Sullivan's Ledge--onsite	2	180	140	160	110	94	100
Marsh Island	12	52	60	56	2.3	3.7	3.0
Cushman Park--onsite	6	16	15	16	<2	<2	-
Cumulative Background <sup>b</sup> ( $\bar{X} \pm S_x$ )		11 $\pm$ 6.0	7.6 $\pm$ 3.8	9.5 $\pm$ 5.2	-	-	-

<sup>a</sup>Areas suspected of containing PCB contamination based on existing historical information and hence providing a potential source of PCB contamination to the ambient atmosphere.

<sup>b</sup>Reflects cumulative values from all background stations as shown in Table 20.

TABLE 23. POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS: CUMULATIVE TEST RESULTS--  
AREA SOURCE AEROVOX/UPPER ACUSHNET RIVER<sup>a</sup>

Site area	Site No.	Concentration (ng/m <sup>3</sup> )					
		Aroclor 1242/1016			Aroclor 1254		
		Day 2	Day 3	$\bar{X}$	Day 2	Day 3	$\bar{X}$
Acushnet Nursing Home (ENE)	8	84	48	66	3.7	3.0	3.4
C&W Welding <sup>b</sup> (N)	9	99 62	86 90	93 76	4.4 <2	4.6 3.7	4.5 -
Burt School (SE)	10	13	9.4	11	<2	<2	-
Brooklawn Park (WSW)	11	<1	10	-	<2	<2	-
Cumulative Data ( $\bar{X} \pm Sx$ )		52 $\pm$ 43	49 $\pm$ 39	50 $\pm$ 38	-	-	-
Cumulative Background <sup>c</sup> ( $\bar{X} \pm Sx$ )		11 $\pm$ 6.0	7.6 $\pm$ 3.8	9.5 $\pm$ 5.2	-	-	-

<sup>a</sup>Aerovox facility and adjacent properties historically considered a fugitive area source of PCBs as demonstrated by existing test data.

<sup>b</sup>Collocated monitors at this station. Values shown for both samples A and B.

<sup>c</sup>Reflects cumulative values from all background stations as shown in Table 20.

TABLE 24. POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS: CUMULATIVE TEST RESULTS--  
SUSPECTED AREA SOURCE CORNELL-DUBILIER<sup>a</sup>

Site area	Site No.	Concentration (ng/m <sup>3</sup> )					
		Aroclor 1242/1016			Aroclor 1254		
		Day 2	Day 3	$\bar{X}$	Day 2	Day 3	$\bar{X}$
Hurricane Barrier (NNW)	14	5.4	5.0	5.2	<2	<2	-
St. Anne's Rectory (WNW)	15	9.8	4.4	7.1	<2	<2	-
Fire Station #11 (WSW)	16	10	11	11	<2	2.5	-
Cumulative Data ( $\bar{X} \pm S_x$ )		8.4 $\pm$ 2.6	6.8 $\pm$ 3.6	7.6 $\pm$ 3.0	-	-	-
Cumulative Background <sup>b</sup> ( $\bar{X} \pm S_x$ )		11 $\pm$ 6.0	7.6 $\pm$ 3.8	9.5 $\pm$ 5.2	-	-	-

<sup>a</sup>Cornell-Dubilier facility and adjacent property historically considered a fugitive area source of PCBs as demonstrated by existing test data.

<sup>b</sup>Reflects cumulative values derived from all background locations as shown in Table 20.

TABLE 25. POLYCHLORINATED BIPHENYL (PCB) MEASUREMENTS: CUMULATIVE TEST RESULTS--  
SUSPECTED AREA SOURCE SEWAGE SLUDGE INCINERATOR<sup>a</sup>

Site area	Site No.	Concentration (ng/m <sup>3</sup> )					
		Aroclor 1242/1016			Aroclor 1254		
		Day 2	Day 3	$\bar{X}$	Day 2	Day 3	$\bar{X}$
Location # 1 (E)	20	4.9	11	8.0	<2	<2	-
Location # 2 (NE)	19	83	66	75	4.0	4.3	4.2
Location # 3 (NNE)	18	33	42	38	<2	2.2	-
Location # 4 (SW)	21	9.8	8.0	8.9	<2	<2	-
Cumulative Data ( $\bar{X} \pm S_x$ )		33 $\pm$ 36	32 $\pm$ 28	32 $\pm$ 30	-	-	-
Cumulative Background <sup>b</sup> ( $\bar{X} \pm S_x$ )		11 $\pm$ 6.0	7.6 $\pm$ 3.8	9.5 $\pm$ 5.2	-	-	-

<sup>a</sup>New Bedford municipal sewage sludge incinerator site historically considered both a fugitive area source and point source of PCBs as demonstrated by existing test data.

<sup>b</sup>Reflects cumulative values derived from all background locations as shown in Table 20.

TABLE 26. SUMMARY LISTING OF SITES INVESTIGATED USING GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)<sup>a</sup>

Site location <sup>b</sup> (Source)	Site No. <sup>b</sup>	Day	GCA Control No.	
			Filter	PUF
Dartmouth Town Hall <sup>c</sup>	1	2	25430	25429
		3	25573	25572
Sullivan's Ledge <sup>d</sup>	2	2	NA	25423
		3	NA	25556
Shawmut St. - A (Landfill) <sup>c</sup>	3	2	25436	25435
		3	25581	25580
Shawmut St. - B (Landfill) <sup>c</sup>	3	2	25440	25439
		3	25577	25578
Cushman Park <sup>c</sup>	6	2	25400	25399
		3	25553	25552
Acushnet Nursing Home (Aerovox) <sup>d</sup>	8	2	NA	25405
		3	NA	25574
C&W Welding - A (Aerovox) <sup>c</sup>	9	2	25446	25445
		3	25607	25606
C&W Welding - B (Aerovox) <sup>c</sup>	9	2	25444	25443
		3	25611	25610
Taber St. Station (Marsh Island) <sup>d</sup>	12	2	NA	25401
		3	NA	25564
Fire Station #2 <sup>c</sup> (New Bedford Background)	13	2	25422	25421
		3	25561	25560
Incinerator #2 <sup>d</sup> (Municipal Incinerator)	19	2	NA	25397
		3	NA	25582
Incinerator #3 <sup>c</sup> (Municipal Incinerator)	18	2	25432	25431
		3	25605	25604
Field Biased Blank <sup>d</sup>	--	3	----	25558

<sup>a</sup>GC/MS analytical protocols and component listings as specified in Section 4. Components categorically listed in Tables 27 through 30.

<sup>b</sup>Site location and no. as specified earlier in Section 2, both in regional schematic (Figure 1) and site summary listing (Table 1).

<sup>c</sup>Comprehensive stations as noted earlier in Section 2. As a consequence both the filter and polyurethane (PUF) cartridges were analyzed. These stations were selected on the basis of their proximity to the prevailing wind direction at each of the pre-designated sites.

<sup>d</sup>Not a comprehensive station. GC/MS analysis provided on the basis of elevated PCB levels as indicated by GC/ECD analysis summarized in Tables 18 and 19. Filter samples were not analyzed from these stations.

TABLE 27. AMBIENT MONITORING MEASUREMENTS: POLYCHLORINATED BIPHENYL ISOMERS--GC/MS<sup>a</sup>

Site location	Number	Day	GCA Control No.		Total concentration (ng/m <sup>3</sup> ) - positional isomer category <sup>c,d</sup>										
			Filter <sup>b</sup>	PUF	Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Non	Deca	Total
Cushman Park	6	2	25400	25399	ND	ND	4.5	ND	ND	ND	ND	ND	ND	ND	4.5
		3	25551	25552	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	1.4
Acushnet Nursing Home (Aerovox)	8	2	NA	24505	ND	5.6	32	13	ND	ND	ND	ND	ND	ND	51
		3	NA	25374	ND	4.7	17	3.9	ND	ND	ND	ND	ND	ND	26
C&W Welding - A (Aerovox)	9	2	25446	25445	ND	3.4	18	7.3	ND	ND	ND	ND	ND	ND	29
		3	25607	25606	ND	9.1	30	14	ND	ND	ND	ND	ND	ND	53
C&W Welding - B (Aerovox)	9	2	25444	25443	ND	6.2	30	6.6	ND	ND	ND	ND	ND	ND	43
		3	25611	25610	ND	6.9	28	9.7	ND	ND	ND	ND	ND	ND	45
Taber St. Station (Marsh Island)	12	2	NA	25401	ND	2.4	16	ND	ND	ND	ND	ND	ND	ND	18
		3	NA	25564	ND	1.4	11	2.5	ND	ND	ND	ND	ND	ND	15
Fire Station #2 (New Bedford Background)	13	2	25422	25421	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		3	25561	25560	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dartmouth Town Hall	1	2	25430	25429	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		3	25573	25572	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sullivan's Ledge	2	2	NA	25423	ND	ND	2.8	13	30	2.3	ND	ND	ND	ND	48
		3	NA	25556	ND	0.8	1.9	28	74	4.9	ND	ND	ND	ND	110
Shawmut St. - A (Landfill)	3	2	25436	25435	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		3	25581	25580	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Shawmut St. - B (Landfill)	3	2	25430	25439	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		3	25579	25578	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Incinerator #2 (Municipal Incinerator)	19	2	NA	25379	ND	3.7	17	13	ND	ND	ND	ND	ND	ND	34
		3	NA	25582	ND	5.4	31	15	ND	ND	ND	ND	ND	ND	51
Incinerator #3	18	2	25432	25431	ND	3.8	17	3.2	ND	ND	ND	ND	ND	ND	24
		3	25605	25604	ND	2.8	13	2.8	ND	ND	ND	ND	ND	ND	19

<sup>a</sup>Analyses conducted using GC/MS protocols provided in Section 4.

<sup>b</sup>NA denotes a noncomprehensive station - GC/MS analyses conducted on PUF only, filter not analyzed.

<sup>c</sup>The concentration provided is a total concentration for the positional isomers within the PCB category (e.g. the value for Tetra- represents the total concentration of all tetrachlorobiphenyl isomers). Quantitations achieved using response factors established for representative isomers within each PCB category.

<sup>d</sup>Detection limits were determined on the basis of instrument response to standard mixes of PCB isomers representative of each category. Standards, as listed in Section 4, were analyzed at 3 concentration levels to establish calibration curves and detection limits. Detection limits are as follows: mono-, di-, tri-chlorobiphenyl: 0.5 ng/m<sup>3</sup>; tetra-, penta-, hexa-chlorobiphenyl: 2 ng/m<sup>3</sup>; hepta-, octa-, non-, deca-chlorobiphenyl: 5 ng/m<sup>3</sup>.

adsorbed on ambient particulate matter, the majority of PCB isomers are quantitatively transferred to the polyurethane foam cartridges under the conditions of high volume air sampling as employed in this study. As a consequence of these previous investigations only the polyurethane foam samples were analyzed by GC/ECD as noted in Section 4 and earlier in Section 5. The GC/MS analyses reported here provide further confirmation of the behavior of PCBs both in ambient air and under the conditions of high-volume air sampling.

#### CHLORINATED BENZENES, CHLORINATED PHENOLS, AND PESTICIDES (GC/MS)

Each of the samples listed in Table 26 additionally was analyzed for individual isomers of chlorinated phenols, chlorinated benzenes and selected chlorinated pesticides. Analyses were conducted using the GC/MS protocols detailed in Section 4. It should be noted that the sampling and analysis protocols employed during the program for polychlorinated biphenyls are also amenable to the analysis of the above chlorinated compound classes. The overall preparative scheme including GC/MS analysis was verified at the start of this program using a number of representative chlorinated phenols, chlorinated benzenes and chlorinated pesticides. Results for these analyses are summarized in the Quality Control section of this report (Section 7). Verification of ambient air sampling procedures employing polyurethane foam for the collection of a number of these components have been reported by a number of other investigators.<sup>4,11-18</sup>

However, despite the widespread use of polyurethane foam in high-volume air sampling procedures, collection trapping efficiency data have been reported only for a small number of components representative of the compound classes investigated in this study (collection efficiency data for the polynuclear aromatic hydrocarbons have not been provided to date in the literature). It was envisioned that formal collection/trapping efficiency studies could be conducted prior to the conclusion of this program. However, due to limitations on available funds and reallocation of monies to other technical tasks, these experiments could not be conducted.

Results for each of the three compound classes are provided in Tables 28 and 29. The majority of the samples tested contained nondetectable quantities and hence the detection limits provided in Table 28 are applicable. While all of the samples listed in Table 26 were investigated, only those shown in Table 29 contained measurable quantities of these components. Values in the latter table are provided in  $\text{ng}/\text{m}^3$  and are blank corrected. Results shown are for analysis of polyurethane foam extracts only. For those samples comprised of both a PUF and filter portion (see Table 26) no measurable levels were noted in the filter samples. Again, these observations are consistent with the behavior of PCBs under the conditions of high-volume air sampling, noted earlier.

TABLE 28. SUMMARY LISTING OF ANALYTES AND DETECTION LIMITS FOR GC/MS ANALYSES OF CHLORINATED BENZENES, CHLORINATED PHENOLS AND SELECTED PESTICIDES<sup>a</sup>

Component	Detection limits <sup>b</sup> (ng/m <sup>3</sup> )
<u>Chlorinated Phenols</u>	
2-chlorophenol <sup>c</sup>	<0.8
3-chlorophenol	<0.8
4-chlorophenol	<0.8
2,3-dichlorophenol	<0.8
2,4-dichlorophenol	<0.8
2,5-dichlorophenol <sup>c</sup>	<0.8
2,6-dichlorophenol	<0.8
3,4-dichlorophenol	<0.8
3,5-dichlorophenol	<0.8
2,3,4-trichlorophenol	<0.8
2,3,5-trichlorophenol	<0.8
2,3,6-trichlorophenol <sup>c</sup>	<0.8
2,4,5-trichlorophenol	<0.8
2,4,6-trichlorophenol	<0.8
3,4,5-trichlorophenol	<0.8
2,3,4,6-tetrachlorophenol	<0.8
2,3,4,5-tetrachlorophenol	<0.8
2,3,5,6-tetrachlorophenol	<0.8
Pentachlorophenol	<0.8
<u>Chlorinated Benzenes</u>	
1,2,3-trichlorobenzene	<1
1,2,4-trichlorobenzene <sup>c</sup>	<1
1,3,5-trichlorobenzene	<1
1,2,3,4-tetrachlorobenzene	<1
1,2,3,5-tetrachlorobenzene	<1
1,2,4,5-tetrachlorobenzene <sup>c</sup>	<1
Pentachlorobenzene	<1
Hexachlorobenzene	<1

(continued)

TABLE 28 (continued)

Component	Detection limits <sup>b</sup> (ng/m <sup>3</sup> )
<u>Pesticides</u>	
α-BHC	<2
γ-BHC	<2
Heptachlor	<2
Aldrin	<2
p,p'-DDT	<2

<sup>a</sup>As shown previously in Section 4 - GC/MS analytical protocols (Table 10) and Section 4 of the program test and quality assurance project plan - (see Appendix A for complete text).

<sup>b</sup>Numerical detection limits unless otherwise noted are the result of instrument response to a 3 point calibration curve established using the respective positional isomer. Value provided reflects analysis of sample extracts from each of the stations listed in Table 26. All measurements provided using the GC/MS analytical protocols detailed in Section 4 of this report.

<sup>c</sup>Positional isomers not available during this program. Detection limits provided using response elicited by most closely eluting positional isomer.

TABLE 29. GC/MS ANALYSIS OF CHLORINATED BENZENES, CHLORINATED PHENOLS AND SELECTED PESTICIDES<sup>a</sup>

Site location (Source)	Site No.	Day	Component	Isomer identification	Concentration (ng/m <sup>3</sup> ) <sup>b</sup>
Dartmouth Town Hall	1	2	BHC		2.1
		3	Dichlorophenol	2,3- or 2,4- <sup>α</sup> or 2,5- <sup>c</sup>	0.8
			Hexachlorobenzene	NA	16
Shawmut St. - A (Landfill)	3	3	Pentachlorophenol	NA	1.4
Shawmut St. - B (Landfill)	3	3	Pentachlorophenol	NA	2.6
Acushnet Nursing Home (Aerovox)	8	2	BHC	α	3.6
		3	BHC	α	4.4
			Hexachlorobenzene	NA	1.5
C&W Welding - A (Aerovox)	9	3	Pentachlorophenol	NA	2.6
C&W Welding - B (Aerovox)	9	3	Dichlorophenol	2,3- or 2,4- or 2,5- <sup>c</sup>	0.8
			Pentachlorophenol	NA	6.4
			BHC	α	2.4
Incinerator #3	18	3	Pentachlorophenol	NA	2.7

<sup>a</sup>Values provided for analysis of polyurethane foam plugs only. Filters, when analyzed, contained no detectable quantities of components listed.

<sup>b</sup>Method detection limits are as follows: chlorinated benzenes <1 ng/m<sup>3</sup>, chlorinated phenols <0.8 ng/m<sup>3</sup>, pesticides <2 ng/m<sup>3</sup>. See Table 28 for complete listings on each compound category.

<sup>c</sup>Specific isomer assignment is not possible: 2,5-dichlorophenol isomer was unavailable at the time of analysis; 2,4- and 2,3-dichlorophenol isomers coelute under conditions noted in Table 9.

NA - Not Applicable - single isomer only.

## POLYNUCLEAR AROMATIC HYDROCARBONS (GC/MS)

Each of the samples listed in Table 26 additionally was analyzed for a number of polynuclear aromatic hydrocarbons (PAHs). Analyses were again conducted using the GC/MS protocols detailed in Section 4. A summary of results is provided in Table 30. Values are again provided in  $\text{ng}/\text{m}^3$  and are blank corrected.

It should be noted that PAH measurements were not within the scope of the program at the outset and hence were not addressed in the Test and Quality Assurance Plan (Appendix A) prepared in August of this past year. The program scope did, however, contain provisions for the identification and quantitation of approximately 20 major components in selected PUF and filter samples. The majority of additional components noted were PAHs.

It should be further noted that while PAHs are typical components of ambient particulate matter, only recently have high-volume air sampling procedures employing polyurethane foam been employed in the collection of airborne polynuclear aromatic hydrocarbons.<sup>16-18</sup> As a consequence, literature collection/trapping efficiency data are limited for this compound class at the present time. Some further discussion of this particular subject can be found in a manuscript entitled "Ambient Monitoring of Polynuclear Aromatic Hydrocarbons (PAHs) Employing High Volume Polyurethane Foam (PUF) Samplers" contained in Appendix F of this report.

## PARTICULATE MEASUREMENTS

A summary of ambient particulate data pertinent to the Day 2 and Day 3 samples is provided in Tables 31 and 32, respectively. Data are provided for both net particulate weights (mg) and concentrations ( $\mu\text{g}/\text{m}^3$ ) for each of the 24 monitors sited on each test day. The data provided here are for reference purposes only, since these values do not represent Total Suspended Particulate (TSP) measurements. High-volume sampler flow rates, collection times and volumes were not commensurate with protocols for the collection of Total Suspended Particulate (TSP).

The modified sampling approach employed here consisted of collection flows of 30 cfm in lieu of the 40 to 60 cfm characteristic of the TSP sampling protocol. As a consequence of this and potential problems with the filter net weights, the particulate data shown cannot be offered as TSP data and, hence, may not provide overall precision in accord with existing TSP criteria of  $\pm 15$  percent. It should be further noted that these discrepancies apply only to the total particulate measurements contained in Tables 31 and 32. Similar variability in sampler precision as evidenced by the collocated sampler data for the metals, PCBs and polynuclear aromatic hydrocarbons (PAHs) was not observed.

TABLE 30. AMBIENT MONITORING MEASUREMENTS: POLYNUCLEAR AROMATIC HYDROCARBONS<sup>a</sup>

Component	Concentration (ng/m <sup>3</sup> )															
	Dartmouth Town Hall				Cushman Park				Fire Station No. 2				Incinerator #3			
	Day 2		Day 3		Day 2		Day 3		Day 2		Day 3		Day 2		Day 3	
	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF
Naphthalene	ND	7.5	ND	3.0	ND	9.6	ND	8.2	ND	3.5	ND	5.9	ND	6.2	ND	9.3
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	1.1	ND	1.1	ND	2.2	ND	1.8	ND	0.9	ND	2.6	ND	0.5	ND	ND
Acenaphthene	ND	4.5	ND	1.6	ND	22	ND	17	ND	2.8	ND	5.8	ND	2.4	ND	0.9
Fluorene	ND	2.8	ND	1.6	ND	15	ND	13	ND	3.3	ND	6.3	ND	2.7	ND	2.5
Phenanthrene/Anthracene <sup>b</sup>	ND	14	ND	9.3	ND	90	ND	52	ND	52	ND	68	ND	14	ND	9.0
Fluoranthene	ND	1.8	ND	1.4	ND	8.5	ND	5.5	ND	4.7	ND	6.2	ND	2.0	ND	1.1
Pyrene	ND	1.1	ND	1.2	ND	5.1	ND	3.4	ND	2.9	ND	4.1	ND	1.2	ND	0.6
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Dibenzo(a,h)anthracene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Benzo(g,h,i)perylene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Biphenyl	ND	4.4	ND	2.0	ND	4.3	ND	2.9	ND	4.7	ND	9.6	ND	1.8	ND	2.8
Total Methylnaphthalene isomers <sup>c</sup>	ND	12	ND	4.0	ND	14	ND	13	ND	5.1	ND	9.8	ND	8.0	ND	7.4
Total Ethylnaphthalene and Dimethylnaphthalene isomers <sup>c</sup>	ND	14	ND	5.6	ND	34	ND	29	ND	9.8	ND	15	ND	12	ND	16

ND = <0.5 ng/m<sup>3</sup>  
 ND\* = <2 ng/m<sup>3</sup>

(continued)

TABLE 30 (continued)

Component	Concentration (ng/m <sup>3</sup> )															
	Shawmut Station - A				Shawmut Station - B				C&W Welding - A				C&W Welding - B			
	Day 2		Day 3		Day 2		Day 3		Day 2		Day 3		Day 2		Day 3	
	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF	Filter	PUF
Naphthalene	ND	3.0	ND	1.6	ND	8.0	ND	2.2	ND	11	ND	6.7	ND	12	ND	6.4
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	1.1	ND	ND	ND	2.4	ND	ND	ND	8.9	ND	4.3	ND	6.5	ND	4.1
Acenaphthene	ND	1.4	ND	ND	ND	3.5	ND	0.8	ND	9.4	ND	7.1	ND	7.1	ND	5.8
Fluorene	ND	1.0	ND	0.8	ND	2.2	ND	1.1	ND	19	ND	18	ND	10	ND	15
Phenanthrene/Anthracene <sup>b</sup>	ND	3.5	ND	4.1	ND	8.1	ND	6.1	ND	250	ND	230	ND	180	ND	190
Fluoranthene	ND	ND	ND	0.6	ND	0.8	ND	0.8	ND	15	ND	12	ND	22	ND	10
Pyrene	ND	ND	ND	ND	ND	0.7	ND	0.5	ND	7.6	ND	5.6	ND	22	ND	5.3
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Dibenzo(a,h)anthracene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Benzo(g,h,i)perylene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
Biphenyl	ND	0.6	ND	1.2	ND	1.6	ND	1.4	ND	2.6	ND	2.6	ND	3.1	ND	2.4
Total Methylnaphthalene isomers <sup>c</sup>	ND	4.7	ND	2.7	ND	13	ND	3.4	ND	19	ND	8.6	ND	20	ND	7.9
Total Ethylnaphthalene and Dimethylnaphthalene isomers <sup>c</sup>	ND	3.8	ND	3.3	ND	14	ND	4.0	ND	21	ND	11	ND	23	ND	8.8

ND = <0.5 ng/m<sup>3</sup>  
 ND\* = <2 ng/m<sup>3</sup>

(continued)

TABLE 30 (continued)

Component	Concentration (ng/m <sup>3</sup> )							
	Sullivan's Ledge <sup>d</sup>		Acushnet Nuring <sup>d</sup>		Taber St. Station <sup>d</sup>		Incinerator #2 <sup>d</sup>	
	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3	Day 2	Day 3
	PUF	PUF	PUF	PUF	PUF	PUF	PUF	PUF
Naphthalene	9.1	4.1	8.1	6.7	5.5	4.3	1.9	9.9
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	2.6	1.1	5.3	2.1	1.7	1.0	ND	ND
Acenaphthene	16	4.0	8.6	6.7	4.1	3.8	1.0	0.9
Fluorene	10	6.1	15	9.7	4.1	3.5	1.1	2.9
Phenanthrene/Anthracene <sup>b</sup>	42	28	150	110	18	16	5.4	9.8
Fluoranthene	2.7	2.2	11	8.5	1.8	1.7	0.7	1.0
Pyrene	1.7	1.2	5.6	4.2	1.3	1.1	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>
Dibenzo(a,h)anthracene	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>
Benzo(g,h,i)perylene	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>	ND <sup>a</sup>
Biphenyl	2.9	1.4	2.6	2.4	1.4	1.4	1.1	2.0
Total Methylanthracene isomers	12	7.8	12	8.7	8.7	6.7	3.2	9.2
Total Ethylnaphthalene and Dimethylnaphthalene isomers <sup>c</sup>	11	7.6	18	11	9.5	10	7.6	16

ND = <0.5 ng/m<sup>3</sup>; ND<sup>a</sup> = <2 ng/m<sup>3</sup>

<sup>a</sup>All identifications and quantitations provided are based on the GC/MS protocols detailed in Section 4 of this report. Calibration curves were established with standard mixes of polynuclear aromatics prepared at three concentration levels.

