Combined work/quality assurance project plan (CW/QAPP) revision 1

for

Fish and Shellfish Monitoring: 1998 - 2001

Massachusetts Water Resources Authority

Environmental Quality Department
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COMBINED WORK/QUALITY ASSURANCE PROJECT PLAN (CW/QAPP) REVISION 1

for

Fish and Shellfish Monitoring: 1998 - 2001

Tasks 21, 22, 23, 24 and 25

MWRA Harbor and Outfall Monitoring Project
Contract No. S274

Submitted to

Massachusetts Water Resources Authority
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Report No. MS-49 Revision 1

COMBINED WORK/QUALITY ASSURANCE PROJECT PLAN (CW/QAPP) REVISION 1

for

FISH AND SHELLFISH MONITORING: 1998 - 2001

MWRA Harbor and Outfall Monitoring Project
Contract No. S274

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1.0 PROJECT NAME

Fish and Shellfish Monitoring (1998 – 2001)
Tasks 21, 22, 23, 24, and 25
MWRA Harbor and Outfall Monitoring Project

2.0 PROJECT REQUESTED BY

Massachusetts Water Resources Authority

3.0 DATE OF REQUEST

November 5, 1997

4.0 DATE OF PROJECT INITIATION

November 5, 1997

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7.0 PROJECT DESCRIPTION

7.1 Objective and Scope

The Massachusetts Water Resources Authority (MWRA) is continuing a long-term biomonitoring program for fish and shellfish (MWRA, 1991) for the MWRA effluent outfall that is located in Massachusetts Bay (see Figures 1 through 3). The goal of the biomonitoring is to provide data that may be used to assess potential environmental impact of effluent discharge into Massachusetts Bay. This data will be used to evaluate compliance with the NPDES discharge permit and to ensure that discharge from the new outfall does not result in adverse impacts by comparing values with established thresholds (MWRA 1997a).

The overall objective of the fish and shellfish monitoring is to define the condition of fish and shellfish health in terms of the presence of disease (external and internal), and organic and inorganic (metal) contaminant concentrations in the liver (winter flounder), hepatopancreas (lobster), and edible tissue (winter flounder, lobster and mussel) of these selected organisms. To help determine the body burden of toxic substances and to assess the physiological status of winter flounder *(Pseudopleuronectes americanus)* and lobster *(Homarus americanus),* one survey per species will be conducted in Boston Harbor, Massachusetts Bay, and Cape Cod Bay (hereafter: Boston Harbor and the Bays) during 1998 through 2001 to collect specimens for analysis. To determine body burden and physiological status of blue mussel *(Mytilus edulis)*, arrays of mussels will be deployed in Boston Harbor and the Bays and collected in 1998 through 2001. With effluent discharge beginning in September 2000, results from these monitoring activities occurring post-2000 should alert MWRA to potential changes resulting from the relocation of the outfall discharge. The MWRA (1997a) developed a Contingency Plan that specifies numerical or qualitative thresholds that may suggest that environmental conditions in the Bay may be changing or might be likely to change. The Plan provides a mechanism to confirm that a threshold has been exceeded, to determine the causes and significance of the event, and to identify the action necessary to return the trigger parameter to a level below the threshold (if the change resulted from effluent discharge). Fish and shellfish thresholds have been established for tissue contaminant concentrations (organic and inorganic) and liver disease incidence (MWRA 1997a, MWRA in prep). Specific objectives for each of the five tasks included in this program are described in Sections 7.1.1 through 7.1.5.

This Combined Work/Quality Assurance Project Plan (CW/QAPP) presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the Fish and Shellfish Monitoring that will be conducted under Tasks 21 through 25 of the MWRA Harbor and Outfall Monitoring Program (Contract S274). This document also describes the specific protocols that will be followed for sampling, sample handling and storage, chain of custody, and laboratory and field analyses. The CW/QAPP was prepared in accordance with EPA guidance documents on CW/QAPP-preparation (EPA 1984, 1988) and is based on the CW/QAPP produced previously under the contract between MWRA and Battelle (Lefkovitz *et al*, 1998). Separate survey plans developed for each survey will supplement the CW/QAPP. The survey plans will provide the operational details required to conduct each survey, and will describe participating staff, schedule details, and specific equipment.