<sup>b</sup>Components coelute under chromatographic conditions noted in Section 4.

<sup>c</sup>Concentrations based on typical response factors observed for isomers of these components in the GCA laboratory. Reference materials not analyzed during the time frame of this program.

<sup>d</sup>Values provided for analysis of polyurethane foam plugs (PUF) only. Stations noted were not comprehensive sites, hence filter samples were not analyzed.

TABLE 31. AMBIENT PARTICULATE CONCENTRATIONS:<sup>a</sup> DAY 2--SEPTEMBER 3, 1982

Site No.	Location	Filter numbers		Net wt. gain (mg)	Sample volume (Std. m <sup>3</sup> )	Concentration (ug/m <sup>3</sup> )
		GCA Control No.	Filter No.			
1	Dartmouth Town Hall	25430	5163945	b	409.5	-
2	Sullivan's Ledge	25424	5163943	5.49	366.6	14.98
3	Shawmut Pump Station A	25436	5163949	14.53	414.5	35.05
3	Shawmut Pump Station B	25440	5163951	52.66	399.3	131.88
4	Adams Oil	25418	5163939	11.09	456.9	24.27
5	New Bedford Airport	25448	5163955	8.85	396.4	22.33
6	Cushman Park	25401	5163931	11.78	444.5	26.50
7	Tripp School A	25396	5163929	1.38	461.3	2.99
7	Tripp School B	25434	5163948	17.58	434.8	40.43
8	Acushnet Nursing	25406	5163935	16.31	408.3	39.95
9	C&W Welding A	25446	5163954	20.99	407.0	51.57
9	C&W Welding B	25444	5163953	30.30	386.6	78.38
10	Burt School	25414	5163936	12.62	428.7	29.44
11	Brooklawn Park	25460	5163959	202.34	407.1	497.03
12	Taber St. Pump Station	25402	5163933	11.58	507.4	22.82
13	Fire Station No. 2	25422	5163941	1.69	299.4	5.64
14	Hurricane Barrier	25442	5163952	4.60	416.9	11.03
15	St. Anne's Rectory	25412	5163932	11.47	388.0	29.56
16	Fire Station No. 11	25416	5163938	22.85	398.2	57.38
17	Guy's Pharmacy	25404	5163934	11.09	426.8	25.98
18	Incinerator No. 3	25432	5163946	12.38	455.09	27.21
19	Incinerator No. 2	25498	5163930	17.37	439.1	39.56
20	Incinerator No. 1	25408	5163937	b	412.4	-
21	Incinerator No. 4	25426	5163944	5.91	390.5	15.13

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<sup>a</sup>Particulate weights collected using high-volume air sampling protocols noted in Section 3 and Appendix A.

<sup>b</sup>No particulate weight available. Final filter weight less than or equal to filter tare weight. It is likely that the resulting negative net weight values were caused by either an inadvertent error in the initial filter weighing process or a small loss of filter material during sampling or sample handling procedures.

TABLE 32. AMBIENT PARTICULATE CONCENTRATIONS:<sup>a</sup> DAY 3--SEPTEMBER 9, 1982

Site No.	Location	Filter numbers		Net wt. gain (mg)	Sample volume (Std. m <sup>3</sup> )	Concentration (µg/m <sup>3</sup> )
		GCA Control No.	Filter No.			
1	Dartmouth Town Hall	25573	5163970	9.01 <sup>b</sup>	461.3	19.53
2	Sullivan's Ledge	25557	5163962	13.01	401.9	32.37
3	Shawmut Pump Station A	25581	5163974	13.11	433.1	30.27
3	Shawmut Pump Station B	25579	5163973	8.53	408.8	20.87
4	Adams Oil	25587	5163977	16.60	444.8	37.32
5	New Bedford Airport	25589	5163981	7.71	406.7	18.96
6	Cushman Park	25553	5163960	22.56	331.2	68.12
7	Tripp School A	25555	5163061	20.78	470.9	44.06
7	Tripp School B	25593	5163986	b	447.5	-
8	Acushnet Nursing	25575	5163971	3.88	427.4	9.08
9	C&W Welding A	25607	5163978	27.54	413.0	66.68
9	C&W Welding B	25611	5163980	24.02	423.3	56.74
10	Burt School	25599	5163981	7.71	419.5	18.38
11	Brooklawn Park	25595	5163987	9.06	413.0	21.94
12	Taber St. Pump Station	25565	5163965	5.32	452.3	11.56
13	Fire Station No. 2	25561	5163964	22.36	414.3	53.97
14	Hurricane Basrrier	25609	5163979	30.72	461.4	66.80
15	St. Anne's Rectory	25577	5163972	10.48	219.0	47.85
16	Fire Station No. 11	25601	5163980	24.02	431.4	55.55
17	Guy's Pharmacy	25571	5163969	23.35	368.2	63.42
18	Incinerator No. 3	25605	5163976	49.14	398.3	123.37
19	Incinerator No. 2	25583	5163975	18.56	401.2	46.26
20	Incinerator No. 1	25597	5163988	13.93	464.7	29.98
21	Incinerator No. 4	25569	5163968	6.45	426.9	15.11

<sup>a</sup>Particulate weights collected using high-volume air sampling protocols noted in Section 3 and Appendix A.

<sup>b</sup>No particulate weight available. Final filter weight less than or equal to filter tare weight. It is likely that the resulting negative net weight values were caused by either an inadvertent error in the initial filter weighing process or a small loss of filter material during the sampling or sample handling procedures.

## SECTION 6

### DISCUSSION OF RESULTS

#### POLYCHLORINATED BIPHENYLS (PCBs)

##### Overview

The present discussion as noted earlier in the introductory comments will focus on the overall significance of the PCB measurements collected in the study region on each of 2 test days. Particular attention will be paid to the following:

- Apparent trends in present data set.
- Comparison of data with PCB concentrations noted in other North American locations including both U.S. and Canadian urban and rural sites. Strictly for comparison purposes, literature values for PCBs in ambient air over the open ocean and near sites of manufacture and use will also be provided.
- Comparison of data provided here with existing PCB data from study region.
- Where available test data will be compared to existing ambient air guidelines.
- Recommendations for future study.

Data comparisons in most instances will be limited to the GC/ECD measurements shown in Tables 18 and 19 as this technique most closely approximates the cumulative procedures used in the development of the existing PCB ambient air data base. (A representative collection of this existing PCB data base is provided in Tables 33 through 36.) Unlike the vast majority of previous ambient monitoring programs, however, mass spectral confirmatory data have been provided on approximately 50 percent of the samples from Days 2 and 3. As shown earlier (Table 27) this includes both qualitative and quantitative information on PCB concentrations observed on both ambient particulate filters and polyurethane foam samples. As a consequence, comments will be provided incorporating the mass spectral confirmatory data summarized in Table 27. This information will be particularly useful in identifying individual PCB positional isomer categories and providing an additional quantitative data set to supplement the GC/ECD measurements.

TABLE 33. TYPICAL AMBIENT PCB CONCENTRATIONS--URBAN AND RURAL SITES IN NORTH AMERICA

Location	Total PCBs (ng/m <sup>3</sup> )			Comments	Ref. No.
	$\bar{X}$	N	Range		
Boston, MA	7.1	-	26% RSD	Reported as combined Aroclor 1016/1242 and Aroclor 1254. Average ( $\bar{X}$ ) values based on eight independent analyses of a single air sample.	19
Columbia, SC	4.4	-	39% RSD		20
Chicago (Lake Michigan)	8 ± 3.8	-	-	Reported as Aroclor 1242.	21
Bay City, MI	49	3	28 - 67	Total PCB in the combined particulate and vapor phase reported as decachlorobiphenyl.	22
Gainesville, FL	30	6	11 - 44		2
Research Triangle Park, Durham Co., NC	13	1	-		8
Arizona	-	-	<0.02 - 0.41		8, 23
La Jolla, CA	-	-	0.5 - 14	Conducted in period 1973-1975; quantitated and reported as Aroclor 1254.	8, 23
Kingston, RI	-	6	1 - 15	Conducted in 1973; quantitated and reported as Aroclor 1254.	24
Providence, RI	-	-	9.4		

(continued)

TABLE 33 (continued)

Location	Total PCBs (ng/m <sup>3</sup> )			Comments	Ref. No.
	$\bar{X}$	N	Range		
Jacksonville, FL	-	-	3 - 36	Conducted in 1976.	25
Shadow Fox Farm, Wake Co., NC	14	1	-		2
Toronto, Canada (Urban)	10 $\pm$ 7	24	2 - 33		26
Hamilton, Ontario (Urban)	9 $\pm$ 14	26	1 - 74		26
Burlington, Ontario (Urban)	6 $\pm$ 5	25	1 - 24		26
Thunder Bay, Ontario (Rural)	4 $\pm$ 3	26	1 - 10		26
Windsor, Ontario (Urban)	6 $\pm$ 4	27	2 - 16		26
Denver, CO (January 1980)	1.9	9	1.05 - 2.43	Aroclor 1016 and Aroclor 1254; comparison of three sampling media at same site.	11

TABLE 34. TYPICAL AMBIENT PCB CONCENTRATIONS--COASTAL WATERS AND OPEN OCEAN

Location	Total PCBs (ng/m <sup>3</sup> )			Comments	Ref. No.
	$\bar{X}$	N	Range		
Georges Bank (North Atlantic)	0.97	6	0.58 - 1.6	Values calculated and reported as Aroclor 1254. Collection method employed approximates PCB concentrations in the combined particulate and vapor-aerosol phase.	9
Vineyard Sound, Cape Cod, MA	4.6	2	3.9 - 5.3		9
Grand Banks (North Atlantic)	0.09	5	0.05 - 0.16		9
Northwest Gulf of Mexico	0.35	10	0.13 - 0.79	Values represent analyses of both the particulate and vapor phase.	7
Bermuda	0.20	-	0.08 - 0.48		8
Bermuda	0.30	4	0.15 - 0.5	Values calculated and reported as Aroclor 1254. Collection method employed approximates PCB concentrations in particulate/vapor phase combined.	9
Chesapeake Bay	-	-	1.0 - 2.0		10
Lake Michigan	-	-	0.12 - 1.46		27

TABLE 35. TYPICAL PCB CONCENTRATIONS--INDOOR AIR AND AMBIENT AIR IN THE VICINITY OF SITES OF MANUFACTURE AND USE

Location	Total PCBs (ng/m <sup>3</sup> )			Comments	Ref. No.
	$\bar{X}$	N	Range		
Transformer manufacturing site, Goldsboro, NC					2
• Perimeter of site		10	430 - 3400	All values reported as ng/m <sup>3</sup> of Aroclor 1254.	
• 150-300 m from site		11	39 - 900		
• 300 m from site	37	5	12 - 72		
Capacitor disposal operation, El Dorado, AR					3
• In-plant air (during pulverizing process)	4310 x 10 <sup>3</sup>	3	1850 x 10 <sup>3</sup> - 5830 x 10 <sup>3</sup>	Average values based on a single sampling session employing three independent procedures; all values reported as ng/m <sup>3</sup> of Aroclor 1254.	
• Outside ambient air (during pulverizing operation)	3290	3	650 - 8360		
Transformer maintenance facility--Breathing zone within transformer repair vault					28
• Premaintenance	500	6	100 - 900		
• During maintenance	15,000	8	19,000 - 55,000		
• Postmaintenance	800	7	100 - 1900		

(continued)

TABLE 35 (continued)

Location	Total PCBs (ng/m <sup>3</sup> )			Comments	Ref. No.
	$\bar{X}$	N	Range		
Electric power substation, Durham, NC					2
● Site A				All concentrations calculated as Aroclor 1242 and 1254; "N" denotes number of separate days on which samples were collected.	
- Upwind	13	2	10 - 16		
- Downwind	23	4	8 - 47		
● Site B					
- Upwind	21	2	1 - 42		
- Downwind	31	3	21 - 41		
Indoor residential air					29
● Kitchen	-	24	150 - 580		
● Bedroom	170	3	23% RSD		
● Basement	120	3	28% RSD		
● Library	400	3	26% RSD		
● Garage	64	4	30% RSD		
● Office (Shopping complex)	44	2	35% RSD		

TABLE 36. EXISTING AMBIENT PCB MEASUREMENTS--NEW BEDFORD REGION

Location	Sampling date	Total PCBs (ng/m <sup>3</sup> )	Comments	Ref. No.
<b>New Bedford Sewage Sludge Incinerator</b>				
Upwind, 165 ft from stack	3/1/77	38 58	Wind 15-20 mph from W/SW; Aroclor 1242/1016; predominance of trichlorobiphenyls.	30
Downwind, 380 ft from stack		150 240		
Upwind, 95 ft from stack	3/3/77	20 20	Aroclor 1242/1016; wind 12-15 mph westerly direction.	30
Downwind, 250 ft from stack		110 95		
Upwind	1/24/78	4.3		
Downwind		13		31
<b>New Bedford Municipal Landfill</b>				
Upwind (Municipal Airport)	9/5/78	27	Approximate value; Aroclor 1242/1016.	32
Downwind (Upton St.)	9/5/78	18 21		32
Onsite	9/5/78	367	334 ng/m <sup>3</sup> Aroclor 1242/1016; 33 ng/m <sup>3</sup> Aroclor 1254.	32

(continued)

TABLE 36 (continued)

Location	Sampling date	Total PCBs (ng/m <sup>3</sup> )	Comments	Ref. No.
New Bedford Municipal Landfill (continued)				
Onsite	9/5/78	726	703 ng/m <sup>3</sup> Aroclor 1242/1016; 23 ng/m <sup>3</sup> Aroclor 1254.	32
Onsite (2 m above ground)	6/17-6/18/80	44.6	Average of three data sets collected using three separate sorbents; 36.2 ng/m <sup>3</sup> Aroclor 1016; 8.4 ng/m <sup>3</sup> Aroclor 1254.	11
Onsite (2 m above ground)	6/18-6/20/80	48.0	Average of three data sets collected using three separate sorbents; 39 ng/m <sup>3</sup> Aroclor 1016; 9 ng/m <sup>3</sup> Aroclor 1254.	11
Onsite	6/20-6/21/80	31.9	Average of three separate measurements with three sorbents; 25.2 ng/m <sup>3</sup> Aroclor 1016; 6.7 ng/m <sup>3</sup> Aroclor 1254.	11
Onsite	6/28/77	1500 890	Samples collected and analyzed by ESE; wind from W/SW at 10 mph; Aroclor 1242/1016.	31
Onsite	6/30/77	410	Winds from NW at 12-15 mph; Aroclor 1242; ambient temperature, 26°C; Aroclor 1242/1016.	31

(continued)

TABLE 36 (continued)

Location	Sampling date	Total PCBs (ng/m <sup>3</sup> )	Comments	Ref. No.
New Bedford Municipal Landfill (continued)				
Onsite	1/17/78	21	Ambient temperature, 0°C; during sampling, ground was frozen and light snow was falling; Aroclor 1242/1016.	31
Upwind	1/17/78	8.5	Conditions same as above; Aroclor 1242/1016.	31
Downwind	1/17/78	13	Conditions same as above; Aroclor 1242/1016.	31
Onsite	1/17/78	28 24	Samples collected and analyzed by EPA Region I.	33
Downwind	1/17/78	12 18	Samples collected and analyzed by EPA Region I.	33
Cornell-Dubilier				
Upwind (corner of Cleveland and David Streets)	9/7/78	18	Aroclor 1242/1016.	32
Downwind (top of sea wall)	9/7/78	767 862	Aroclor 1242/1016 combined with Aroclor 1254.	32
Upwind	1/19/78	19	Sampling by ESE, Gainesville, FL.	31

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(continued)

TABLE 36 (continued)

Location	Sampling date	Total PCBs (ng/m <sup>3</sup> )	Comments	Ref. No.
Cornell-Dubilier (continued)				
Downwind	1/19/78	32 30	Sampling by EPA Region I.	33
Aerovox				
Upwind (Tinkham & Hope St.)	9/6/78	41	Aroclor 1016/1242 sampling and analysis by EPA Region I.	32
Downwind (Wood St. and River Rd.)	9/6/78	310 268	Aroclor 1016/1242 and Aroclor 1254.	32
Upwind	1/27/78	5.6	Sampling and analysis by ESE. Aroclor 1242/1016.	31
Downwind	1/27/78	490	Sampling and analysis by ESE. Aroclor 1016 only.	31
Downwind (Bittean St.)	1/27/78	703 774	Sampling and analysis by EPA Region I.	33

For the purposes of the discussion to follow, please refer to the data sets shown in Tables 18, 19 and 27. Additionally, each of the 21 test sites can be further classified by site category; i.e., background, Aerovox, Cornell-Dubilier, etc. These results are provided by site category in Tables 20 through 25.

### Background Stations

Cumulative test results (Days 2 and 3) are provided for the background site category in Table 20. As shown, values for total PCBs (i.e., Aroclor 1242/1016) range from 3.6 to 18 ng/m<sup>3</sup> with a cumulative mean of 9.5 and a standard deviation (Sx) of 5.2.

Cumulative results for Day 2 and Day 3 are comparable as are the values reported for the collocated monitors sited on the Job C. Tripp Elementary School (Site 7) on each of the 2 test days. The values shown here are consistent with literature values for PCBs in U.S. and Canadian urban centers as shown in Table 33. Typical values, as reported for approximately 10 to 15 urban centers, are consistent with individual as well as cumulative values reported in Table 20. Again, within the precision and accuracy constraints of the procedures employed (See Section 7) and comparable sampling and analysis procedures in the literature,<sup>4,19</sup> it is fair to say that the New Bedford background station values do not differ significantly from values typically noted in other North American urban centers. It is interesting to note that 2-day average values noted at both the New Bedford Fire Station (4.8 ng/m<sup>3</sup>) and the Dartmouth Town Hall (4.3 ng/m<sup>3</sup>) are in agreement with an average PCB value of 4.6 ng/m<sup>3</sup> reported by Harvey et al.<sup>9</sup> over Vineyard Sound in 1974. These values can be further contrasted to PCB concentrations typically noted over the open ocean as shown in Table 34. As shown, concentrations ranging from 0.58 ng/m<sup>3</sup> to 1.6 ng/m<sup>3</sup> have been reported for the Georges Bank region and values of 0.05 ng/m<sup>3</sup> to 0.66 ng/m<sup>3</sup> for the Grand Banks region in the North Atlantic. Again, average values for the open ocean (See Table 34) are approximately one order of magnitude lower than values reported here for the Dartmouth Town Hall and the New Bedford Fire Station. These concentrations are consistent with PCB levels anticipated in coastal air masses as shown for Vineyard Sound and Chesapeake Bay in Table 34. Harvey<sup>9</sup> has in fact shown that the decrease in PCB concentration vs. distance away from coastal industrial regions towards the open ocean follows an exponential relationship.

GC/MS analyses conducted on both filter and foam samples from Dartmouth Town Hall (Site No. 1) and the New Bedford Fire Station (Site No. 13) indicate the absence of measurable levels of PCB isomers providing further evidence of the lower levels observed by GC/ECD in these background stations. It should be added that the GC/MS protocols employed do not provide detection limits commensurate with those of GC/ECD. As a result PCB confirmation by GC/MS could not be provided unless reported GC/ECD concentrations were in excess of 15 to 20 ng/m<sup>3</sup>.

## New Bedford Municipal Landfill

Cumulative test results for stations in the vicinity of the New Bedford Municipal Landfill are provided in Table 21. Average test results for each of three stations, while lower than the cumulative values for the preselected background stations, are comparable again in light of the precision inherent in the combined sampling and analysis scheme. Concentrations in the vicinity of the landfill are consistent with values reported for other North American urban sites as shown in Table 33. Values recorded at the Shawmut St. site are particularly noteworthy since this station was due northeast of the landfill proper and generally in the prevailing wind direction on each of the 2 test days. Winds on Day 2 were stronger than Day 3, spanning from 7 to 18 miles per hour from the southwest (SW) with the ambient temperature ranging from 24 to 25°C during the 12-hour sampling period. Winds on Day 3 were 2 to 8 mph from the south-southwest (S-SW) with an ambient temperature range of 21 to 24°C at each of the three area locations. (These values were recorded by the meteorological monitoring station situated at the Municipal Airport.) Again, the 2-day average values both upwind and downwind of the landfill are comparable as shown in Table 21. These findings are contrasted to values previously reported in the vicinity of the landfill as shown in Table 36. Testing was conducted onsite, upwind and downwind in June 1977, January 1978, and September 1978. Most recently samples were collected onsite only in June of 1980. Testing conducted in June of 1977 indicated values in excess of 1000 ng/m<sup>3</sup> onsite while testing done in the winter of 1978 noted levels markedly lower (21 to 28 ng/m<sup>3</sup>, Table 36) owing to adverse seasonal conditions. More specifically, an ambient temperature of 0°C was noted with the ground frozen and a light snow falling.<sup>31</sup> Concentrations upwind and downwind of the site during this time registered 8.5 ng/m<sup>3</sup> and 13 ng/m<sup>3</sup>, respectively. Sampling repeated in the late-summer of 1978 once again indicated elevated values of 367 ng/m<sup>3</sup> to 726 ng/m<sup>3</sup> onsite, 27 ng/m<sup>3</sup> in the upwind vector and 18 to 21 ng/m<sup>3</sup> downwind of the site. Results reported here are generally lower than values reported in September 1978 particularly in the prevailing wind direction (NE). The Shawmut St. collocated monitors sited to the northeast of the landfill registered average values of 2.4 ng/m<sup>3</sup> on Day 2 and 4.9 ng/m<sup>3</sup> on Day 3.

Concentrations at the Municipal Airport (NW) while not in the general upwind direction from the site provide an identical location to the upwind monitor in the September 1978 study.<sup>32</sup> A value of 27 ng/m<sup>3</sup> was reported at that time. (Seasonal conditions during both this study and the 1978 effort were comparable since each was conducted during the first week in September.) The values reported here clearly indicate that PCB concentrations in the vicinity of the landfill have declined in recent years. This observation is particularly noteworthy in light of recent observations by Billings and Bidleman<sup>11</sup> from sampling conducted in the summer of 1980. Their values reported for combined Aroclor 1242 and 1254 using three separate sampling procedures ranged from 31.9 ng/m<sup>3</sup> to 48 ng/m<sup>3</sup> during the calendar period June 17 to 21, 1980. These investigators reported that Aroclor 1016 predominated with smaller concentrations of Aroclor 1254. Samples were collected at the perimeter of the site generally "upwind of the main work area".<sup>11</sup> The authors suggest that continual additions of fill material to the site in recent years may account for the lower PCB levels noted in the

summer months. Our results clearly support these observations. An earlier publication has indicated that an estimated one-half million pounds of PCB may be contained in the landfill.<sup>31</sup> A recent publication by the Massachusetts Coastal Zone Management reports that prior to 1970 Aroclor 1242 was the primary contaminant in fill material. During the period 1970 to 1977, however, Aroclor 1016 was the principal Aroclor contaminant. Assuming deposition of contaminated materials has ceased, ambient concentrations in the vicinity of the landfill should continue to decline. Periodic monitoring on the site proper, however, is suggested to monitor this apparent trend. Future monitoring could be limited to one time per year, perhaps during the summer months when "worst case" conditions should prevail.

### Sullivan's Ledge

Daily test results for total PCBs measured using onsite monitors are shown in Table 22. The average values for both Aroclor 1016/1242 and Aroclor 1254 are significantly higher than the cumulative background values reported earlier. It is particularly noteworthy that the levels of Aroclor 1254 noted here account for approximately 40 percent of the reported total on each test day. At no other location in the study region do the Aroclor 1254 values (as determined by GC/ECD) exceed a value of 5 ng/m<sup>3</sup>. The Aroclor 1254 values reported here are 110 ng/m<sup>3</sup> and 94 ng/m<sup>3</sup> for test days 2 and 3, respectively. Further confirmation is provided upon review of the GC/MS data in Table 27 for the Sullivan's Ledge monitors (also see Appendices D and E). The predominance of the tetra and pentachlorobiphenyl isomer groups indicative of an Aroclor 1254 mixture (note that the majority of the sites shown in Table 27 exhibit positional isomer patterns (GC/MS) equivalent to an Aroclor 1242 or 1016 mixture with the di, tri and tetrachlorobiphenyl isomers predominating). These findings, although not conclusive evidence of PCB contamination at the Ledge, are consistent with comments contained in a recent report<sup>1</sup> prepared by the Massachusetts Coastal Zone Management which indicated that "It is possible that large volumes of PCBs are buried in Sullivan's Ledge."

Comparison of the Sullivan's Ledge data to ambient air quality standards for total PCBs as established by the Canadian Ministry of the Environment<sup>34,35</sup> are shown in Figures 4 through 6. Despite the fact that the daily values for the Sullivan's Ledge site represent only 12-hour averages, they are in excess of the 24-hour average Canadian ambient air guideline of 150 ng/m<sup>3</sup>. Further extrapolation of these 2-day average values as representative of an arithmetic annual mean indicate values in excess of the 35 ng/m<sup>3</sup> concentration suggested by the Canadian Ministry of the Environment.

The data collected here, while limited, suggest that the Sullivan's Ledge area may be a source of polychlorinated biphenyls to the ambient atmosphere. In fact, the concentrations reported here do approach concentrations typically reported for indoor atmospheres as shown in Table 35. The total PCB concentrations at Sullivan's Ledge are well below the recommended NIOSH levels of 1 ug/m<sup>3</sup> for an indoor work atmosphere, however. Further ambient monitoring in the vicinity of this site may be warranted. Subsequent surveys should include additional monitors, not only onsite, but upwind and downwind

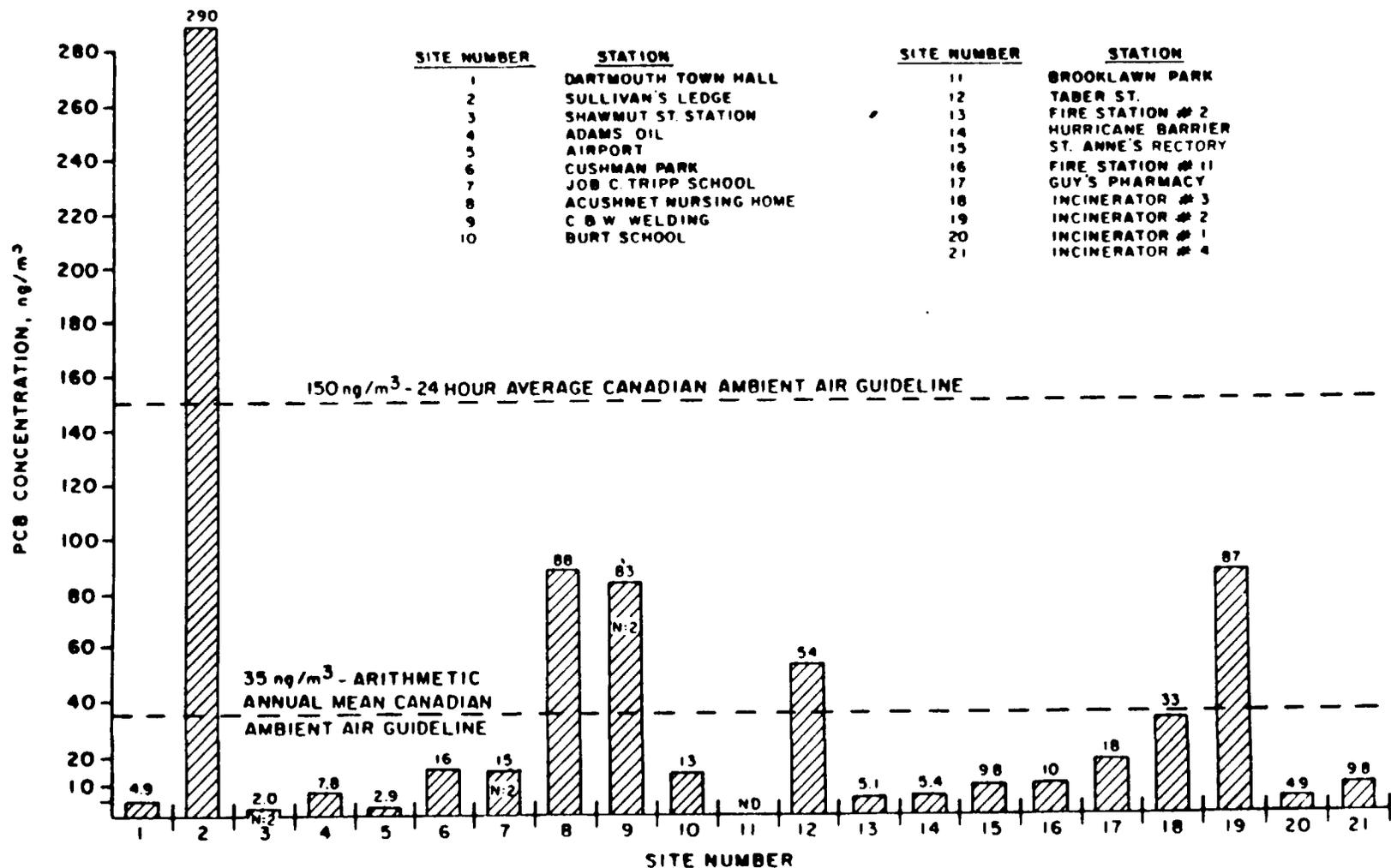


Figure 4. New Bedford ambient monitoring program--Day 2 PCB test results (total Aroclor 1016/1242 and 1254)--a comparison of values to existing air quality standards.

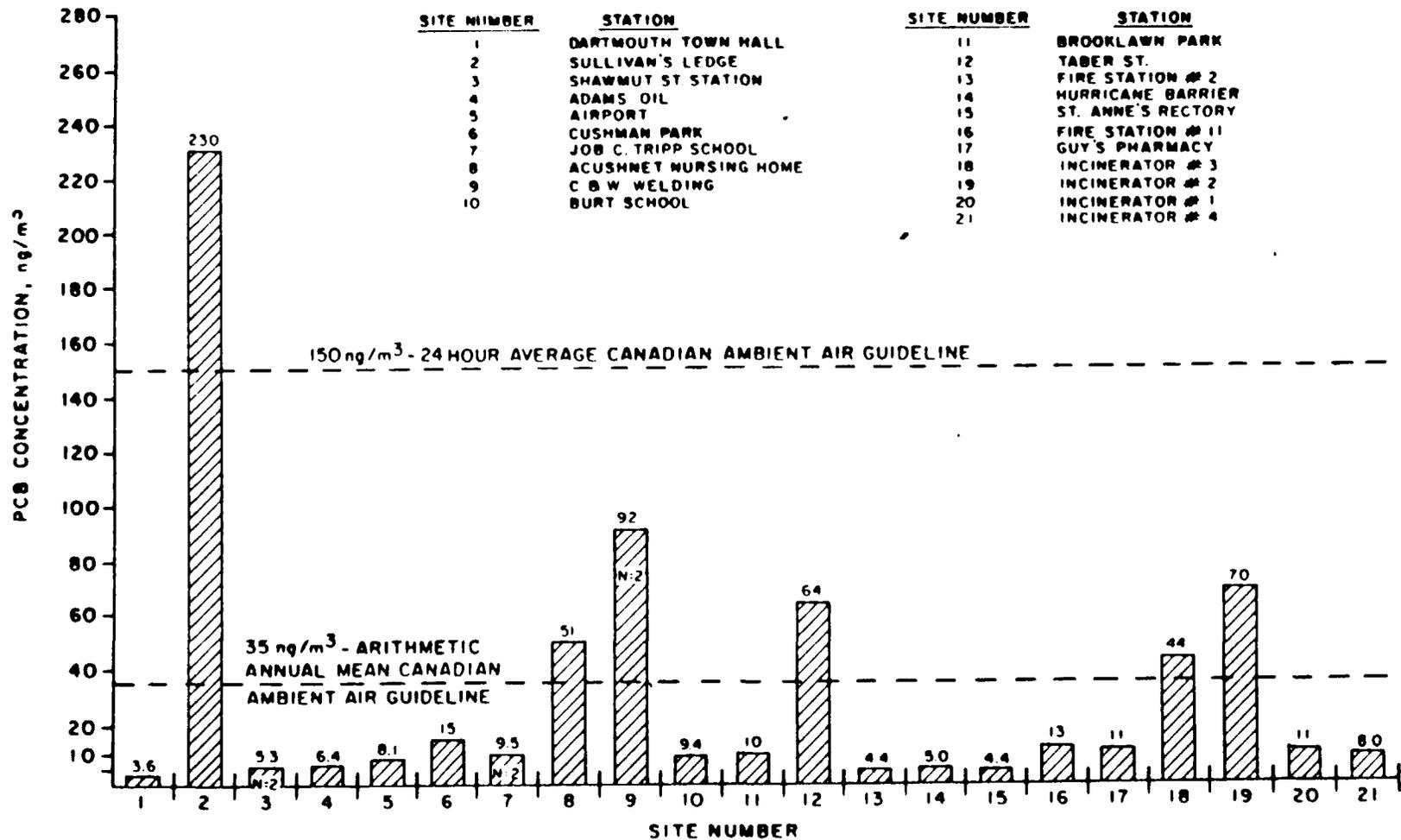


Figure 5. New Bedford ambient monitoring program--Day 3 PCB test results (total Aroclor 1016/1242 and 1254)--a comparison of values to available air quality standards.

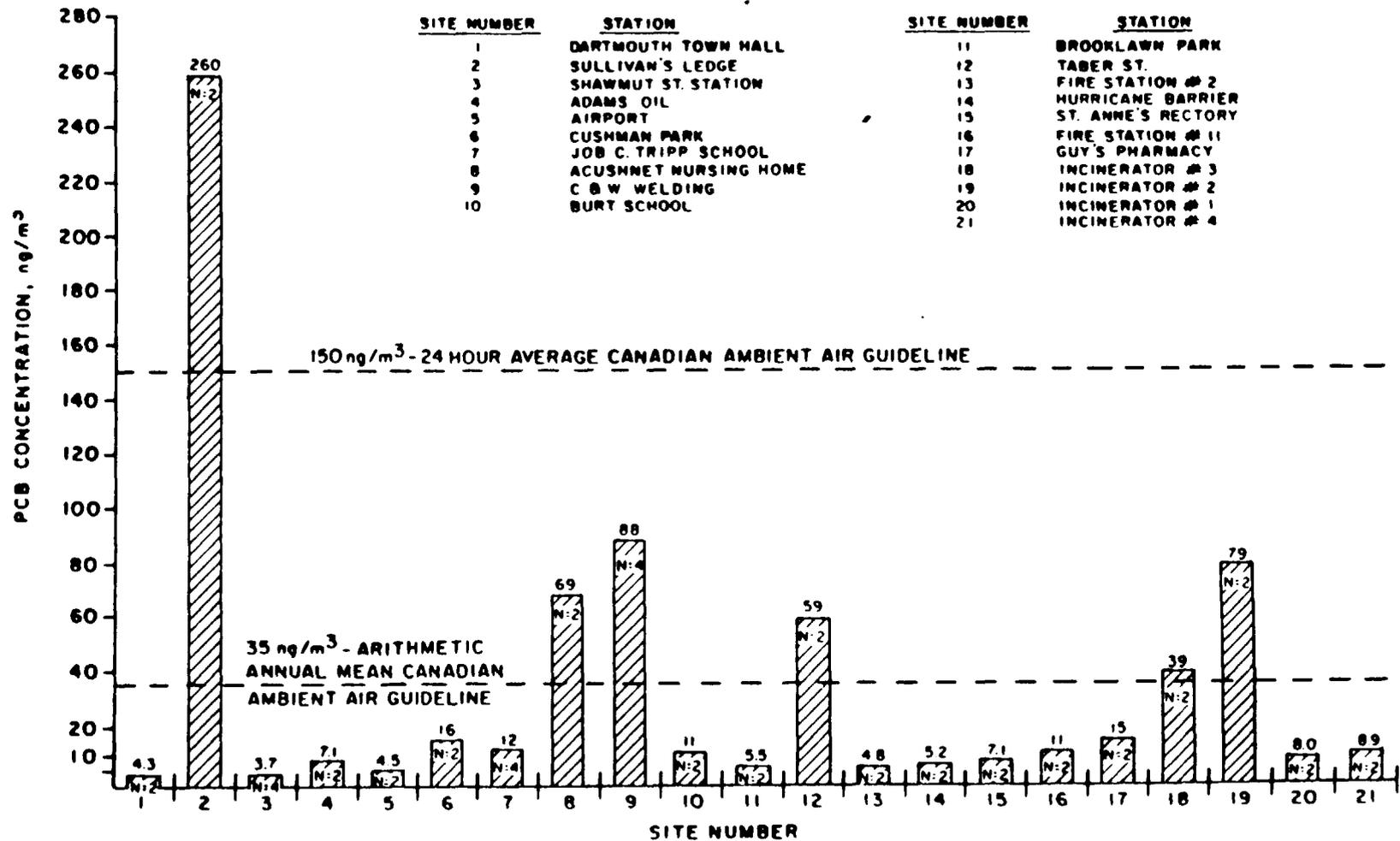


Figure 6. New Bedford ambient monitoring program--comparison of average PCB test results (Day 2/3) to available air quality standards.

with particular emphasis on siting in the prevailing wind direction. Again, to assess "worst case" impact, future monitoring should be conducted under summer conditions.

#### Cushman Park/Fairhaven

Results for Cushman Park are shown in Table 22. Again, total PCB concentrations do not differ significantly from values noted for the Job C. Tripp School located across the street (NE) in the prevailing wind direction. Additionally, the concentrations noted here and at the Tripp School are in good agreement with the urban Fairhaven values recorded at Guy's Pharmacy on Days 2 and 3. Cumulative Fairhaven test results for the present program (i.e., Job C. Tripp, Cushman Park and Guy's Pharmacy) while slightly above concentration ranges established by our regional background monitors do not differ significantly from the urban cross-sectional values listed in Table 33. Additionally, all of the Fairhaven sites noted here are well below the 24-hour Canadian ambient air quality guidelines of 150 ng/m<sup>3</sup>. Graphical comparison of the Fairhaven test data to these guidelines are provided in Figures 4 through 6.

Recommendations for future testing in the Fairhaven area could be limited to a single monitor situated in urban Fairhaven. Periodic testing, again, should be conducted in the summer months and ideally should be synchronized with testing planned for other New Bedford locations.

#### Marsh Island-Taber St. Station

Daily test results for total PCBs using an onsite monitor are shown in Table 22. The 2-day average value for total PCBs (Aroclor 1242/1016) of 59 ng/m<sup>3</sup> is significantly higher than the cumulative background value also shown in Table 22. It is particularly noteworthy that the Marsh Island values are also much higher than values typically reported for other Fairhaven sites. This includes average values reported for Guy's Pharmacy, Cushman Park and the Job C. Tripp School. The availability of results from only a single onsite monitor prohibits us from determining whether the elevated concentrations are attributable to an upwind source (e.g., Acushnet River) or ambient concentrations at the site itself. It should be noted that the Marsh Island site is adjacent to the Acushnet River and was generally in the course of the prevailing winds off the river on each of the test days. A definitive answer cannot be provided, however, and as a consequence further monitoring in the vicinity of Marsh Island is warranted. These monitoring activities should focus on the potential effects of diurnal tidal cycles on ambient air quality downwind of contaminated bottom sediments. Such areas for instance may become exposed during low tide periods and impact ambient air quality.

GC/MS analyses of the Day 2 and Day 3 samples again confirmed a characteristic Aroclor 1016/1242 pattern characterized by the predominance of the di, tri and tetrachlorobiphenyl isomer groupings. All of the PCB values shown for the Marsh Island monitor are well below the 150 ng/m<sup>3</sup> Canadian

guideline established for a 24-hour test period. However, assuming the 2-day average values are typical of the site and as a result represent an arithmetic annual mean, they do exceed the suggested Canadian guideline of 35 ng/m<sup>3</sup>.

Recommendations for future testing should include more frequent monitoring in both upwind and downwind vectors to ascertain the "true" source of the elevated PCB levels. Suggested sources may include an upwind site such as the Acushnet River or contamination on the Marsh Island site itself (e.g., contaminated dredge fill material). Again periodic testing in the summer months should be prioritized and ideally this should be coordinated with ambient monitoring planned for other sites in the study region. Again, some emphasis should be placed on coordinating sampling intervals with prevailing tidal cycles.

### Aerovox

Daily and cumulative averages for monitors in the general vicinity of the Aerovox facility are provided in Table 23. As shown, a total of five monitors were situated in the defined study area on each test day (see Figure 1). Two were generally in an upwind direction from the property, one due southwest and another due southeast. The three remaining monitors were sited on anticipated downwind vectors, one to the east-northeast and a collocated pair due north of the site. Total PCB concentrations reported for the Burt School and Brooklawn Park, averaged 10 to 11 ng/m<sup>3</sup> for the 2-day test period and hence were in excellent agreement with the cumulative ranges established by the regional background monitors.

Concentrations at C&W Welding and the Acushnet Nursing Home situated to the North (N) and Northeast (ENE), respectively, were significantly higher than the upwind monitors on each of the 2 test days. The maximum total PCB concentration of 103 ng/m<sup>3</sup> was noted at the C&W Welding site on Day 2. Daily total PCB concentrations for the collocated monitors at this site averaged 83 ng/m<sup>3</sup> and 92 ng/m<sup>3</sup> on Days 2 and 3, respectively. The overall agreement of the collocated monitors while within the precision of reported replicate samples in the literature,<sup>4</sup> was much better on Day 3 than Day 2. The overall precision of replicate collocated samples is provided in Section 7.

Daily and 2-day average values for monitors in the ENE vector (Acushnet Nursing Home) while lower than the C&W Welding values were again significantly higher than PCB concentrations recorded by the upwind samplers. Apparent trends as noted here are consistent with meteorological conditions recorded at the Municipal Airport on each of the test days. Winds on Day 2 (9/3) were 6 to 16 mph from the southwest, while winds on Day 3 (9/9) again ranged from 6 to 15 mph from the south-southwest. Ambient temperatures on Day 2 ranged from 24 to 28°C and from 22 to 23°C on Day 3 at each of the four site locations. The downwind monitor situated at the Acushnet Nursing Home appears to have been more directly in the path of the prevailing winds on Day 2 than on Day 3. This is consistent with the values of 88 ng/m<sup>3</sup> and 51 ng/m<sup>3</sup> reported for test Days 2 and 3, respectively. Average total PCB concentrations

recorded for each of the 2 days at the C&W Welding site did not differ, however, despite the Day 3 monitor being more directly in the path of the southwesterly winds.

As shown in Table 27, mass spectral analyses were conducted on both ambient particulate and polyurethane foam samples from each of the C&W Welding collocated samplers from both Days 2 and 3. Additionally, GC/MS analyses were performed on the Day 2 and Day 3 polyurethane foam samples only from the Acushnet Nursing Home site. As in the case of all other samples containing measurable levels of Aroclor 1242/1016, the di, tri, and tetrachlorobiphenyl isomer groups predominated.

As shown in Figures 4 through 6, total PCB concentrations at both the C&W Welding and Acushnet Nursing Home sites while in compliance with the Canadian ambient air guideline of 150 ng/m<sup>3</sup> total PCB for a 24-hour period do exceed the annual arithmetic mean value of 35 ng/m<sup>3</sup>, again assuming these values can be extrapolated to annual mean values.

Previous testing by both the Environmental Protection Agency<sup>33</sup> and Environmental Science and Engineering<sup>31</sup> conducted on January 27, 1978 reported 5.6 ng/m<sup>3</sup> upwind of the Aerovox facility and values ranging from 490 ng/m<sup>3</sup> to 774 ng/m<sup>3</sup> total PCBs downwind of the site. These values are particularly significant in that samples were collected under winter conditions. It is likely as suggested by summertime values reported at other locations that the concentrations reported would in these 1978 studies have been higher had samples been collected during the summer months.

In contrast to these findings, it appears that total PCB concentrations in the vicinity of the Aerovox facility have declined in the past 5 years. This is particularly the case in comparing levels of 268 to 310 ng/m<sup>3</sup> reported downwind of the site by the EPA in September of 1978. Sampling conditions during this period were most similar to those encountered during the present study. Total PCB concentrations both downwind and upwind of the site are approximately one-third (10 to 11 ng/m<sup>3</sup> upwind) of those reported in 1978 (41 ng/m<sup>3</sup> upwind). It appears, however, that while the overall PCB concentrations in the vicinity of the Aerovox site have diminished, the site area (including both the site proper and the contaminated portions of the Acushnet River adjacent to the site) as defined by our monitors remains a low level source of PCBs to the ambient atmosphere.

Recommendations for future testing should include at least two monitors, one each upwind and downwind of the site. This exercise should be repeated at least once annually during the summer months to monitor the apparent decline in PCB concentrations in the affected area. Again, it should be noted that during periods of low tide that the highly contaminated bottom sediments (as high as 190,000 ppm) may become exposed and perhaps account for a significant portion of the ambient PCB concentrations noted in the prevailing wind direction during this program. As a consequence, future monitoring activities should be synchronized with prevailing tidal cycles as much as possible.

### Cornell-Dubilier

Cumulative test results for monitors in the vicinity of the Cornell-Dubilier facility are shown in Table 24. Daily average results for each of the three stations are again consistent with values reported for both program background stations and values reported for a variety of North American urban centers as shown in Table 33. Total PCB concentrations reported in Table 24 are markedly lower than values reported previously in the vicinity of the Cornell site (see Table 36). Sampling done in September of 1978 indicated values of 767 and 862 ng/m<sup>3</sup> on the sea wall directly across the street from the Cornell-Dubilier facility. A sample collected upwind of the site recorded 18 ng/m<sup>3</sup> on the same day. The designated samplers for the present program were located atop the hurricane barrier approximately 1500 to 2000 feet north-northwest of the site perimeter. The winds on both test days were from the southwest at 10 to 15 mph (ambient temperatures as shown in Tables 16 and 17 measured 20 to 23°C on Day 2 and 23 to 24°C on Day 3). PCB levels were once again consistent with those reported for the corresponding upwind samplers and the cumulative regional background as noted in Table 24.

Values reported here suggest that PCB concentrations in the vicinity of the Cornell-Dubilier facility are not presently impacting PCB concentrations in the New Bedford region. Future sampling in this area should include sampling upwind and downwind of the site perimeter again in the prevailing wind direction. Sampling should be conducted in the summer months perhaps at a location atop the sea wall adjacent to the property.

### New Bedford Municipal Sewage Sludge Incinerator

Daily and cumulative averages for the four monitors situated on the municipal incinerator site are shown in Table 25. Concentrations reported at locations No. 2 (NE) and No. 3 (NNE) are significantly elevated above the established regional background level. This trend is consistent on both test days 2 and 3. The maximum total PCB concentrations of 87 ng/m<sup>3</sup> and 70 ng/m<sup>3</sup> were noted on Days 2 and 3 respectively at location No. 2. This particular monitor was located on the site perimeter northeast of the incinerator proper in the direct course of the prevailing winds on both test days 2 and 3. On Day 2, winds were generally brisk (10 to 23 mph) originating from the west-southwest (WSW) during most of the day. On Day 3 winds again ranged from 7 to 18 mph along the west-southwest vector. Ambient temperatures on Day 2 ranged from 22 to 24°C and 21 to 23°C on Day 3 at each of the four site locations. The monitors in the No. 3 location were situated more directly in the north-northeast (NNE) vector, once again on the site perimeter and were impacted to a lesser degree by prevailing winds on each of the 2 days. Accordingly, total PCB concentrations were significantly lower at this location. Concentrations reported for location No. 1 were markedly lower than either of the other two downwind sites averaging 8.0 ng/m<sup>3</sup> for the 2-day test period. This monitor was again situated at the site perimeter on a direct easterly vector from the incinerator stack. This value is identical to the total PCB concentration to the southwest reported by the No. 4 monitor.

The latter monitor was directly upwind of the incinerator on both test days. Again, values on both test days for locations 1 and 4 (see Table 25) were in good agreement with the regional background values and were consistent with values reported for typical North American urban centers.

As shown in Figures 4 through 6, total PCB concentrations downwind of the incinerator in both the NE and NNE vectors are in excess of the arithmetic annual mean of 35 ng/m<sup>3</sup> suggested by the Canadian Ministry for the Environment. Again this assumes that our 2-day values can be extrapolated to an annual arithmetic mean PCB concentration. Mass spectral results for locations 2 and 3 are provided in Table 27. Again the predominance of di, tri and tetrachlorobiphenyl homologues confirms the presence of elevated levels of an Aroclor 1242 or 1016 type Aroclor at each of these locations.

It is particularly noteworthy that the sewage sludge incinerator was not in actual operation on either of the 2 test days. In fact, during the time period of this program the dewatered sludge was stored on the site proper. This is apparently a common practice during periods in which the incinerator is not in operation. As a consequence, it appears that the site itself represents an area or fugitive source of PCBs to the ambient atmosphere. This is strongly supported by the PCB values recorded at the site perimeter in the prevailing wind direction on each of the 2 test days as contrasted to the values recorded upwind of the site, again at the site perimeter. Future testing should focus on this area source concept as well as the potential impact of the flue gas itself on downwind ambient PCB levels.

Previous testing conducted by the Environmental Protection Agency<sup>30</sup> in March of 1977 resulted in upwind values ranging from 20 to 58 ng/m<sup>3</sup> and corresponding downwind values ranging from 95 to 240 ng/m<sup>3</sup> during a 2-day test period. The downwind monitors on March 1, 1977, were located 380 feet from the stack with W/SW winds of 15 to 20 mph. The downwind monitors on March 3 were located 250 feet from the stack with westerly winds of 12 to 15 mph. A typical Aroclor 1242/1016 type pattern was reported containing a predominance of trichlorobiphenyl isomers as confirmed by mass spectral analyses. These results are consistent with the data reported in the present survey.

A limited survey consisting of one upwind and one downwind sampler conducted by Stratton, et al.<sup>31</sup> in January 1978, (see Table 36) concluded at the time that the "municipal sewage sludge incinerator is a low-level PCB emitter."<sup>31</sup> Our results reported here are consistent with these observations owing to the elevated PCB concentrations on both test days noted in the prevailing downwind directions.

It is our suggestion that future monitoring at the incinerator site include both an upwind and downwind monitor. Again, in light of the trends noted here, consideration should be given to testing on a more frequent basis than suggested at the other stations. Sampling during the summer months should be a priority, however.

## POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

A more detailed presentation and discussion of the polynuclear aromatic hydrocarbon (PAH) data is provided in Appendix F of this report. This includes further comparison of cumulative 21 station concentrations for selected PAHs on each of the 2 test days in both tabular and graphical form. A comparison of the cumulative PAH data base to representative summertime PAH data from selected U.S. and European rural and urban locations is also provided.

## SECTION 7

### QUALITY CONTROL RESULTS

#### INTRODUCTION

Quality control (QC) protocols implemented for this program, as specified in the Program Test and Quality Assurance Plan (see Appendix A) included the use of a number of control elements including method blanks, field-biased blanks, laboratory control spikes, blind spikes, and a series of deuterated surrogate spikes contained in each sample designated for GC/MS analyses. Additional quality control elements for the verification of the combined sampling and analysis procedures included the use of collocated monitors at three preselected stations in the study region on each of 3 test days; a storage stability study to assess the stability of an Aroclor mixture sorbed on polyurethane foam (PUF) under actual sample storage conditions; and a collection efficiency study to assess the overall trapping efficiency of the high-volume air sampler for PCBs. A brief synopsis of each of these control elements is provided below. A more detailed discussion of each element including results for each of the respective categories is provided in the subsequent portions of this section.

#### Blank Samples

##### Method Blanks--

Blank glass fiber filters and precleaned polyurethane foam cartridges were processed through the entire analytical scheme to assess spurious contamination arising from the media itself or the respective analytical scheme (e.g., solvents, glassware, etc.).

##### Field-Biased Blanks--

These blank glass fiber filters and precleaned polyurethane foam cartridges were assigned GCA Control numbers prior to transfer to field personnel. Field-biased blanks accompanied actual samples during transfer in the field and were placed in a high-volume air sampler on each test day.

##### Calibration Blanks--

This element consists of blanks used in instrument calibration containing all of the necessary reagents, etc. used to prepare reference calibration solutions. These blanks, however, do not contain standard reference materials. They are typically used in trace metal analyses only.

### Laboratory Control Samples

Laboratory control samples for this program consisted of both spiked polyurethane foam plugs and spiked glass fiber filters. Samples were fortified with predetermined quantities of the components of interest and accompanied program samples throughout the entire analytical scheme.

### Instrument Check Samples

These samples were typically prepared from EPA/EMSL concentrates and used on a daily basis to verify existing instrument calibration. When appropriate EPA/EMSL reference concentrates are unavailable (e.g., chlorinated benzenes, chlorinated phenols), instrument check samples are usually made from a mixture of stock reference materials prepared independently from the actual stock calibration mixture.

### "Blind" Spike Samples

For this program, "blind" spike samples consisted of both glass fiber filters and polyurethane foams plugs (PUF) fortified with a number of components of interest. These samples were coded with GCA Control numbers reserved for this purpose and inserted through the sample bank manager in order to mimic actual program samples. The origin and contents of these samples are unknown to the analyst. "Blind" spike filter samples were inserted for trace metal analyses, and "blind" spike foam (PUF) cartridges were inserted for PCB/pesticide analysis by GC/ECD. Additionally, spiked foam cartridges containing a variety of chlorinated organics (e.g., chlorinated benzenes, chlorinated phenols and PCBs) were submitted for GC/MS analysis.

### Surrogate Spikes

A series of deuterated analogues of components of interest (i.e., d<sub>3</sub>-trichlorobenzene, d<sub>10</sub>-biphenyl, d<sub>6</sub>-tetrachlorobiphenyl and d<sub>12</sub>-chrysene) were spiked into each program sample scheduled for GC/MS analyses. It was anticipated that these components would assess the behavior of actual components in individual program samples during the entire preparative and analysis scheme.

### POLYCHLORINATED BIPHENYLS (PCBs)--GC/ECD

Quality control elements for the analysis of PCBs and pesticides by GC/ECD consisted of method blanks, laboratory control spikes and "blind" spike samples.

### Laboratory Control Spikes

Each of three sets of polyurethane foam plugs was fortified with an aliquot of an EPA/EMSL concentrate containing a 40 µg quantity of Aroclor 1254. Analyses were conducted employing the sample preparation and analysis (GC/ECD) procedures outlined earlier in Section 4. Percent recovery data are summarized in Table 37.

TABLE 37. QUALITY CONTROL RESULTS: LABORATORY CONTROL SPIKES--GC/ECD

Sample #	Aroclor 1254 ( $\mu\text{g}$ )		% Recovery
	Expected	Observed	
QC 1006	40 <sup>a</sup>	44	110
QC 1007	40 <sup>a</sup>	44	110
QC 1008	40 <sup>a</sup>	43	110
QC 1012	NA	<0.1	---

<sup>a</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, this spiking level of Aroclor 1254 corresponds to an ambient concentration of 100 ng/m<sup>3</sup>.

NA - None Applied. This particular sample was a laboratory method blank to which no actual spike was applied.

### "Blind" Spike Samples

Two sets of polyurethane foam cartridges were again fortified with an EPA/EMSL concentrate containing 48 µg of Aroclor 1254 and 12 to 13 µg quantities of hexachlorobenzene, lindane and aldrin. Analyses were conducted employing procedures (GC/ECD) noted in Section 4. Percent recovery data are summarized in Table 38.

### POLYCHLORINATED BIPHENYL (PCB) STABILITY STUDY

A small-scale storage stability study was conducted to assess potential effects of interim (48 to 72 hours) sample storage conditions (ambient temperature) on actual polyurethane foam plug samples. Actual samples, it should be noted, were stored under refrigerated conditions upon receipt at the GCA Sample Bank until the time of actual analyses. However, cartridges were contained in the high-volume air sampler for a minimum of 12 to 16 hours and typically returned to the laboratory the next day. The total duration of the sample collection, sample recovery and transport sequence could approach 48 to 72 hours, as a result. For this reason two polyurethane foam cartridges were fortified with 40 µg quantities of Aroclor 1254 and placed in sample jars (with foil lids) and stored for a 64-hour period without refrigeration. It was anticipated that this would mimic worst case conditions for actual program samples.

Analyses were again conducted using the GC/ECD analytical protocols noted in Section 4. Results are provided in Table 39. As shown, the interim storage conditions had no adverse effect on the quantities of Aroclor 1254 applied. These results are consistent with observations noted in a more comprehensive storage stability study conducted by Lewis, et al.<sup>12</sup> using a smaller size PUF cartridge (20 mm x 3.8) than used here. In the former study, cartridges were fortified with a group of 20 organic components, 14 of which are directly applicable to the present study. Cartridges were stored at 32°C for a 15-day period during July and August. Component recoveries ranged from 76 to 116 percent for 13 of the 14 components applicable here (e.g., BHC isomers, chlorinated benzenes, chlorinated phenols). A 57 percent recovery was noted for 1,3,5-trichlorobenzene, however.

### PCBS--COLLOCATED MONITORS

Collocated high-volume air samplers were placed at three separate locations on each of the test days. All samples were collected and analyzed in an identical fashion. Polyurethane foam sampler extracts were submitted for PCB analyses by GC/ECD and GC/MS. Additionally, analyses were also conducted by GC/MS for chlorinated benzenes, chlorinated phenols, pesticides and polynuclear aromatic hydrocarbons.

Results for PCBs using GC/ECD are provided in Table 40. Please note that for the purposes of this discussion the ambient PCB concentrations noted at each of the collocated sites were considered to be equivalent for both the Day 2 and 3 sampling periods. (This is generally confirmed upon review of the data provided in Sections 5 and 6 for all of the 21 locations.)

TABLE 38. QUALITY CONTROL RESULTS: BLIND SPIKE POLYURETHANE  
FOAM (PUF)--GC/ECD

Component	Quantity ( $\mu\text{g}$ )				% Recovery
	Expected	Observed		$\bar{X}$	
		GCA 25427	GCA 25451		
Aroclor 1254	48 <sup>a</sup>	44	39	41	85
Hexachlorobenzene	13 <sup>b</sup>	14	14	14	110
$\gamma$ -BHC (Lindane)	12 <sup>b</sup>	11	11	11	92
Aldrin	13 <sup>b</sup>	12	3.6	7.8	60

<sup>a</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, the spiking level of Aroclor 1254 corresponds to an ambient concentration of 120 ng/m<sup>3</sup>.

<sup>b</sup>The pesticide spiking levels correspond to ambient concentrations of approximately 30 ng/m<sup>3</sup>.

TABLE 39. QUALITY CONTROL RESULTS: PCB STORAGE STABILITY STUDY--GC/ECD

Sample #	Aroclor 1254 ( $\mu\text{g}$ )		% Recovery
	Expected <sup>a</sup>	Observed	
QC 013	40	44	108
QC 014	40	39	98
		Average	103

<sup>a</sup>Assuming a typical sample volume of  $400 \text{ m}^3$ , this spiking level of Aroclor 1254 corresponds to an ambient concentration of  $100 \text{ ng}/\text{m}^3$ .

TABLE 40. QUALITY CONTROL RESULTS: COLLOCATED MONITORS--PCBs

Site	PCB concentration (ng/m <sup>3</sup> )				$\bar{X}$	S <sub>x</sub>	Relative standard deviation (% RSD)
	Day 2	Day 3	Day 4	Day 5			
Shawmut St. (Site 3)	2.4	1.6	2.4	8.2 <sup>a</sup>	2.1	0.46	22
Job C. Tripp School (Site 7)	15	14	7	12	12	3.6	30
C&W Welding (Site 9)	99	62	86	90	84	16	19

<sup>a</sup>This value was rejected as an outlier using Dixon Criteria for Testing of Extreme Observation (EPA-600/9-76-005).

As a consequence, a total of four values (two each from Days 2 and 3) are included in the statistical analyses shown in Table 40. As shown, the percent relative standard deviations (RSD) range from 19 to 30 percent for the three collocated monitor sites. Averaging the three values results in a percent RSD of 24 percent. Variations in PCB concentrations for a given day at selected sites are in fact better than the 2 day RSD values. Assuming legitimate RSD values can be derived from two data points, the percent RSD at the C&W Welding site on Day 3 is 3.2 percent, for example.

The overall RSD values shown in Table 40 are in agreement with sampling and analysis variability noted by other investigators in measuring ambient PCB concentrations with PUF cartridges under conditions of high-volume air sampling. Billings and Bidleman,<sup>4</sup> for example, report that replicate ambient air samples (two or three) generally agree within 20 percent when using the same sorbent media. In the same publication they report an average percent RSD value of 14 percent for Aroclor 1016 and 1254 when using PUF in conjunction with high-volume air sampling (300 to 700 m<sup>3</sup>). In a more recent study, Billings and Bidleman<sup>11</sup> again report percent RSD values of 5 to 16 percent when measuring ambient PCB concentrations using replicate samplers, each containing a different sorbent media.

#### PAHS--COLLOCATED MONITORS

A summary of PAH results for each of four pairs of collocated monitors is provided in Appendix F of this report. The overall precision of the combined sampling and analysis scheme for each of nine measured PAH parameters expressed as an average percent difference is also provided.

#### GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

##### Laboratory Control Spikes

Quality control procedures for the analysis of PUF and filter samples by GC/MS included the analysis of a series of laboratory control spikes containing representative components from each of the compound classes selected for investigation (Appendix A). It was anticipated that these spikes would provide precision and accuracy boundaries and hence validate the combined sample preparation and analysis scheme (see Figure 2). Three sets of polyurethane foam plugs and three particulate filters were spiked with a number of representative organics and processed in an identical fashion to actual program samples.

It should be noted that the spiking solutions were prepared independently of the actual instrument calibration mixtures and hence provide an independent check on each standard reference solution. Results for the filters and polyurethane foam spikes, including both expected and observed values are provided in Tables 41 and 42, respectively.

TABLE 41. QUALITY CONTROL DATA: RESULTS OF FILTER LABORATORY CONTROL SPIKES--GC/MS

Component	Quantity (ug)					Average recovery (%)	% RSD
	Expected <sup>a</sup>	Observed			$\bar{X}$		
		QC 117	QC 118	QC 119			
4-Chlorophenol	4.2	4.2	3.1	4.1	3.8	90	16
2,4-Dichlorophenol	5.3	6.0	5.6	6.9	6.2	117	11
2,3,5-Trichlorophenol	3.5	4.2	3.5	4.6	4.1	117	14
1,2,3-Trichlorobenzene	6.0	5.7	4.9	6.9	5.8	97	17
1,2,3,5-Tetrachlorobenzene	5.6	7.4	5.9	5.6	6.3	113	15
Hexachlorobenzene	6.6	7.0	4.0	11	7.3	111	48
2,3,5-Trichlorobiphenyl	8.0	13	7.8	20	14	175	44
2,3,4,5-Tetrachlorobiphenyl	14	34	19	48	34	243	44
Aldrin	6.5	9.0	4.6	11	8.2	126	40
γ-BHC	5.8	6.1	3.5	8.3	6.0	103	40

<sup>a</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, the spiking levels correspond to ambient concentrations in the range 9 to 35 ng/m<sup>3</sup>.

TABLE 42. QUALITY CONTROL DATA: RESULTS OF POLYURETHANE FOAM (PUF) LABORATORY CONTROL SPIKES--GC/MS

Component	Quantity (ug)					Average recovery (%)	% RSD
	Expected <sup>a</sup>	Observed			$\bar{X}$		
		QC 114	QC 115	QC 116			
4-Chlorophenol	5.2	3.2	4.2	3.7	3.7	71	14
2,4-Dichlorophenol	6.6	4.3	5.5	5.3	5.0	76	13
2,3,5-Trichlorophenol	4.4	3.7	5.2	4.9	4.6	105	17
1,2,3-Trichlorobenzene	7.5	4.9	5.8	5.9	5.5	73	10
1,2,3,5-Tetrachlorobenzene	7.0	5.1	6.4	6.5	6.0	86	13
Hexachlorobenzene	8.2	7.2	7.9	8.7	7.9	96	9.5
2,3,5-Trichlorobiphenyl	10	7.5	9.4	9.6	8.8	88	14
2,3,4,5-Tetrachlorobiphenyl	18	18	22	22	21	117	11
Aldrin	8.1	7.0	8.1	8.1	7.7	95	8.3
γ-BHC	7.3	6.6	8.5	7.6	7.6	104	13

<sup>a</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, the spiking levels correspond to ambient concentrations in the range 11 to 45 ng/m<sup>3</sup>.

### "Blind" Spike Samples

Two sets of "blind" spike polyurethane foam cartridges were also submitted for GC/MS analyses. Each of these samples was coded with a GCA Control number and analyzed simultaneously with program samples. Results including expected and observed values ( $\mu\text{g}$ ) are provided in Table 43. Please note that while each sample contained 40  $\mu\text{g}$  quantities of an Aroclor 1254 reference material, results are provided for individual isomer groups. As before, all spiked components were the result of independently prepared reference solutions.

Again, these results are consistent with the PCB data reported earlier using the GC/MS protocols noted in Section 4. These results provide some indication of the accuracy and reliability of the GC/MS data reported in Section 5.

### Surrogate Spikes

As noted previously, all program samples submitted for GC/MS analysis contained a series of deuterated surrogate compounds. In the case of polyurethane foam samples, the surrogate mixture contained 20 to 50  $\mu\text{g}$  quantities each of  $\text{d}_3$ -trichlorobenzene,  $\text{d}_{10}$ -biphenyl,  $\text{d}_{12}$ -chrysene and  $\text{d}_6$ -tetrachlorobiphenyl. This mixture was applied to a 5.0-ml aliquot of each PUF extract immediately prior to the nitrogen blowdown procedure. (Since the chlorinated components would pose significant interferences in the GC/ECD analysis, the surrogate mixture could not be introduced at the outset of the analysis scheme.) Samples were then submitted for GC/MS analysis. A summary of surrogate spike results, including quantities applied and recovered with appropriate statistical analysis, is provided in Table 44. Surrogate recovery data for each individual PUF sample are provided in Table 45.

In the case of particulate filter samples, the surrogate mixture containing 20 to 26  $\mu\text{g}$  quantities of the surrogates noted above was introduced prior to the initial filter extraction procedure. As a result, the surrogate recovery values are indicative of the entire filter preparation and analysis scheme. A summary of surrogate spike results, including quantities applied and recovered with appropriate statistical analysis, is provided in Table 46. Surrogate recovery data for each filter sample are provided in Table 47.

### COLLECTION EFFICIENCY MEASUREMENTS

A small-scale collection efficiency study was conducted to assess the overall trapping efficiency of the polyurethane foam cartridges for a typical Aroclor mixture. For this experiment, two high-volume air samplers were configured in an identical fashion to those used in the actual field studies.

Each sampler contained a particulate filter followed by two PUF cartridges. One filter was spiked with a 40  $\mu\text{g}$  quantity of Aroclor 1254 in hexane and the solvent allowed to evaporate. The second filter served as a blank and was not spiked. Each filter was placed in a high-volume sampler containing two PUF cartridges. Both samplers were placed on the roof of the GCA facility.

TABLE 43. QUALITY CONTROL DATA: RESULTS OF POLYURETHANE FOAM (PUF)  
 "BLIND" SPIKE SAMPLES--GC/MS

Component	Quantity (µg)				Average recovery (%)
	Expected	Observed			
		GCA 25427	GCA 25451	$\bar{X}$	
2,4-Dichlorophenol	13	10	12	11	85
4-Chlorophenol	10	5.6	8.8	7.2	72
2,3,5-Trichlorophenol	8.7	7.0	11	9.0	103
1,2,3,5-Tetrachlorobenzene	14	13	14	13	93
1,2,3-Trichlorobenzene	15	13	13	13	87
Hexachlorobenzene	13	13	15	14	108
Aldrin	13	12	16	14	108
γ-BHC	12	11	14	12	100
Tetrachlorobiphenyl	40a	7.4	8.8	8.1	107
Pentachlorobiphenyl		30	56	43	
Hexachlorobiphenyl		7.2	5.4	6.3	

<sup>a</sup>Spiked as Aroclor 1254. Results provided for PCB positional isomer groups noted (per GC/MS protocols in Section 4).

TABLE 44. QUALITY CONTROL DATA: SUMMARY OF RESULTS OF SURROGATE-SPIKED POLYURETHANE FOAM (PUF) SAMPLES<sup>a</sup>--GC/MS

Surrogate component	Expected <sup>b</sup> ( $\mu\text{g}$ )	Reported ( $\mu\text{g}$ )		Average recovery (%)	RSD (%)
		$\bar{X}$ (n=25)	$S_x$		
d <sub>3</sub> -trichlorobenzene	21	23	6.6	110	29
d <sub>10</sub> -biphenyl	26	38	7.7	150	20
d <sub>12</sub> -chrysene	25	23	5.3	92	23
d <sub>6</sub> -tetrachlorobiphenyl	52	43	9.3	83	22

<sup>a</sup>As indicated in Section 4, the surrogate mixture was applied to a 5.0-ml aliquot of each PUF extract immediately prior to nitrogen blowdown and subsequent GC/MS analysis.

<sup>b</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, the spiking levels correspond to ambient concentrations of 53 to 130 ng/m<sup>3</sup>.

TABLE 45. QUALITY CONTROL DATA: SURROGATE RECOVERY DATA FOR INDIVIDUAL POLYURETHANE FOAM (PUF) SAMPLES<sup>a</sup>--GC/MS

GCA Control No.	Reported (ug)			
	d <sub>3</sub> -trichlorobenzene (expected=21 ug)	d <sub>10</sub> -biphenyl (expected=26 ug)	d <sub>12</sub> -chrysene (expected=25 ug)	d <sub>6</sub> -tetrachlorobiphenyl (expected=52 ug)
25397	12	29	23	52
25399	23	46	30	59
25401	15	28	28	43
25405	22	38	26	48
25421	17	31	13	22
25423	8.2	15	11	22
25429	25	40	23	43
25431	24	39	31	44
25435	20	34	15	39
25439	26	41	22	47
25443	27	40	18	35
25445	21	37	24	44
25552	24	39	29	57
25556	22	37	26	45
25558	29	40	20	37
25560	23	43	21	39
25564	27	48	29	49
25572	43	58	21	49
25574	32	44	30	57
25578	27	39	18	38
25580	24	37	22	39
25582	21	38	23	47
25604	23	40	25	36
25606	24	39	25	37
25610	26	40	23	35

<sup>a</sup>As indicated in Section 4, the surrogate mixture was applied to a 5.0-ml aliquot of each PUF extract immediately prior to nitrogen blowdown and subsequent GC/MS analysis.

TABLE 46. QUALITY CONTROL DATA: SUMMARY OF RESULTS OF SURROGATE-SPIKED PARTICULATE FILTER SAMPLES<sup>a</sup>--GC/MS

Surrogate component	Expected <sup>b</sup> ( $\mu\text{g}$ )	Reported ( $\mu\text{g}$ )		Average recovery (%)	RSD (%)
		$\bar{X}$ (n=15)	$S_x$		
d <sub>3</sub> -trichlorobenzene	21	4.4	3.4	21	77
d <sub>10</sub> -biphenyl	26	8.5	7.1	33	84
d <sub>12</sub> -chrysene	26	39	24	150	62
d <sub>6</sub> -tetrachlorobiphenyl	26	28	22	110	79

<sup>a</sup>As indicated in Section 4, the surrogate mixture was introduced in the soxhlet extraction apparatus prior to beginning the sample preparation procedures. As a result, reported recoveries (%) reflect the entire analytical scheme (i.e., extraction, concentration, GC/MS).

<sup>b</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, the spiking levels correspond to ambient concentrations of 53 to 65 ng/m<sup>3</sup>.

100001400000 prior to nitrogen blowdown and subsequent GC/MS analysis.

TABLE 47. QUALITY CONTROL DATA: SURROGATE RECOVERY DATA FOR INDIVIDUAL PARTICULATE FILTER SAMPLES<sup>a</sup>--GC/MS

GCA Control No.	Reported (µg)			
	d <sub>3</sub> -trichlorobenzene (expected=21 µg)	d <sub>10</sub> -biphenyl (expected=26 µg)	d <sub>12</sub> -chrysene (expected=26 µg)	d <sub>6</sub> -tetrachlorobiphenyl (expected=26 µg)
25400	1.2	3.0	26	17
25422	2.7	4.0	22	14
25430	4.8	6.7	28	19
25432	2.2	4.2	35	24
25436	0.57	6.8	27	17
25440	2.1	4.3	20	12
25444	3.3	5.3	not spiked	17
25446	38 <sup>b</sup>	58 <sup>b</sup>	166 <sup>b</sup>	93 <sup>b</sup>
25553	7.6	11	71	39
25561	11	12	89	52
25573	7.4	9.7	57	40
25579	10	14	35	19
25581	7.3	8.6	52	33
25605	2.3	3.5	62	31
25607	2.6	3.4	8.8	7.1
25611	0.54	31 <sup>c</sup>	9.6	6.5

<sup>a</sup>As indicated in Section 4, the surrogate mixture was introduced in the soxhlet extraction apparatus prior to beginning the sample preparation procedures. As a result, reported recoveries (%) reflect the entire analytical scheme (i.e., extraction, concentration, GC/MS).

<sup>b</sup>These values were rejected as outliers using Dixon Criteria for Testing of Extreme Observation (EPA-600/9-76-005). It appears that this sample may have been spiked twice.

<sup>c</sup>This value was rejected as an outlier using Dixon Criteria as stated in EPA-600/9-76-005 and F. E. Grubbs, 1969, "Procedures for Detecting Outlying Observations in Samples," Technometrics, 11 (1), pp. 1-21.

The samplers were run overnight for a 12-hour period in order to collect approximately 400 m<sup>3</sup>. This exercise was conducted in early September under meteorological conditions identical to those encountered during the field studies (i.e., ambient temperature 20-25°C).

Thirty-one (31) µg of the 40 µg of Aroclor 1254 applied were recovered in the PUF cartridges resulting in a trapping efficiency of 78 percent. This value is lower than the value of 100 percent reported by GCA in an earlier ambient study<sup>21</sup> conducted using Aroclor 1242. The latter value, however, was reported for a 3-hour sampling period and a total air volume of 131 m<sup>3</sup>. The value reported here, while lower than anticipated, is consistent with collection efficiency measurements reported by other investigators. Lewis et al.<sup>14</sup> reported average collection efficiencies for PUF of 70 to 80 percent for replicate samples fortified with Aroclor 1242 and a value of 85 percent for Aroclor 1254. Sample collection volumes in most instances were 326 m<sup>3</sup>. They further commented that a 75 percent value constituted an acceptable trapping efficiency.

#### TRACE ELEMENTS

Two filters spiked with several elements of interest in this program were submitted as blind quality control samples; these results are presented in Table 48. The recoveries are generally lower than might be expected; spike recoveries on the order of 80 to 90 percent are generally observed for this analysis. A review of the instrument log book indicated that the EPA QC concentrate analyzed with this group of samples was within acceptable limits (Table 49); therefore the low recoveries were not due to instrument performance. The low recoveries appear to be related to the sample preparation or the spiking procedures.

TABLE 48. QUALITY CONTROL DATA: RESULTS OF "BLIND"  
SPIKE SAMPLES--TRACE ELEMENTS

Element	Expected <sup>a</sup> ( $\mu\text{g}$ )	Reported ( $\mu\text{g}$ )			Average recovery (%)
		GCA No. 25428	GCA No. 25452	$\bar{X}$	
Beryllium	190	122	134	128	67
Cadmium	88	56.5	61.0	58.8	67
Chromium	93	54.0	60.0	57.0	61
Copper	95	60.5	66.5	63.5	67
Vanadium	260	159	175	167	64

<sup>a</sup>Assuming a typical sample volume of 400 m<sup>3</sup>, the spiking levels correspond to ambient concentrations of 220 to 650 ng/m<sup>3</sup>.

TABLE 49. QUALITY CONTROL DATA: RESULTS OF INSTRUMENT  
CONTROL SAMPLE--TRACE ELEMENTS

Element	Expected ( $\mu\text{g}/\text{l}$ )	Reported ( $\mu\text{g}/\text{l}$ )	Percent recovery
Aluminum	700	565	81
Arsenic	200	204	102
Beryllium	750	769	103
Cadmium	50	54	108
Chromium	150	136	91
Cobalt	500	519	104
Copper	250	255	102
Iron	600	593	99
Lead	250	247	99
Manganese	350	357	102
Nickel	250	251	100
Selenium	40	40	100
Vanadium	750	782	104
Zinc	200	203	102

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APPENDIX A

SAMPLING AND ANALYSIS PROTOCOLS FOR AMBIENT MONITORING  
IN SUPPORT OF THE NEW BEDFORD ENVIRONMENTAL INVESTIGATION -  
TEST AND QUALITY ASSURANCE PROJECT PLAN

Prepared for  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
Research Triangle Park, NC 27711

EPA Project Officer

Deborah Dalton

Contract No. 68-02-3168  
Work Assignment No. 79,  
Task 2

SAMPLING AND ANALYSIS  
PROTOCOLS FOR AMBIENT MONITORING  
IN SUPPORT OF THE NEW BEDFORD  
ENVIRONMENTAL INVESTIGATION

Test and Quality  
Assurance Project Plan

August 1982

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GCA/TECHNOLOGY DIVISION  
Bedford, Massachusetts

EPA CONTRACT NO. 68-02-3168  
WORK ASSIGNMENT NO. 79, TASK 2  
(GCA 1-619-079B)

QUALITY ASSURANCE PROJECT PLAN  
FOR  
AMBIENT MONITORING IN SUPPORT OF THE  
NEW BEDFORD ENVIRONMENTAL INVESTIGATION

APPROVAL:

GCA PROGRAM MANAGER

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SECTION 1  
INTRODUCTION

SCOPE OF WORK

The Environmental Protection Agency is currently conducting a comprehensive evaluation of the occurrences, transport and fate of polychlorinated biphenyls (PCBs) and related organic contaminants within the New Bedford harbor area. An integral part of this program is a complete evaluation of the ambient air in and around the New Bedford Metropolitan Area. The program as detailed in this document presents a comprehensive monitoring network designed to measure ambient concentrations of polychlorinated biphenyls (PCBs) and other organic contaminants. It is the intent of this program to provide quantitative, "real time" measurements for ambient PCB concentrations simultaneously at each of twenty-three (23) stations encompassing a geographical area which includes New Bedford, Fairhaven, and Dartmouth. The specific site listing, as presented in Section 2, includes several areas of particular interest to the Environmental Protection Agency and the Mass. Department of Environmental Quality Engineering as well as both state and local health agencies. Included in the "target" site summary listing are several potentially contaminated areas as well as a number of background stations located throughout the study region. It is anticipated that the sampling and analysis program described herein will provide the following information to supplement health studies presently in progress in the study area:

- Quantify fugitive PCB emissions from a number of locations suspected of containing onsite PCBs.
- Provide comprehensive coverage of the study area in an attempt to define any additional sources adversely impacting present organic ambient air quality.
- Provide quantitative, "real time" measurements on PCBs and other potentially toxic organics to assist federal, state and local health officials presently studying the impact of ambient air quality on residents of the New Bedford area.
- Define, within the scope of this program, any obvious ambient transport mechanisms of PCBs and other contaminants within the study area.

- Provide comprehensive organic analysis on a number of preselected sites throughout the study area. This will include at a minimum selected chlorinated pesticides and chlorinated isomers of biphenyl, benzene, and phenol.

The monitoring network described in Sections 2 and 3 will be comprised of high volume air samplers located at each of 23 stations. Analytical protocols described in Section 4 will include total suspended particulate (TSP) measurements, trace metals via inductively coupled argon plasma (ICAP) as well as numerous organic measurements provided through the use of gas chromatography in conjunction with both mass spectrometry and electron capture detection.

Quality control protocols are detailed in Section 5, the Quality Assurance Project Plan. Quality control measures specific to this program will include the use of co-located samplers at three stations to evaluate the precision of the overall sampling and analysis scheme. Further quality control measures will include method recovery and breakthrough studies for representative analytes from each of the organic compound classes.

#### PROJECT ORGANIZATION AND RESPONSIBILITIES

Figure 1-1 presents GCA's organization chart for this project showing the individuals responsible for each element of the overall task. The key individual responsible for QA is the Division QA Manager who reports directly to the Division General Manager. The department QC Coordinators report directly to their Department Manager and the QA Manager, enabling them to implement QC measures on all projects independent of the project manager. The responsibilities of these individuals on this project are briefly described below.

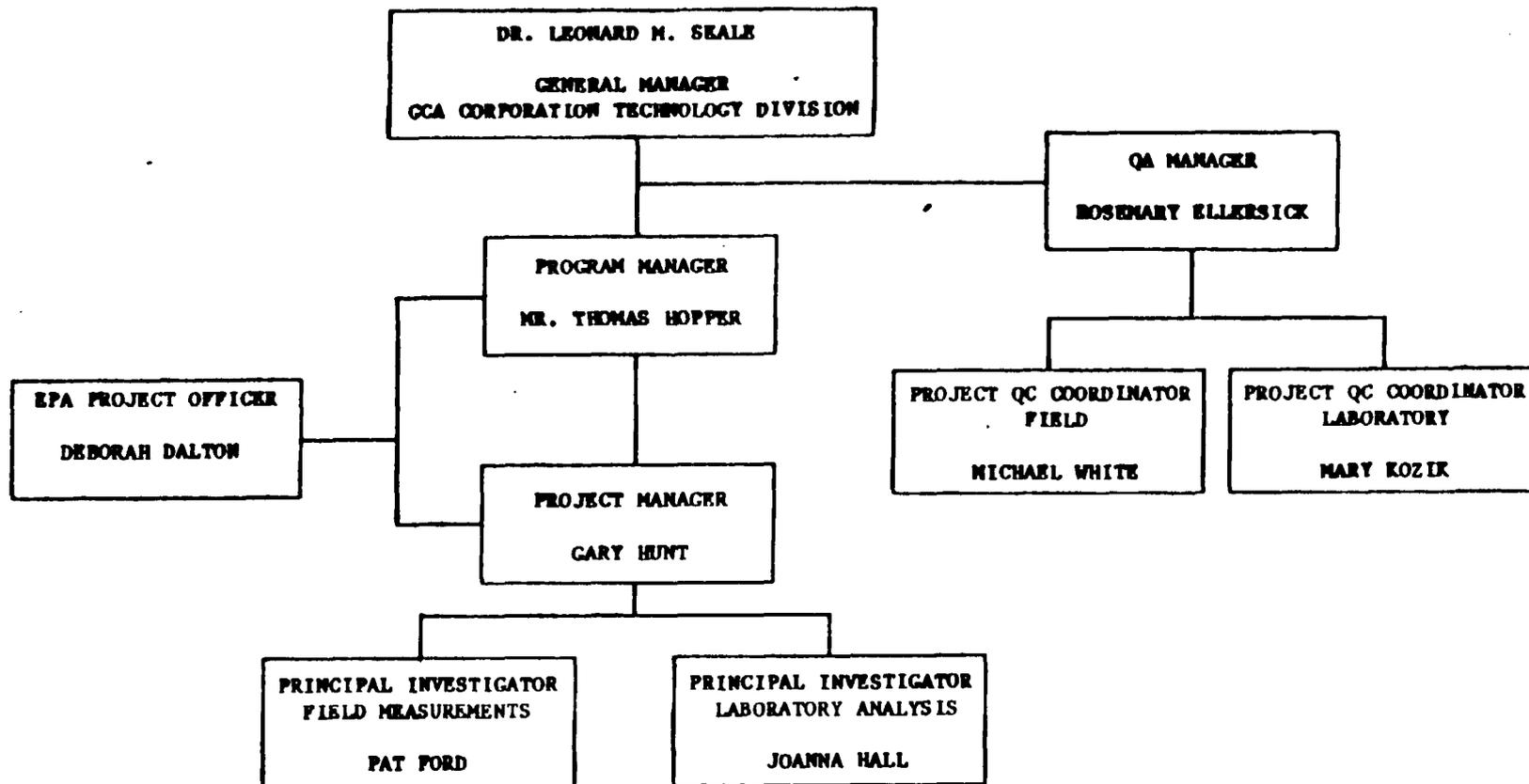
#### QA MANAGER'S RESPONSIBILITIES

The Division QA Manager is the responsible Quality Assurance Officer for this project. She has aided in the development of the QA Project Plan and reviewed and approved the plan before its submittal to the Project Officer. She will ensure that any necessary revisions are made and she will check on implementation of the QA Plan during the life of the project, scheduling performance or system audits as necessary.

She will initiate or follow-up on corrective actions and aid in preparation of a section of the Final Report summarizing QA/QC activities and including estimates of the precision, accuracy and completeness of data achieved. Quality problems found and corrective actions taken will be described.

#### FIELD AND LABORATORY QC COORDINATOR'S RESPONSIBILITIES

The Environmental Measurements Department (Field) and the Laboratory Analysis Department QC Coordinators oversee and implement the ongoing QC



125

Figure 1-1. Project organization and responsibility.

program within their departments. They have aided in the preparation of this QA Plan and will ensure that the required QC procedures are followed. They will initiate corrective actions as necessary, and maintain and report the QC records and results for this project.

## SECTION 2

### SITE SELECTION METHODOLOGY

#### OVERVIEW

The site selection process, as noted in the introduction, addresses a number of sites of particular interest to federal, state and local health and environmental agencies. Included in the target site summary listing are several suspected emission sources of PCBs as well as a number of potentially contaminated areas previously uncharacterized. A number of background stations situated throughout the study area, have also been selected. At each of the suspected emission sites, samplers will be located in order to adequately assess contaminant levels (e.g., PCBs) in fugitive emissions exiting the site area.

For sites suspected of being fugitive sources, samplers (high-volume) will be placed in a downwind position to measure emissions emanating from the source and an upwind position to assess concentrations impacting on the site itself. It is anticipated that this approach will effectively demonstrate whether a suspected site, and not some point upwind of the site, is actually an emission source.

The siting methodology described herein was based on historical meteorological data which indicates that during the calendar period of the program (late summer, early fall) the prevailing winds are from the southwest. This season is also characterized by prevalent sea-breeze conditions. Generally, the sea-breeze flow is onshore, from the south and southeast in the daytime, and offshore, from the north and northwest in the evening.

The fugitive source sampling regime is designed such that samplers will be placed as closely as possible to flow vectors in the northeast, northwest, and southeast directions. These three locations will adequately accommodate wind flow from the southwesterly, southeasterly and northwesterly directions, respectively. In addition, two sites will have a sampler located to the southwest of the suspected fugitive source in order provide total directional coverage. Figure 2-1 illustrates the ambient network as described above.

Meteorological data will be collected in order to define the atmospheric regimes occurring during the ambient sampling periods and to provide data to assist in determining potential source locations and characteristics. As many

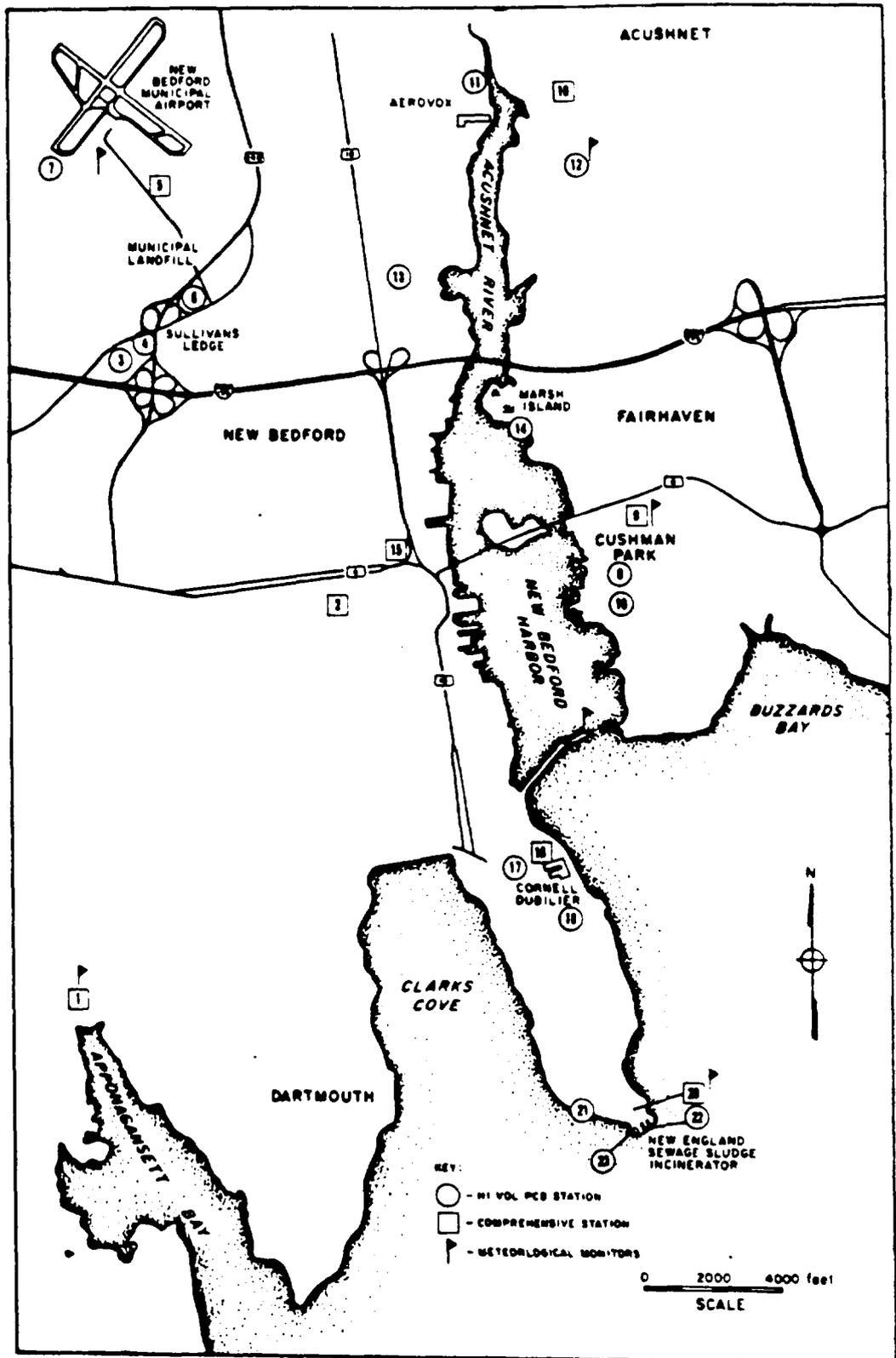


Figure 2-1. Ambient monitoring network--site location schematic.

six meteorological sampling locations as shown in Figure 2-1 will be sited in order to adequately categorize background conditions and to assist in identifying possible "new" sources of PCB emissions.

Due to the anticipated meteorological variability in the study region, it was decided to increase the number of sampling periods from 1 day (for 12 hours) to 3 days during the course of 1 week (each for 12 hours). In this way, data affected by a strong wind shift or an air mass or temperature change can be eliminated from the analysis and data from conditions as close as possible to prevailing winds can be analyzed.

Sampling has been scheduled to take place over a 12 hour period spanning from mid-morning to early evening (e.g., 9:00 a.m. to 9:00 p.m.). It is anticipated that this interval will serve program objectives in each of two separate ways: (1) encompass the more noteworthy meteorological trends of a given day (e.g., turbulence of mid-morning, late morning-mid afternoon warmth and the cooling trend towards stabler conditions in the evening), (2) provide "real time" measurements over the course of a "working" day to assist health studies investigating the impact of ambient air quality on the New Bedford population.

#### Ambient Monitoring Sites

As noted earlier, 23 separate sampling locations have been selected to adequately define the study region. The program objectives, as noted in the introduction, place each of the selected sites in one of three categories:

- Background sites--either urban in the impacted region of New Bedford or Fairhaven or suburban background out of the impacted area.
- Fugitive area sources containing onsite contamination as demonstrated in previous monitoring efforts or suspected sources previously uncharacterized.
- Point sources--such as the New Bedford Municipal Sewage Sludge Incinerator.

The background locations were selected in areas not suspected of being impacted by "known" sources of PCB emissions. These include the following sites:

- Dartmouth Town Hall
- New Bedford High School
- New Bedford Fire Station
- Fairhaven Town Hall
- Cushman Park (Fairhaven)

Suspected area sources of fugitive emissions include the following sites:

- Marsh Island
- New Bedford Municipal Landfill
- Sullivan's Ledge
- Aerovox/Upper Acushnet River
- Cornell Dublier

The only true "point" source in the study area, historically noted as a known emission source of PCBs, is the New Bedford Sewage Sludge Incinerator. It is anticipated that ambient measurements will be collected during a period when the incinerator is not in operation. These measurements may also permit evaluation of the incinerator site and adjacent properties as an area source. Future ambient monitoring during actual incinerator operation will be conducted in conjunction with a testing program to be conducted by GCA at the incinerator in late September or early October. In the latter study sample locations will be selected from those chosen for the present program.

Table 2-1 lists each of the designated sites, respective site category and monitor locations proposed for each.

#### Meteorological Monitoring Sites

Meteorological data will be collected from two existing data sources: the Army Corps of Engineers' instrument tower on the hurricane barrier in Acushnet Harbor, and the New Bedford Airport. The parameters collected will include wind direction, wind speed, air temperature, and any available stability indicators. In addition, four sets of portable meteorological instruments will be located with ambient samplers. Three will be located near suspected sources of PCB emissions and one near a background site. The suspected sources will include: the New Bedford Municipal Landfill site, Aerovox, and Cornell Dublier. The background meteorological data site is near the Dartmouth Town Hall. Figure 2-1 as noted earlier, illustrates the suspected PCB emission sources, ambient monitoring sites, as well as the meteorological monitoring locations.

TABLE 2-1. AMBIENT MONITORING SITE LOCATIONS<sup>B</sup>

Site Area	Type	Site No.	Location	Criteria
Dartmouth	Background	1	Roof of Town Hall <sup>a,d,e</sup>	Outside Affected Region
New Bedford High School	Urban Background Poss. Area Source	2	Roof of Admin. Building	Suspected Area Source
Sullivan's Lodge	Area Source	3	One on Site	Suspected Area Source
		4	One to N.E.	Prevailing Wind Direction
New Bedford Municipal Landfill	Area Source	5	One to N.E. <sup>d,e,f</sup>	Prevailing Wind Direction
		6	One to S.E. <sup>b</sup>	Offshore Flow
		7	One to N.W.	Onshore Flow
Cushman Park, Fairhaven	Urban Background Poss. Area Source	8	Amphitheater (onsite) <sup>d</sup>	Suspected Area Source
		9	Job C. Trip School <sup>g</sup>	Approx. Prevailing Wind Direction
Aerovex	Area Source	10	One to N.E. <sup>d,f</sup>	Prevailing Wind Direction
		11	One to N.W.	Onshore Flow
		12	One to S.E. <sup>g</sup>	Offshore Flow
		13	One to S.W.	Upwind of Prevailing Wind Direction
Marsh Island	Area Source	14	One on Site	Suspected Area Source
New Bedford Fire Station	Urban Background	15	Roof of Building <sup>d</sup>	Assumed Unaffected Area
Cornell Dublier	Area Source	16	One to N.E.	Prevailing Wind Direction
		17	One to N.W.	Onshore Flow
		18	One to S.E.	Offshore Flow
Fairhaven	Urban Background	19	Roof of Town Hall <sup>c</sup>	Assumed Unaffected Area
New Bedford Sewage Sludge Incinerator	Point Source	20	One to N.E. <sup>d,e</sup>	Prevailing Wind Direction
		21	One to N.W.	Onshore Flow
		22	One to S.E.	Offshore Flow
		23	One to S.W.	Upwind of Prevailing Wind Direction

<sup>a</sup>This monitor will provide upwind coverage for Cornell Dublier.

<sup>b</sup>This monitor will serve the dual purpose of covering Sullivan's Lodge or be an upwind sampler, depending upon wind direction.

<sup>c</sup>It is anticipated that this site will provide data on the impact of Cushman Park and Cornell Dublier on Fairhaven ambient air.

<sup>d</sup>These sites will undergo comprehensive analysis to include PCBs, other chlorinated organics and trace metals.

<sup>e</sup>Co-located meteorological monitoring instrumentation.

<sup>f</sup>Co-located high volume samplers.

<sup>g</sup>See Figure 2-1 for site map.

Note: High-Volume sampling apparatus will be operated at all of the locations listed above. Analyses will be performed for PCBs only. Subsequent work will include analysis for other chlorinated organics on samples containing levels compatible with GC/MS detection limits.

### SECTION 3

#### SAMPLING AND METEOROLOGICAL MONITORING PROCEDURES

Sampling will be conducted in and around the New Bedford/Fall River area for a period encompassing approximately 10 working days. During this time frame, three sampling runs of 8 to 12 hours duration will be conducted for the collection of airborne polychlorinated biphenyls (PCBs), pesticides, trace metals, total suspended particulate (TSP), volatile organics, and a variety of chlorinated derivatives of phenol and benzene. Sampling days will be selected to allow for optimum weather conditions, desirable prevailing winds and required sample turnaround time. Based upon evaluation of sampling conditions, the "best" set of samples will then be selected for immediate analysis and the additional two sets will be stored for future analysis, if desired.

As discussed in Section 2 of this document, a total of 23 sampling stations have been selected in the study area. In addition, three co-located samplers will be placed at prespecified locations. Sampling for PCBs will be conducted at all locations, however, only eight stations have been designated as "comprehensive locations" in which sampling for all previously listed parameters (PCBs, pesticides, trace metals and TSP) will be accomplished.

Modified High Volume samplers will be utilized for the collection of PCBs, pesticides, trace metals and Total Suspended Particulate (TSP). The employed procedure will be essentially the same as described by Stratton, et al., in "A Method for the Sampling of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA-600/4-78-048, August 1978.

Meteorological conditions will be monitored continuously during the course of the sampling effort. Data will be obtained from either existing sources or by locating sensors at specified locations. Data from permanent sources will be used to determine general meteorological trends in the area during the sampling period while data from the "temporary" installation will be used to determine micrometeorological conditions affecting specific locations. Conditions to be monitored include: wind speed, wind direction and ambient temperature. Barometric pressure, relative humidity and vapor pressure determinations will also be made on the day of sampling at a minimum frequency of two per day.

## HIGH VOLUME SAMPLING

Sampling for PCBs, pesticides, trace metals, and TSP will be performed using high volume samplers which comply with 40 CFR 50 Appendix B--Reference Method for the Determination of Suspended Particulates in Ambient Atmosphere (High Volume Method) modified as described in "A Method for Sampling and Analyses of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA 600/4-78-048, August 1978. This modification involves an extension of the throat assembly at the filter holder outlet with a piece of cylindrical aluminum. Additional modifications include replacement of rubber gasket material with Teflon and the attachment of flexible duct work to direct motor exhaust downward of the sampler inlet.

Total Suspended Particulate (TSP) and trace metals are collected on a glass fiber filter and PCBs, pesticides and related organics are trapped in two precleaned polyurethane foam plugs housed in the aluminum throat extension located downstream of the filter assembly. Flow rates through the sampler will be adjusted to between 0.566 to 0.850 m<sup>3</sup>/min (20 to 30 ft<sup>3</sup>/min), depending upon total expected sampling times. In no case, however, will sample volume be allowed to exceed a total of 400 m<sup>3</sup> (14,124 ft<sup>3</sup>).

### Sampling Procedure

#### A. Sampling Equipment

##### 1. High Volume Air Sampler Description

- a. PCBs, pesticides, trace metals and TSP will be collected using the high volume sampler depicted in Figure 3-1.
- b. The sampler will be equipped as described in the Federal Register Volume 36, No. 84 dated April 30, 1971 "Reference Method for the Determination of Suspended Particulates in the Atmosphere" modified as described in "A Method for Analysis of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA 600/4-78-048, August 1978.

##### 2. Filter Media (Glass Fiber Filters)

- a. Filter Collection Efficiency--Only filters having a collection efficiency of at least 99 percent for particles 0.3  $\mu$ m diameter, as measured by the DOP test, will be used. The manufacturer will be required to furnish proof of the collection efficiency of a batch of new filters when purchased.
- b. Filter Surface Alkalinity--It is recommended that only filters with a surface alkalinity between 6.5 and 7.5 on the pH scale be used.

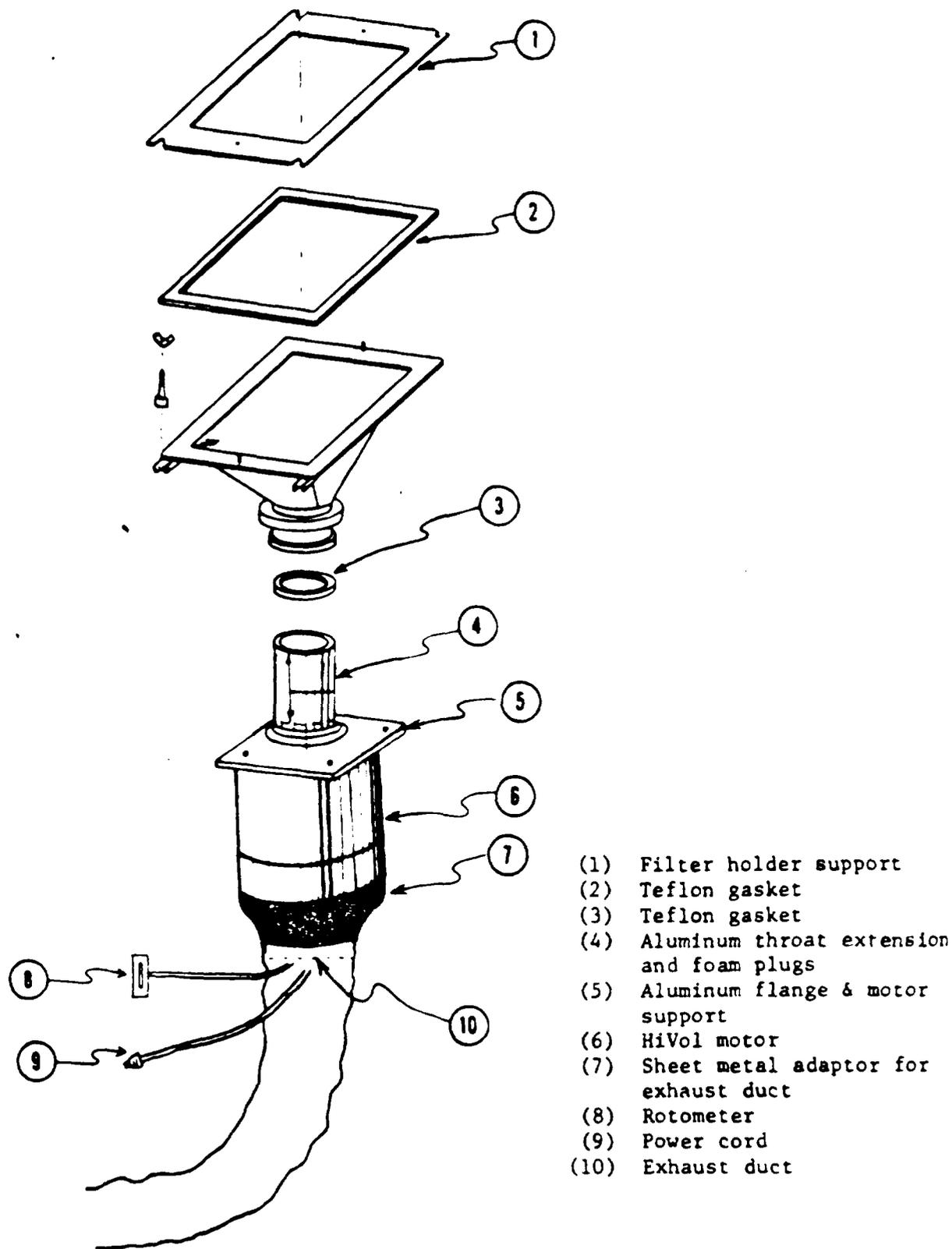


Figure 3-1. Schematic of High Volume Sampling System modified for addition of a Polyurethane Foam Cartridge.

(Source: EPA-R4-73-028b-Guidelines for Development of a Quality Assurance Program--Reference Method for the Determination of Suspended Particulates in the Atmosphere, High Volume Method.)

3. Polyurethane Foam (PUF)

Soxhlet extracted polyurethane foam plugs (polyether type 0.21 gm/cm<sup>3</sup>) will be used as the collection media for PCBs, pesticides and related organics. Two 4 in. diameter cylindrical foam plugs, cut from 3 in. (depth) stocks will be placed, under slight compression, in hexane rinsed aluminum throat assemblies.

Polyurethane foam plugs are cleaned in the laboratory to remove potential interferences prior to their use in the field. The cleaning procedure includes the following steps:

- a. Soxhlet extract foam plugs for 24 hours in 5 percent diethyl ether in hexane.
- b. Remove excess solvent by pressing the extracted plugs against the inside of the extractor apparatus. Remove the remaining solvent by placing the plugs in a clear vacuum desiccator or oven, heating to 40°C and drawing clean air or other suitable gas through them.
- c. Plugs extracted and dried as a group are assigned the same lot number. One plug from each lot is subjected to a quality control check; i.e., extraction and analysis for the organics of interest. Rejection criteria must be established individually based on the analytical sensitivity required. All plugs from a given lot must be re-cleaned if the quality control check sample is rejected. The solvents used in the cleaning process, quality control check and as field reagents must first be evaluated using similar rejection criteria.
- d. After cleanup, wrap each plus in hexane-rinsed aluminum foil and stored in a cleaned glass jar with a Teflon-lined cap.

B. Calibration

Samplers will be calibrated using the procedures described in Section 5.

C. Sampling Procedures

1. One 8 to 12 hour integrated sample will be collected at each of the 23 stations during each sample run. Three co-located samples will also be collected during each sample run. A total

of three sample collection runs will be conducted during this phase of the project.

2. Sample flow rates will be adjusted between 0.566 and 0.850  $\text{m}^3/\text{min}$  so that the total volume sampled does not exceed 400  $\text{m}^3$ .
3. Installation of Filter and PUF Cartridge (Item a through h to be completed in the laboratory)
  - a. Remove faceplate by loosening the four wing nuts and rotating the bolts upward.
  - b. Obtain a clean, weighed filter and record the filter number, Hi-Vol serial number and flow meter serial number in the log book.
  - c. Carefully place the clean filter rough side up, on the wire screen, and center the filter so that when the faceplate is in position, the gasket will form a tight seal on the outside edge of the filter.
  - d. Replace faceplate being careful not to move filter, and tighten the wing nuts until gasket is air tight against the filter.
  - e. Place a piece of hexane rinsed aluminum foil over filter and secure around edges of the filter holder.
  - f. Remove aluminum foil from inlet of a prepacked (PUF) aluminum throat assembly.
  - g. Place Teflon gasket in place between outlet of filter housing and inlet of throat assembly and thread into place.
  - h. Remove foil from outlet end of throat assembly and attach motor.
  - i. Carefully pack assembly in upright position for transport to the field.
  - j. Unpack assembly and carefully seat in high volume sampler shelter.
  - k. Attach 8 to 10 ft length of flexible dryer hose to outlet of motor and locate downwind of sampler.
4. Operational Checks
  - a. Allow sampler motor to warm up at least 5 minutes to reach normal operating temperature.

- b. Attach rotameter and record initial sample flow rate. Disconnect rotameter.
- c. Record Run Start time and date, location description, site ID, sampler serial No., flow meter serial No. and filter No. on the data sheet.
- d. Turn sampler off and set clock switch to start at desired time on the specified run date.
- e. Reset elapsed timer to 0.00 minutes.
- f. Perform calibration procedures detailed in Section 5.

#### 5. Recovering Filter/PUF Assembly

- a. Check final sampler flow rate prior to sampler shut off.
- b. If sampler has automatically shut-off, turn sampler on and allow to warm up for 5 minutes prior to checking final flow rate.
- c. Turn sampler off and record elapsed time in sample log book.
- d. Secure a prerinsed (hexane) sheet of aluminum foil over exposed filter.
- e. Carefully remove entire assembly from high volume samplers shelter.
- f. Pack in upright position for transport to laboratory.

#### 6. Sample Identification

Samples will be identified with a securely attached Air Sample Tag, shown in Section 5 of this document and with the completed data sheet and Custody Record.

#### 7. Delivery to Analytical Laboratory

All samples will be delivered to GCA/Technology Divisions Analytical Laboratory in Bedford, Massachusetts within 6 hours of sample collection under chain-of-custody procedures outlined in Section 5.

### METEOROLOGICAL MONITORING

Four temporary meteorological monitoring stations will be established in the study area as specified in Section 2. These stations will be equipped to continuously monitor the following parameters: wind speed, wind direction and ambient temperature.

Barometric pressure and relative humidity data will also be recorded at specified intervals on days of sampling. In addition, data will also be collected from two permanent installations in the study area as indicated in Section 2.

A. Equipment

1. Unless otherwise specified, meteorological equipment for the measurement of wind speed and direction will be the Climatronics Wind Mark III Wind Measuring System. Wind speed is measured by a stainless steel three-cup anemometer, and converted to an electrical signal by a photochopper, which uses a solid state light source for maximum reliability. Wind direction is obtained with a counterbalanced wind vane, coupled to a precision potentiometer. Wind speed and direction will be recorded continuously on a dual channel recorder with a chart width of 2-5/16 in. per channel.
2. Ambient Air Temperature will be obtained continuously with a Weather Measure Ambient Air Temperature Measuring System. Temperature is sensed by a shielded TP-200 Thermistor temperature sensor. The output signal is appropriately conditioned and recorded on a portable strip chart recorder.
3. Any changes to the equipment listed in 1 and 2 above will be approved by the project officer prior to installation.

B. Calibration

All calibrations will be as specified in the manufacturers operating manual as delineated in Section 5.

C. Operation

1. Each instrument and recorder shall be checked daily to ensure proper operation.
2. At each site visited the strip charts will be labeled for parameter, time, and date.

D. Data Reduction

All strip chart outputs will be collected at the end of the field effort and data reduction and computer coding performed by Envirodata Inc. of Chelmsford, MA. Data will be reported in the form of a digitized computer output and a wind rose.

SECTION 4  
ANALYTICAL PROTOCOLS

HIGH-VOLUME SAMPLES

As previously discussed, high-volume sampling techniques will be used at each of 23 stations. Samples from eight of these stations have been designated for comprehensive analysis; i.e., PCBs, chlorinated semivolatile organics, trace metals. Samples from the remaining 15 stations will undergo analysis for PCBs only. Any samples from the latter, noncomprehensive stations, which are found to have significant levels of PCB will be subjected to subsequent analysis for other organic contaminants, including individual chlorobiphenyl isomers.

The high-volume sampling units, previously described in the sampling protocol, will generate two types of samples: (1) a set of two polyurethane foam (PUF) plugs; and (2) particulates collected on a filter. PUF plugs from the comprehensive stations will be analyzed for PCBs and chlorinated semivolatile organics, whereas those collected from noncomprehensive stations will initially be analyzed for PCBs only. The latter will be subjected to analysis for the additional semivolatiles only if the initial analysis indicates the presence of significant, non-Aroclor organic levels. Particulate filters from the comprehensive stations will be aliquotted for the analysis of semivolatile organics and trace metals. Filters from the noncomprehensive stations will be held in reserve pending results obtained from the respective PUF sample.

PUF Plugs

Sets of PUF plugs will be prepared for organics analysis using the analysis scheme presented in Figure 4-1. That scheme is detailed below:

1. Transfer the polyurethane plugs to a soxhlet apparatus using solvent rinsed forceps. Extract for 50 to 100 cycles using 5 percent ethyl ether in hexane.
2. After cooling, transfer solvent extract to a Kuderna-Danish Apparatus and reduce volume to less than 5 ml. Do not allow the extract to go dry.
3. Adjust the extract volume to 10.0 ml, remove 5.0 ml for reserve and proceed with GC/ECD analysis on a 1.0 ml portion of the remaining 5.0 ml.

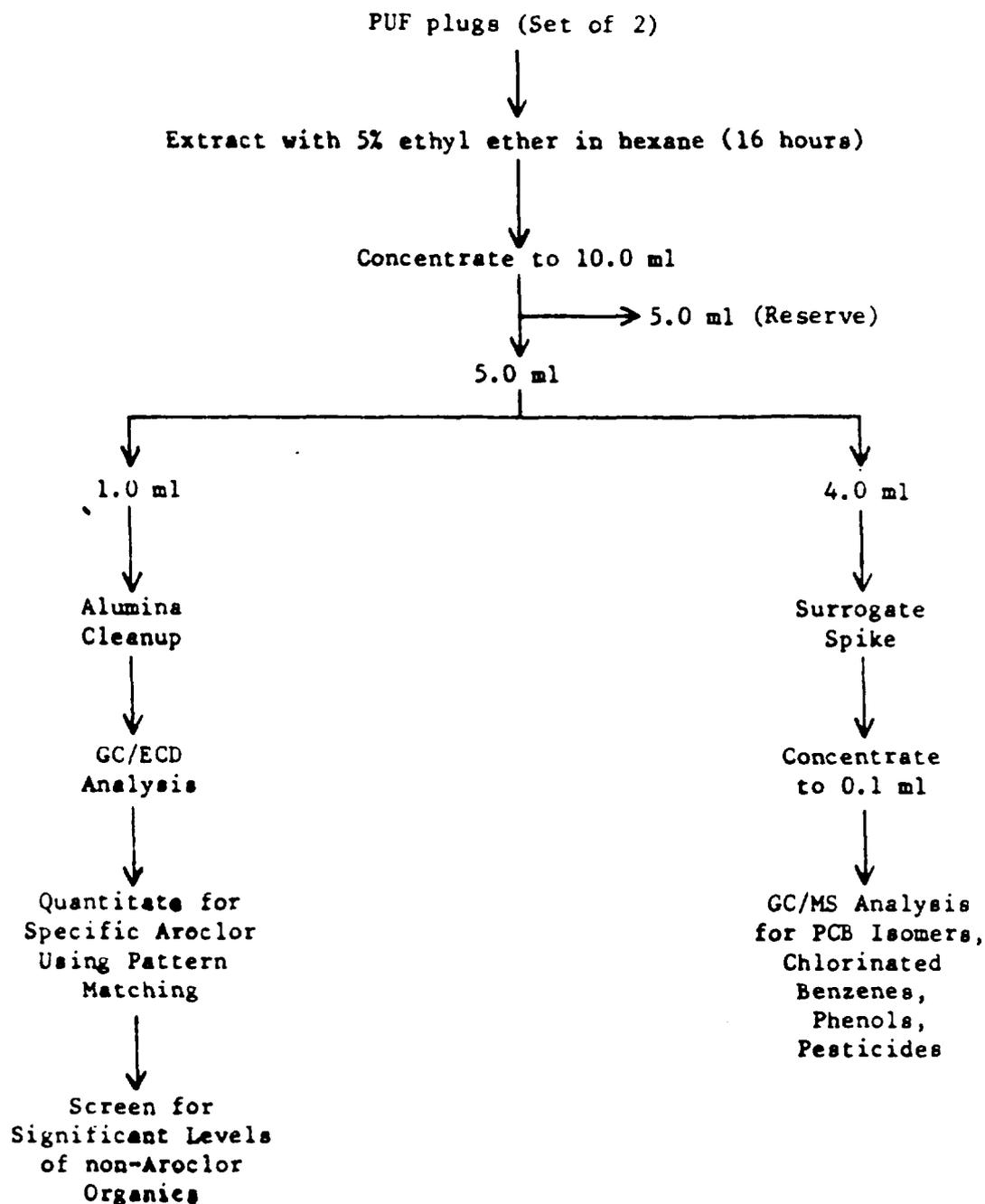


Figure 4-1. Analysis of PUF plugs.

4. Add the 1.0 ml portion to a 10 cm alumina (grade IV) column which has been pre-rinsed with 10 ml of hexane. Collect a 15 ml eluate of hexane and evaporate to 1.0 ml for GC/ECD analysis. Instrument operating conditions are given in Table 4-1. Instrument calibration procedures are detailed in Section 5.
5. The remaining 4.0 ml portion of the 10.0 ml extract (Step 3) is then surrogate spiked with deuterated semivolatile organic components and concentrated via nitrogen blowdown to 0.1 ml for GC/MS analysis.

#### GC/ECD Analysis--

All gas chromatographic peaks will be recorded and integrated using the HP5840A data system. Sample elution patterns will be compared to those of standard Aroclor (PCB) mixtures for identification purposes. Quantitative analysis will be performed using the calibration curve of the identified Aroclor mixture. In addition, a qualitative analysis will be performed to determine whether other organic contaminants, e.g., pesticides are present in quantities sufficient for GC/MS analysis. Particular attention will be paid to a variety of chlorinated derivatives of benzene, and phenol, as well as various chlorinated pesticides. Table 4-2 lists the Aroclor mixtures and chlorinated pesticides of interest. Detection limits for this analysis will be 5 ng/m<sup>3</sup> for Aroclor mixtures and 1 ng/m<sup>3</sup> for single-peak chlorinated pesticides in the absence of significant PCB interferences.

#### GC/MS Analysis--

The 4.0 ml portion remaining after GC/ECD analysis will be surrogate-spiked with appropriate deuterated analogues (e.g., d<sub>4</sub>-tetrachlorobiphenyl, d<sub>10</sub>-biphenyl) and concentrated via nitrogen blowdown to 0.1 ml for capillary column GC/MS analysis in the total ion mode. Instrument conditions for this analysis are listed in Table 4-3. This analysis will provide confirmation of the presence of PCB, as well as provide quantitative measurements for the individual PCB isomers, chlorinated pesticides (Table 4-2), and the chlorinated phenols and benzenes listed in Table 4-4.

The quality control protocols specific to these analyses will include:

- Pretest quality control checks of cleaned lots of PUF plugs. GC/ECD acceptance criteria will be 1 ng/m<sup>3</sup> and 5 ng/m<sup>3</sup> for single-component chlorinated pesticides and Aroclor mixtures, respectively, assuming collection of a 400 m<sup>3</sup> air sample.
- Analysis of available EPA/EMSL check samples to verify calibration standards.
- The generation of analytical recovery data for the analysis of selected isomers of chlorobiphenyl, phenol, and benzene.
- A study to evaluate the occurrence of breakthrough of selected components of interest on PUF plugs using typical sampling flow rates and volumes (400 m<sup>3</sup>).

TABLE 4-1. GC/ECD CONDITIONS FOR PUF PLUG ANALYSIS

Instrument	Hewlett-Packard 5840A with Ni <sup>63</sup> electron capture detector and HP 7671A automatic sampler
Column	1.5% OV-17/1.95% QF-1 on 100/120 Chromosorb WHP, 6 ft x 2 mm
Temperatures	
Column	185°C
Injector	270°C
Detector	350°C
Injector volume	4.0 µl
Run time	30 min
Carrier flow	UHP argon/methane, 35 ml/min

TABLE 4-2. AROCLOR MIXTURES AND CHLORINATED PESTICIDES  
OF INTEREST IN GC/ECD ANALYSIS

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Aroclor Mixtures

Aroclor 1016  
Aroclor 1221  
Aroclor 1232  
Aroclor 1242  
Aroclor 1248  
Aroclor 1254  
Aroclor 1260

Chlorinated Pesticides

Heptachlor  
Dieldrin  
p.p'-DDE  
p.p'-DDT  
 $\alpha$ -BHC  
 $\gamma$ -BHC (Lindane)  
Hexachlorobenzene  
Toxaphene  
Endrin  
Aldrin

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TABLE 4-3. GC/MS OPERATING CONDITIONS FOR SEMIVOLATILE ORGANICS ANALYSIS

<u>Instrument</u>	Hewlett-Packard 5985, Quadrupole Mass Spectrometer
<u>GC Conditions</u>	
Column	SE-54 30M fused silica capillary
Temperature program	50°C held for 2 min then 10°/min to 260°C and held
Injector type	Grob with 0.5 min sweep time
Injector temperature	275°C
Injection volume	1 µl, splitless
Column flow	UHP helium, 0.5 ml/min
<u>MS Conditions</u>	
Emission	300 µa
Electron energy	70 eV
Scan time	1.0 sec/scan
Mass interval	41-350 amu
Source temperature	200°C

TABLE 4-4. CHLORINATED PHENOLS AND BENZENES OF INTEREST IN THE GC/MS ANALYSIS

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Chlorinated Phenols

3-Chlorophenol	2,4,6-Trichlorophenol
4-Chlorophenol ✓	2,3,5-Trichlorophenol
2,3-Dichlorophenol	2,3,6-Trichlorophenol
2,4-Dichlorophenol ✓	3,4,5-Trichlorophenol
2,5-Dichlorophenol	2,3,4,5-Tetrachlorophenol
3,4-Dichlorophenol	2,3,4,6-Tetrachlorophenol
3,5-Dichlorophenol	2,3,5,6-Tetrachlorophenol
2,3,4-Trichlorophenol	Pentachlorophenol
2,4,5-Trichlorophenol	

Chlorinated Benzenes

1,2,3-Trichlorobenzene	1,2,3,5-Tetrachlorobenzene
1,3,5-Trichlorobenzene	Pentachlorobenzene
1,2,3,4-Tetrachlorobenzene	

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### Particulate Filters (Comprehensive Stations)

The recovered filters will be returned to the laboratory for particulate (TSP) analysis. Once particulate weights have been recorded, a 50 percent aliquot of each filter will be surrogate spiked with appropriate deuterated analogues (e.g.,  $d_4$ -tetrachlorobiphenyl,  $d_{10}$ -biphenyl,  $d_8$ -naphthalene,  $d_{12}$ -chrysene) and soxhlet-extracted for a period of 24 hours in methylene chloride. The resultant extract will be concentrated via a Kuderna-Danish apparatus to 10.0 ml. A 5.0 ml portion will be held in reserve and the remaining 5.0 ml further concentrated to 0.1 ml for GC/MS analysis of semivolatile organics. The instrumental operating parameters are as previously listed in Table 4-3. It is anticipated that the majority of semivolatile organics will provide detection limits in the range of 1-10  $ng/m^3$ .

Trace metals analysis of the particulate matter collected on glass fiber filters will be determined by means of Inductively Coupled Argon Plasma Emission Spectroscopy (ICAP). Preparative procedures include the extraction of a 50 percent filter aliquot in a mixture of nitric and hydrochloric acids. During digestion the samples are sonicated at 10 minute intervals to ensure total extraction of entrained particulates. Resultant extracts are subsequently filtered to remove filter media and extraneous particulate prior to metals quantitation by ICAP. The ICAP which is presently capable of simultaneously analyzing 28 elements, will provide at a minimum quantitative values for all of the elements listed in Table 4-5. Detection limits are generally lower than flame Atomic Absorption (AA) and comparable to graphite furnace AA techniques. Table 4-5 provides the expected limits of detection for 27 trace metals reported in units of  $\mu g$ /total filter. Most chemical interferences encountered during AA analyses are precluded due to the high temperature ICAP plasma. This ensures complete sample dissociation. The optical thinness of the plasma also extends the linear concentration over several orders of magnitude and decreases the need for sample dilution. Computer background correction also compensates for any background continuum difficulties. The ICAP is equipped with a Texas Instruments Silent 733 electronic printer giving hard copy and tape record capabilities. Data recorded directly to tape during analysis are transmitted to other in-house computer systems capable of performing all necessary data reduction and final report printing.

TABLE 4-5. DETECTION LIMITS AND WAVELENGTHS FOR ICAP ANALYSIS

Element	Detection limits	Wavelength used for analysis (nm)
	ug/total filter	
Ag	0.1	328.0
Al	0.9	308.2
As	3	197.2
B	0.4	249.6 (second order)
Ba	0.1	493.4
Be	0.1	234.8
Ca	1	317.9
Cd	0.1	228.8 (second order)
Co	0.3	228.6
Cr	0.3	205.5 (second order)
Cu	0.2	324.7
Fe	0.4	259.9
Mg	2	279.0
Mn	0.1	257.6
Mo	0.2	202.0
Na	1	589.0
Ni	0.5	231.6 (second order)
Pb	2	220.3
Sb	2	206.8
Se	2	196.0 (second order)
Si	0.5	251.6
Sn	3	189.9
Sr	0.1	421.5
Ti	0.1	334.9
Tl	4	190.8 (second order)
V	0.5	292.4
Zn	0.1	213.8

## SECTION 5

### QUALITY ASSURANCE PROJECT PLAN

#### QA OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

##### Precision, Accuracy and Completeness

The collection of data which can provide comprehensive identification and quantitation of the constituents of the ambient air in the study area requires that sampling and analysis procedures be conducted with properly operated and calibrated equipment by trained personnel. Precision and accuracy goals for the analytical procedures are shown in Table 5-1.

TABLE 5-1. QA OBJECTIVES FOR PRECISION, ACCURACY AND COMPLETENESS--LABORATORY ANALYSIS

Measurement method	Matrix	Precision (relative standard deviation)	Accuracy	Completeness
GC-ECD	PUF/filter	≤15%	+10%	95%
GC/MS	PUF/filter	≤20%	+20%	95%
ICAP	Filter	≤10%	+10%	95%

##### Representativeness and Comparability

The QA objective is that all measurements be representative of the media and operation being sampled. It is recognized that the usefulness of the data is also contingent upon meeting the criteria for representativeness and comparability. The detailed requirements for sampling ambient air using high-volume filters and polyurethane foam given in References 1-3 will be followed to ensure collection of representative samples.

The corresponding QA objective is that all data resulting from sampling and analysis be comparable with that obtained in other studies of this area. The use of published sampling and analytical methods and standard reporting units will aid in ensuring the comparability of the data.

#### SAMPLE CUSTODY

The purpose of chain-of-custody procedures is to document the identity of the sample and its handling from its collection until analysis and data reduction are completed. Custody records trace a sample from its collection through all transfers of custody until it is transferred to the analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition.

#### Field Sampling Operations

The importance of uncontaminated reagents, collection media and sample containers in collecting valid samples is well recognized by GCA. The collection medium actually becomes part of the sample itself.

The Field/Laboratory Procedure Coordination Form shown in Figure 5-1 is initiated by the Environmental Measurements Department (Field) for all sample collection projects involving analysis of the collected samples at GCA or elsewhere. Each type of sample to be collected is listed individually and assigned a unique identification number. Based on the type of sample and the analysis to be performed, the appropriate sample container and field preservative are specified. Approved lots of solvents and reagents are listed by the Laboratory Analysis Department QC Coordinator who must give final approval to the form.

Preprinted sample identification tags are used by GCA to ensure that the required information is entered in the field. Each collected sample including duplicates and field blanks shall have a completely filled-in sample tag securely attached. In addition, the sample identification number is marked on the container with a permanent marker so that the sample can be properly identified if the tag is separated from the sample.

Figure 5-2 shows the general use GCA sample label and chain-of-custody seal that will be used to identify and seal samples in the field. Figure 5-3 shows a general use chain-of-custody record. This three-part carbonless copy form is based on NEIC format and will be used to document sample transfer in the field and from sampling personnel to the laboratory.

#### Laboratory Operations

All samples submitted to the GCA/Technology Division Analytical Laboratory will be brought to the Sample Bank Manager, Sandra Sandberg, who will continue the chain of custody by assigning a GCA Control Number to each sample on receipt; this number identifies the sample through all further handling. The sample will be recorded in the bound Master Sample Log under



GCA TECHNOLOGY DIVISION ●●▲

DATE \_\_\_\_\_ SAMPLE NO \_\_\_\_\_

SAMPLE DESCRIPTION \_\_\_\_\_

SAMPLE METHOD \_\_\_\_\_

ADJUSTMENTS \_\_\_\_\_

COLLECTED BY \_\_\_\_\_

COMMENTS \_\_\_\_\_

\_\_\_\_\_

SHIPPED \_\_\_\_\_ REC'D \_\_\_\_\_

 <p>GCA/Technology Division Chain of Custody Sample Seal</p>	FIELD	DATE	SEALERS INITIAL
	SAMPLE NO		
	RUN #	SAMPLE DESCRIPTION	
SEALERS NAME (PRINT)		SEAL BROKEN BY & DATE	

Figure 5-2. Sample label and chain of custody seal.



its GCA Control Number. A Master Log page is not depicted here because the hand-written records do not reproduce well; however, each page of the Master log has the following information:

- GCA Control Number
- Sample description
- Sample condition
- Signature of person completing sample record
- Date of sample receipt

GCA/Technology Division maintains large, locked, refrigerated and nonrefrigerated storage areas with provision for hazardous material storage. After necessary preservation or subdivision, the Sample Bank Manager will store each sample in the appropriate area under its GCA Control Number.

The Sample Bank Manager will initiate a page (Figure 5-4) for each sample in the Custody Book and ensure that each handling of the sample is appropriately documented. Each analyst working with the sample will first go to the Sample Bank Manager and record in the Custody Book actions taken on the sample thereby maintaining the chain of custody of the original sample.

When sample preparation and analysis procedures necessitate the transfer of samples between two analysts within the laboratory, a Sample Custody Transfer form (Figure 5-5) is required. This document serves as a supplement to the Custody Notebook record of sample handling and becomes part of the permanent project file.

All materials such as field and laboratory notebooks and logbooks, field and laboratory data records, correspondence, reports, sample tags, chain-of-custody records and instrument printouts will be clearly labeled with the project number and become a permanent part of the project file.

#### Calibration Procedures and Frequency

Calibration procedures for field and laboratory instrumentation are described in the following sections.

#### High Volume Sampling Equipment

The sampler will be equipped as described in the Federal Register Volume 36, No. 84 dated April 30, 1971 "Reference Method for the Determination of Suspended Particulates in the Atmosphere" modified as described in "A Method for Analysis of Polychlorinated Biphenyls (PCBs) in Ambient Air," EPA 600/4-78-048, August 1978.

Samplers must be calibrated when first purchased, after major maintenance on the sampler (e.g., replacement of motor or motor brushes), anytime the flow rate measuring device (i.e., rotameter or recorder) has to be replaced or



**SAMPLE CUSTODY TRANSFER**

**PURPOSE**

Procedure/Analysis required \_\_\_\_\_

(General information only--analyst MUST refer to Project File for specific details.)

Instrumentation required \_\_\_\_\_

**BACKGROUND**

Client \_\_\_\_\_

Contract (Charge) No. \_\_\_\_\_ Work Order No. \_\_\_\_\_

**SAMPLES**

General description of sample type(s) \_\_\_\_\_

List of samples (by GCA Control No.):

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Additional samples (QC-blanks, QC-spikes, etc.):

\_\_\_\_\_  
\_\_\_\_\_

Total number of samples \_\_\_\_\_

Comments \_\_\_\_\_

**TRANSFER**

From \_\_\_\_\_ Date \_\_\_\_\_

Received by \_\_\_\_\_ Date \_\_\_\_\_

(Location of samples) \_\_\_\_\_ )

When completed, make 3 copies--one each for originator, recipient, and Task Manager.

**RETURN ORIGINAL TO PROJECT FILE**

Figure 5-5. Sample custody transfer form.

repaired, or any time a one-point calibration check deviates more than +6 percent from the calibration curve.

- a. Remove filter retaining plate from the sampler and place a clean filter in line.
- b. Attach the variable resistance orifice (VRO, BGI Inc., S/N#3703) to the sampler and position the orifice setting to full open. Secure the VRO fall plate to insure an air tight seal with the orifice gasket. Attach the slack tube manometer to the sampler unit.
- c. Plug sampler into 120 volt source, while checking manometer to insure that the orifice pressure drop does not exceed the range of the manometer. Let the sampler run for about 5 minutes.
- d. Record sampler serial number and rotameter serial number on calibration form.
- e. Determine five approximately equally spaced intermediate points which provide pressure drops between the desired maximum and minimum operating points and record the following data on the calibration sheet:
  1. pressure drop from the manometer (in. H<sub>2</sub>O)
  2. flow rate as indicated on rotameter.
- g. Record the air flow rate from the VRO hi-vol calibration curve for each flow recorder reading.

$$\text{ACCEPTABILITY} = 100 \frac{|(Q_o - Q_c)|}{Q_c} \text{ within 5 percent}$$

Q<sub>o</sub> = observed flow rate

Q<sub>c</sub> = flow rate from calibration curve

- h. If the air flow rate exceeds the acceptable limits, rerun points for which percent deviation exceeds 5 percent until acceptance limits are attained.
- i. Correct the sample flow rate to standard conditions using the following formula:

$$Q_2 = Q_1 \left[ \frac{T_2 P_1}{T_1 P_2} \right]$$

Q<sub>2</sub> = corrected flow rate (scfm)

Q<sub>1</sub> = flow rate from chart

T<sub>2</sub> = absolute temperature (298°K) most sensitive ranges first.

P<sub>1</sub> = barometric pressure during calibration

T<sub>1</sub> = absolute temperature during calibration

P<sub>2</sub> = standard barometric pressure (760 mm Hg)

## Meteorological Equipment

### Wind Speed--

The wind speed measurements will be conducted utilizing a Climatronics Model WM-III, 3 cup anemometer and translator/recorder. The instrument will be calibrated as per manufacturer's instructions and will be further checked in the field with a synchronous motor both before and after use.

### Wind Direction--

The wind direction (run) will be monitored with a Climatronics Model WM III wind vane and translator/recorder equipped with a 180° crossover. The vane will be calibrated in the lab by observing that the instrument response agrees with each 90° rotation of the vane and ensuring that the instrument response is correct at the 0°/360° crossover.

Field calibration will utilize a magnetic compass and USGS 7 1/2 minute topographic quadrangle maps. The wind vane will be manually sited toward landmarks detailed on the USGS maps to coincide with True North as well as the three other cardinal bearings of East, South and West; 0°, 90°, 180°, and 270° respectively.

### Temperature--

The temperature will be monitored utilizing a Weather Measure Corporation Model T621-3 Remote Temperature indicator. The instrument incorporates a platinum wire thermistor inside a natural aspirated radiation shield (model IS-4).

The unit is calibrated in the lab according to manufacturer's instructions. Onsite calibration will be verified with the dry bulb of an aspirated psychrometer. The dry bulb thermometer will have been previously calibrated in both boiling water and an ice bath.

## Analytical Instrumentation

Hewlett-Packard 5840A Gas Chromatograph with Ni<sup>63</sup>  
Electron Capture Detector--

### Calibration Standards--

1. Prepare stock solutions for each Aroclor and pesticide at concentrations of 1 µg/l using standards obtained from the EPA/RTP Reference Standards Repository or Chem Service, Inc., West Chester, PA. Chlorinated biphenyl standards will be prepared using materials obtained from Ultra Scientific, Inc., Hope, Rhode Island. Use the specified purity of each lot of the compound in calculating the standard concentration. Prepare stock solutions every 6 months or as needed.
2. Prepare the working standards by dilution of the stock solution. The working standards will be prepared as needed.

3. Verify the working standards by analysis of appropriate EPA quality control concentrates (EPA/EMSL, Cincinnati, Ohio) before use as calibration standards.

#### Calibration Procedures--

1. Calibrate the instrument daily using 4 to 5 calibration (working) standards.
2. Analyze a laboratory control sample. If the reported values are within 5 percent of the expected values, analysis may proceed. Verify a single point of the calibration curve after every five samples (+6 percent).
3. Enter all instrument operating conditions and quality control results in the instrument logbook. The analyst's notebook must contain all information regarding standard preparation. Sign and date all entries.

Hewlett-Packard 5985 GC/MS--

#### Calibration Standards--

1. Prepare stock solutions of the chlorinated biphenyls, phenols, benzenes and chlorinated pesticides at a concentration of 1 µg/µl using materials obtained from Ultra Scientific, Inc., Hope, Rhode Island. Use the specified purity of each compound lot in calculating the standard concentration. Prepare stock solutions every 6 months or as needed.
2. Prepare working standards by dilution of the stock solutions. The working standards are prepared as needed.
3. Verify the standard solutions by analysis of an independent standard prior to use as calibration standards.

#### Calibration Procedures--

1. Calibrate the instrument daily using a minimum of three calibration (working) standards.
2. The following instrumental conditions will be used:

#### GC Conditions

Column	SE-54, 30-m fused-silica capillary column
Temperature program	50°C held for 2 min, then 10°/min to 260°C and held

Injection volume                      Typically 1 µl  
Column flow                              UHP helium, 0.5 ml/min

MS Conditions

Emission                                300 µs  
Electron energy                        70 eV  
Scan rate                                1.0 sec/scan  
Mass interval                          41-350 amu

3. Analyze a laboratory control sample. If the reported values are within established acceptance limits (generally  $\pm 20$  percent) analysis may proceed,
4. Enter all instrument operating conditions and quality control results in the instrument logbook. The analyst's notebook must contain all information regarding standard preparation. Sign and date all entries.

Jarrell Ash Model 855 Inductively Coupled Plasma Spectrometer--

Calibration Standards--

1. Prepare the 1000 ppm stock solution from the high purity metal or an appropriate salt; if the salt is used, it must be dried at 105°C for 1 hour unless otherwise specified.
2. Prepare the mixed working standards daily by dilution of the 1000 ppm stock solution.
3. Verify the working standards by analyzing against a sample prepared from an EPA Trace Metals concentrate.

Calibration Procedure--

1. Profile and calibrate the instrument according to the procedures outlined in the instrument operating manual using a minimum of three standards. Flush the system with the calibration blank between each standard.
2. Analyze a quality control sample prior to beginning sample analysis. Enter the reported values for the QC sample in the instrument logbook and sign and date the entry. If the reported values are acceptable, generally within 5 percent of the expected value, sample analysis may begin.
3. Flush the system with the calibration blank between each sample.

4. Reanalyze the quality control sample at the end of the analysis session or after every 10 to 15 samples if the instrument is running for an extended period.
5. Standard preparation must be documented in the analyst's notebook. All instrument operating parameters must be noted in the instrument logbook; the logbook entry must be signed and dated by the analyst.

#### ANALYTICAL PROCEDURES

PUF plug samples will be analyzed for PCBs and, in some cases, for semivolatile organics such as chlorinated pesticides, phenols and benzenes. Particulate filters, from comprehensive stations, will be analyzed for trace metals and semivolatile organics. Table 5-2 lists the parameters of primary interest; specific analytical procedures are described in Section 4.

#### DATA REDUCTION, VALIDATION AND REPORTING

Extensive QC measures will be used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in all projects.

##### Field Data Reduction

The data collected will be reviewed in the field by at least two field crew members. Errors or discrepancies will be noted in the field log book.

Figure 5-6 shows the data flow scheme and Figure 5-7 gives the calculations used to determine sampling volumes. In practice, this form is used as a worksheet in the field.

##### Laboratory Analysis Data Reduction

Analysis results will be reduced to the concentration units specified in EPA's instructions or the analytical procedure, using the equations given in the analytical procedures. If units are not specified, data from the analysis of air samples in most cases will be reported in units of  $\mu\text{g}/\text{m}^3$ . In the case of the chlorinated organics such as PCBs, chlorinated benzenes, phenols and pesticides results were more conveniently reported in units of  $\text{ng}/\text{m}^3$ . This will be calculated by dividing the total weight of the substance detected by the volume of air sampled. Appropriate blank corrections will be applied in all cases.

##### Data Validation

Data validation is the process of filtering data and accepting or rejecting it on the basis of sound criteria. GCA/Technology Division supervisory and QC personnel will use validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records

TABLE 5-2. PARAMETERS TO BE MEASURED IN AMBIENT AIR

Polychlorinated Biphenyls (PCBs)

Aroclor 1016  
 Aroclor 1221  
 Aroclor 1232  
 Aroclor 1242  
 Aroclor 1248  
 Aroclor 1254  
 Aroclor 1260

Chlorinated Pesticides

Heptachlor  
 Dieldrin  
 p,p'-DDE  
 o,p'-DDT  
 α-BHC  
 γ-BHC (Lindane)  
 Hexachlorobenzene  
 Toxaphene  
 Endrin  
 Aldrin

Chlorinated Phenols

3-Chlorophenol  
 4-Chlorophenol  
 2,3-Dichlorophenol  
 2,4-Dichlorophenol  
 2,5-Dichlorophenol  
 3,4-Dichlorophenol  
 3,5-Dichlorophenol  
 2,3,4-Trichlorophenol  
 2,4,5-Trichlorophenol  
 2,4,6-Trichlorophenol  
 2,3,5-Trichlorophenol  
 2,3,6-Trichlorophenol  
 3,4,5-Trichlorophenol  
 2,3,4,5-Tetrachlorophenol  
 2,3,4,6-Tetrachlorophenol  
 2,3,5,6-Tetrachlorophenol  
 Pentachlorophenol

Chlorinated Benzenes

1,2,3-Trichlorobenzene  
 1,3,5-Trichlorobenzene  
 1,2,3,4-Tetrachlorobenzene  
 1,2,3,5-Tetrachlorobenzene  
 Pentachlorobenzene  
Trace Elements

Aluminum  
 Antimony  
 Arsenic  
 Barium  
 Beryllium  
 Boron  
 Cadmium  
 Calcium  
 Chromium  
 Cobalt  
 Copper  
 Iron  
 Lead  
 Magnesium  
 Manganese  
 Molybdenum  
 Nickel  
 Selenium  
 Silicon  
 Silver  
 Sodium  
 Strontium  
 Thallium  
 Tin  
 Titanium  
 Vanadium  
 Zinc

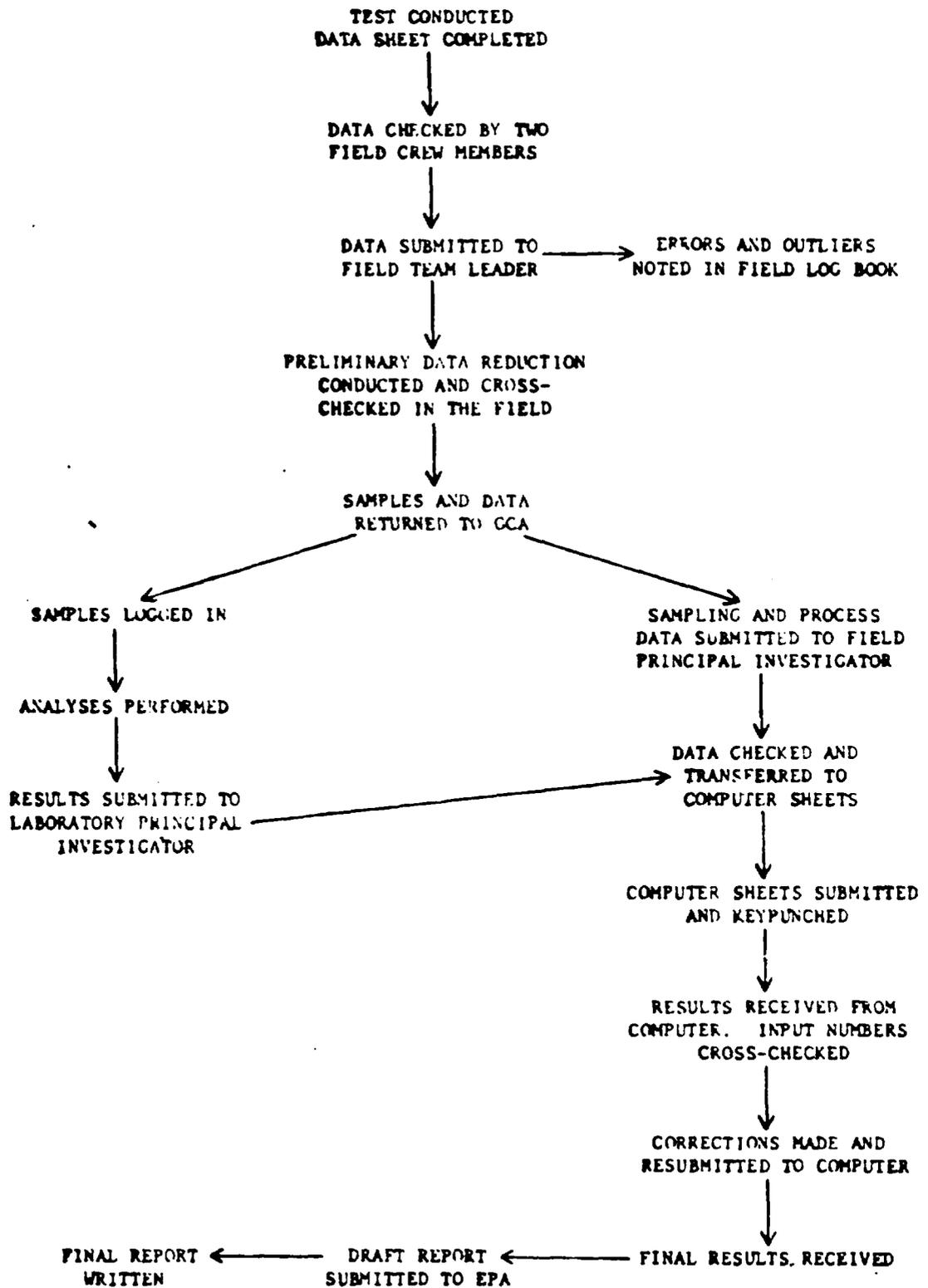


Figure 5-6. Data flow scheme.

HiVol Work Sheet

CCA # \_\_\_\_\_

1. Sample duration (min.) \_\_\_\_\_  $t_s$
2. Actual flow, initial (from graph) \_\_\_\_\_  $Q_1$
3. Actual flow, final (from graph) \_\_\_\_\_  $Q_f$
4. Initial barometric pressure (in. Hg) \_\_\_\_\_  $P_1$
5. Final barometric pressure (in. Hg) \_\_\_\_\_  $P_f$
6. Initial temperature ( $^{\circ}\text{C}$ ) \_\_\_\_\_  $T_1$
7. Final temperature ( $^{\circ}\text{C}$ ) \_\_\_\_\_  $T_f$
8.  $P_1 =$  \_\_\_\_\_ in. Hg  $\times 25.4 \text{ mm/in.} =$  \_\_\_\_\_ mm Hg
9.  $P_f =$  \_\_\_\_\_ in. Hg  $\times 25.4 \text{ mm/in.} =$  \_\_\_\_\_ mm Hg
10.  $T_1 =$  \_\_\_\_\_  $^{\circ}\text{C} + 273 =$  \_\_\_\_\_  $^{\circ}\text{K}$
11.  $T_f =$  \_\_\_\_\_  $^{\circ}\text{C} + 273 =$  \_\_\_\_\_  $^{\circ}\text{K}$

12. Standard flow rate ( $Q_{s1}$  and  $Q_{sf}$ )

$$Q_s = q \sqrt{\frac{298 \times P}{760 \times T}} \times 0.0283168 \text{ m}^3/\text{ft}^3 = \text{_____ m}^3/\text{min}$$

$$Q_{s1} = \text{_____ ft}^3/\text{min} \times 0.0177315^{\circ}\text{K} \times \text{m}^3/\text{mmHg} \times \text{ft}^3 \sqrt{\frac{\text{mmHg}}{\text{K}}} = \text{_____ m}^3/\text{min}$$

$$Q_{sf} = \text{_____ ft}^3/\text{min} \times 0.0177315 \sqrt{\frac{\text{mmHg}}{\text{K}}} = \text{_____ m}^3/\text{min}$$

13. Average Standard Flow ( $Q_{s\bar{x}}$ ):

$$Q_{s\bar{x}} = \frac{Q_{s1} + Q_{sf}}{2} = \frac{\text{_____} + \text{_____}}{2} = \text{_____ m}^3/\text{min}$$

14. Standard Volume:

$$V = Q_{s\bar{x}} \times t_s = \text{_____} \times \text{_____} = \text{_____ m}^3$$

Figure 5-7. Air volume calculations worksheet.

of all data will be maintained, even that judged to be an "outlying" or spurious value. The persons validating the data will have sufficient knowledge of the technical work to identify questionable values.

The following criteria will be used to evaluate the field sampling data:

- Use of approved test procedure
- Use of properly operating and calibrated equipment
- Use of materials that have passed QC checks

The criteria listed below will be used to evaluate the analytical data:

- Use of approved analytical procedure
- Use of properly operating and calibrated instrumentation
- Acceptable results from analyses of EPA QC samples (i.e., the reported values should fall within the EPA 95 percent confidence interval for these samples)
- Precision and accuracy achieved should be comparable to that achieved in previous PCB analytical programs

#### Identification and Treatment of Outliers

Any data point which deviates markedly from others in its set of measurements will be investigated; however, the suspected outlier will be recorded and retained in the data set while it is investigated. One or both of the following tests will be used to identify outliers.

Dixon's test for extreme observations<sup>4,5</sup> is an easily computed procedure for determining whether a single very large or very small value is consistent with the remaining data. The one-tailed t test for difference<sup>4</sup> may also be used in this case. Reference 4 contains calculation formats and tables of critical values for these tests. It should be noted that these tests are designed for testing a single value. If more than one outlier is suspected in the same set of data, other statistical sources will be consulted and the most appropriate test of hypothesis will be used.

Since an outlier may result from unique circumstances at the time of sample analysis or data collection, those persons involved in the analysis and data reduction will be consulted. This may provide an experimental reason for the outlier. Further statistical analyses will be performed with and without the outlier to determine its effect on the conclusions. In many cases, two data sets will be reported, one including and one excluding the outlier.

In summary, every effort will be made to include the outlying value in the reported data. If the value is rejected, it will be identified as an outlier, reported with its data set and its omission noted.

## DATA REPORTING

Figure 5-6 shows the field data reduction, validation and reporting process; Figure 5-8 depicts the analytical data reduction, validation and reporting process. Key personnel who will handle data gathering and evaluation are shown in Figure 1-1, the Project Organization Chart.

## INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

Quality control checks will be performed to ensure the collection of representative samples and the generation of valid analytical results on these samples. These checks will be performed by project participants throughout the program under the guidance of the QA Manager and the Field and Laboratory Department QC Coordinators.

### Sampling QC Procedures

GCA's QC program for the sampling aspects of this program will include the following:

1. Daily calibration check of High Volume Samplers; recalibrate if not within  $\pm 6$  percent of calibration curve.
2. Field-biased blanks of collection media.
3. Co-located high volume samplers.

### Analytical QC Procedures

GCA's Quality Control program for laboratory analysis makes use of a number of different types of QC samples to document the validity of the generated data. The following types of QC samples are used routinely:

1. Blank Samples
  - a. Field-Biased Blanks--Blank samples which have been exposed to field and sampling conditions in order to assess possible contamination from the field.
  - b. Method Blanks--Blanks which are processed through the sample preparation procedures to account for contamination introduced in the laboratory.
  - c. Calibration Blanks--Blanks used in instrument calibration; these blanks contain the reagents used in preparing instrument calibration standards except the parameters of interest.
2. Duplicate Samples--A second aliquot of a sample carried through all sample preparation and analysis procedures to verify the precision of the analytical method.

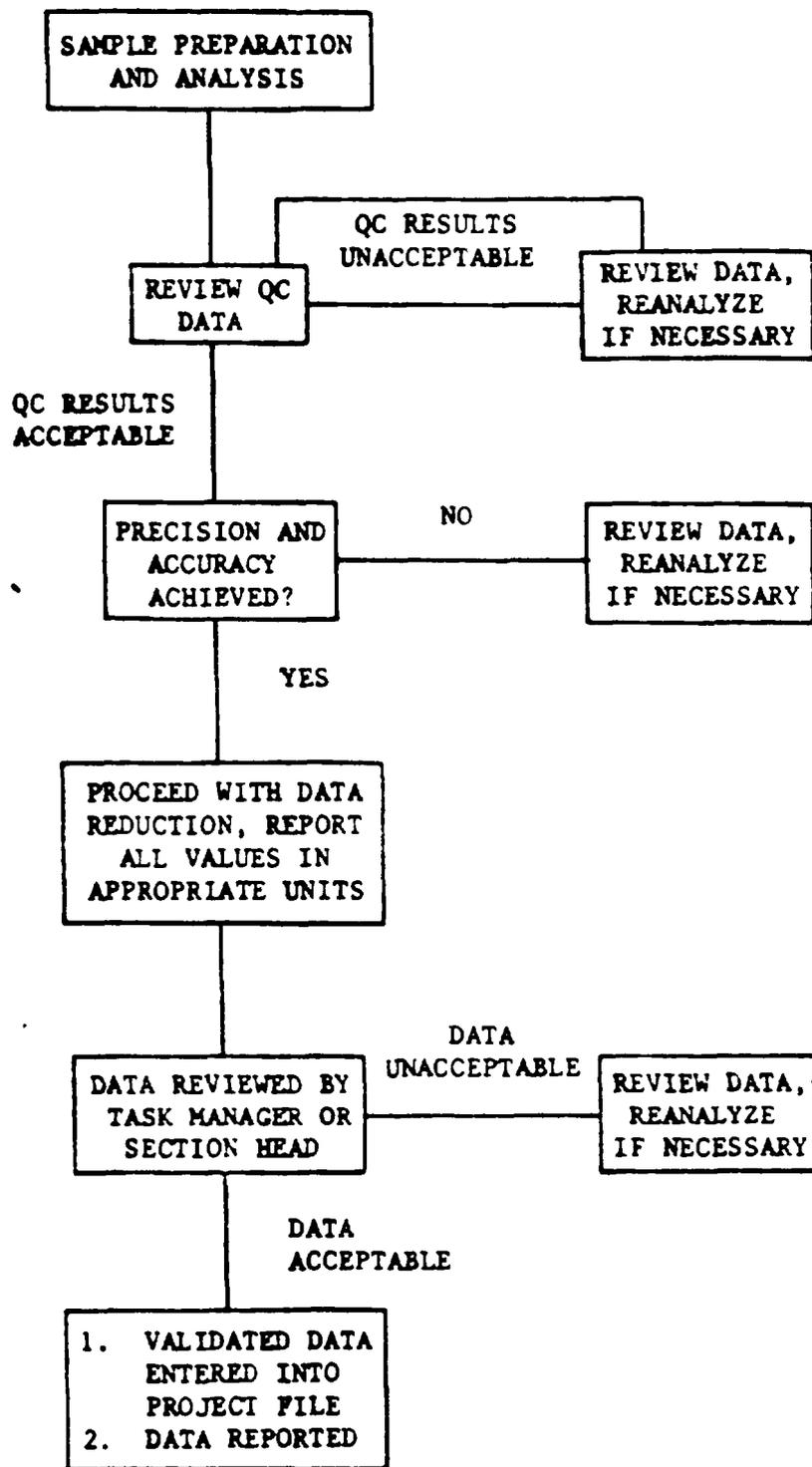


Figure 5-8. GCA analytical data reporting scheme.

3. Spiked Samples. Samples will be spiked with the parameters of interest at a level two to three times the method detection limit. Samples requiring organic analyses are routinely surrogate spiked with an appropriate deuterated analogue.

Specific quality control protocols for this analysis will include the following:

- Analysis of PUF and filter samples spiked with the parameters of interest.
- Analysis of duplicate PUF and filter.

The duplicate and spiked samples will be submitted both as known QC samples, termed laboratory control samples (LCS), or "blind" QC samples, those which are not recognizable to the analyst. LCS are routinely used to ensure that the analytical process is in control. The type and frequency of use of each of these QC measures is summarized below.

- Instrument QC Checks and Frequency
  - daily calibration
  - analyze LCS daily before sample analysis; reported values must be within established control limits.
  - analyze a calibration check sample after every 10 samples; reported value must be within 5 percent of original value.
- Preparation and Analysis Procedure QC Checks and Frequency
  - method blank with each group of 20 or fewer samples
  - laboratory control sample and duplicate with each group of 20 or fewer samples.
  - "blind" quality control sample with each group of samples received.

Reagents used in the laboratory are normally of analytical reagent grade or higher purity; each lot of acid or solvent used is checked for acceptability prior to lab use. All reagents are labeled with the date received and date opened. The quality of the laboratory deionized water is routinely checked.

#### QUALITY ASSURANCE PERFORMANCE AUDITS, SYSTEM AUDITS AND FREQUENCY

GCA/Technology Division's quality assurance program includes both performance and system audits as independent checks of the quality of data obtained from sampling, analysis, and data gathering activities. Every effort is made to have the audit assess the measurement process in normal operation. Either type of audit may show the need for corrective action.

### Performance Audits

The sampling, analysis, and data handling segments of a project are checked in performance audits. A different operator/analyst performs these audit operations to ensure the independence of the quantitative results.

EPA Quality Control concentrates and NBS Standard Reference Materials will be used to assess the analytical work. The Laboratory QC Coordinator will direct the inclusion in the sample load of QC samples appropriate to the analyses performed in each batch of 20 or fewer samples so that they are not recognizable to the analyst. In addition, any appropriate interlaboratory study samples which are available during this program will be analyzed to further audit the analytical work.

### System Audits

A system audit will be conducted by the Division QA Manager at least once during the program to ensure that the elements outlined in the Project QA Plan are functioning.

### External Audits

GCA will cooperate fully in any performance or system audits conducted or arranged by EPA. The QA Manager and Department QC Coordinators are available to aid in scheduling such audits.

### PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

GCA/Technology Division follows an orderly program of positive actions to prevent the failure of equipment or instruments during use. This preventive maintenance and careful calibration helps to assure accurate measurements from field and laboratory instruments.

The High Volume Samplers will be maintained as recommended in EPA's Handbook for Air Pollution Measurement Systems, Volume 2, Section 2.2.7. In the analytical laboratories routine maintenance procedures are followed for glassware, water supply, reagents, and analytical balances. These procedures are contained in GCA's Analytical QC Manual. Table 5-3 summarizes maintenance procedures and their frequency for the major laboratory instrumentation to be used in this program .

### SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY AND COMPLETENESS

#### Precision

Precision will be determined by the collection and analysis of replicate samples. The analysis of the replicate samples collected by the co-located samplers will provide an estimate of overall measurement precision. The analysis of laboratory duplicates (replicate aliquots from one collected sample) will enable the estimation of analytical precision.

TABLE 5-3. MAINTENANCE PROCEDURES AND SCHEDULE FOR MAJOR INSTRUMENTATION

Instrument	Maintenance procedure/schedule	Spare parts
Jarell-Ash Model 855 Inductively Coupled Plasma Spectrometer	<ol style="list-style-type: none"> <li>1. Clean optical surfaces--weekly or as needed.</li> <li>2. Clean torch assembly when discolored or after 8 hr of running high dissolved solids samples.</li> </ol>	Spare torch.
Perkin-Elmer 3920B Gas Chromatograph with Ni <sup>63</sup> Detector	<ol style="list-style-type: none"> <li>1. Change septa daily.</li> <li>2. Check syringe for burrs daily.</li> <li>3. Change gas line dryers quarterly.</li> <li>4. Leak check when installing new analytical column.</li> <li>5. Periodically check inlet system for residue buildup.</li> </ol>	<ol style="list-style-type: none"> <li>1. 10 <math>\mu</math>l syringes</li> <li>2. Inlet septa</li> </ol>
Hewlett-Packard 5985 or 5993 GC/MS	<ol style="list-style-type: none"> <li>1. Replace pump oils annually.</li> <li>2. Change septa daily.</li> <li>3. Change gas line dryers quarterly.</li> <li>4. Replace Electron Multipliers as needed.</li> </ol>	<ol style="list-style-type: none"> <li>1. Syringes</li> <li>2. Septa</li> </ol>
Analytical Balances Mettler (various models)	<ol style="list-style-type: none"> <li>1. Check with Class S weights before each use.</li> <li>2. Clean spills immediately.</li> <li>3. Service (cleaning and calibration) annually.</li> </ol>	1. Light bulbs

Precision will be determined by the collection and analysis of replicate samples and will be expressed as the standard deviation,  $s$ , which is determined according to the following equation:

$$S = \sqrt{\frac{\sum_{i=1}^N X_i^2 - \frac{1}{N} \left( \sum_{i=1}^N X_i \right)^2}{N-1}}$$

where  $S$  = standard deviation

$X_i$  = individual measurement result

$N$  = number of measurements

Relative standard deviation may also be reported. If so, it will be calculated as follows:

$$RSD = 100 \left( \frac{S}{\bar{X}} \right)$$

where  $RSD$  = relative standard deviation, expressed in percent

$S$  = standard deviation

$\bar{X}$  = arithmetic mean of replicate measurements

#### Accuracy

Accuracy will be estimated from the analysis of "blind" QC samples whose true values are known to the Laboratory QC Coordinator. Accuracy will be expressed as percent recovery or as relative error. The formulas to calculate these values are:

$$\text{Percent Recovery} = 100 \frac{\text{Measured Value}}{\text{True Value}}$$

$$\text{Relative Error} = 100 \frac{\text{Measured Value} - \text{True Value}}{\text{True Value}}$$

#### Completeness

Completeness will be reported as the percentage of all measurements made whose results are judged to be valid. The procedures to be used for validating data and determining of outliers were described earlier in this QA Plan. The following formula will be used to estimate completeness:

$$C = 100 \left( \frac{V}{T} \right)$$

ere C = percent completeness

V = number of measurements judged valid

T = total number of measurements

#### CORRECTIVE ACTION

The acceptance limits for the sampling and analyses to be conducted in this program will be those stated in the method or defined by EPA's Project Officer. The corrective actions are likely to be immediate in nature and most often will be implemented by the analyst or Project Manager; the corrective action will usually involve recalculation, reanalysis, or repeating a sample collection run. GCA's ongoing corrective action policy is described here.

#### Immediate Corrective Action

Specific QC procedures and checklists are designed to help analysts detect the need for corrective action. Often the person's experience will be more valuable in alerting the operator to suspicious data or malfunctioning equipment.

If a corrective action can be taken at this point, as part of normal operating procedures, the collection of poor quality data can be avoided. Instrument and equipment malfunctions are amenable to this type of action and GCA's QC procedures include troubleshooting guides and corrective action actions. The actions taken should be noted in field or laboratory books but no other formal documentation is required, unless further corrective action is necessary. These on-the-spot corrective actions are an everyday part of the QA/QC system.

Corrective action during the field sampling portion of a program is most often a result of equipment failure or an operator oversight and may require repeating a run. When equipment is discovered to be defective (i.e., pre- and post-sampling leak check) it is repaired or replaced and a correction factor is established as per the EPA method. If a correction factor is unacceptable, the run is repeated. Operator oversight is best avoided by having field crew members audit each others work before and after a test. Every effort is made by the field team leader to ensure that all QC procedures are followed. Economically, it is preferred to repeat a run during a particular field trip rather than return at a later date.

Corrective action for analytical work would include recalibration of instruments, reanalysis of known QC samples and, if necessary, of actual field samples.

If the problem is not solved in this way, more formalized long-term corrective action may be necessary.

### Long-Term Corrective Action

The need for this action may be identified by standard QC procedures, control charts, performance or system audits. Any quality problem which cannot be solved by immediate corrective action falls into the long-term category. GCA uses a system to ensure that the condition is reported to a person responsible for correcting it who is part of the closed-loop action and follow-up plan. It is patterned after the system described in Reference 4.

The essential steps in the closed-loop corrective action system are:

- Identify and define the problem.
- Assign responsibility for investigating the problem.
- Investigate and determine the cause of the problem.
- Determine a corrective action to eliminate the problem.
- Assign and accept responsibility for implementing the corrective action.
- Establish effectiveness of the corrective action and implement it.
- Verify that the corrective action has eliminated the problem.

Documentation of the problem is important to the system. A Corrective Action Request Form (shown in Figure 5-9) is filled out by the person finding the quality problem. This form identifies the problem, possible causes and the person responsible for action on the problem. The responsible person may be an analyst, field team leader, department QC coordinator or the QA Manager. If no person is identified as responsible for action, the QA Manager investigates the situation and determines who is responsible in each case.

The Corrective Action Request Form includes a description of the corrective action planned and the date it was taken, and space for follow-up. The QA Manager checks to be sure that initial action has been taken and appears effective and, at an appropriate later date, checks again to see if the problem has been fully solved. The QA Manager receives a copy of all Corrective Action Forms and then enters them in the Corrective Action Log. This permanent record aids the QA Manager in follow-up and makes any quality problems visible to management; the log may also prove valuable in listing a similar problem and its solution.

### QUALITY ASSURANCE REPORTS TO MANAGEMENT

#### Internal Reports

The Analytical Laboratory QC Coordinator and the Environmental Measurements Department QC Coordinator prepare written monthly reports on QC activities for their Department Manager and the Division QA Manager. These

CORRECTIVE ACTION REQUEST FORM NO. \_\_\_\_\_

Originator \_\_\_\_\_ Date \_\_\_\_\_

Person Responsible for Replying \_\_\_\_\_ Contract Involved \_\_\_\_\_

Description of problem and when identified: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

State cause of problem, if known or suspected: \_\_\_\_\_

\_\_\_\_\_

Sequence of Corrective Action: (If no responsible person is identified, bring this form directly to QA Manager.)

State Date, Person, and Action Planned:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

CA Initially Approved By: \_\_\_\_\_ Date: \_\_\_\_\_

Follow-up Dates \_\_\_\_\_

Final CA Approval By: \_\_\_\_\_ Date: \_\_\_\_\_

Information copies to:

RESPONSIBLE PERSON: \_\_\_\_\_

QA MANAGER: \_\_\_\_\_

DEPARTMENT MANAGER: \_\_\_\_\_

Figure 5-9. Corrective action request form.

reports detail the results of quality control procedures, problems encountered and any corrective action which may have been required.

All Corrective Action Forms are submitted to the QA Manager for initial approval of the corrective action planned and a copy is provided to the department manager. All system audit reports are provided to the project manager, department manager and the Technology Division General Manager.

#### Reports to EPA

Each monthly report will contain a summary of QC activities; this summary will include:

- Estimates of precision, accuracy and completeness of reported data
- Quality problems found
- Corrective actions taken

The final report will include a section summarizing QA/QC activities during the program. The Laboratory and Environmental Measurements QC Coordinators and the Division QA Manager will participate in preparing this section.

#### REFERENCES

1. Reference Method for the Determination of Suspended Particulates in the Atmosphere (High Volume Method) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II--Ambient Air Specific Methods, EPA-600/4-77-027a, Research Triangle Park, North Carolina, 1977.
2. A Method for Sampling and Analysis of Polychlorinated Biphenyls (PCBs) in Ambient Air, EPA-600/4-78-048, August 1978.
3. Quality Assurance Plan, Love Canal Study, Appendix A, Sampling Procedures, GCA/Technology Division, August 1980.
4. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 1 - Principles, EPA-600/9-76-005, Research Triangle Park, North Carolina. 1976.
5. Dixon, W. J., Processing Data for Outliers, Biometrics, 9(1): 74-89, 1953.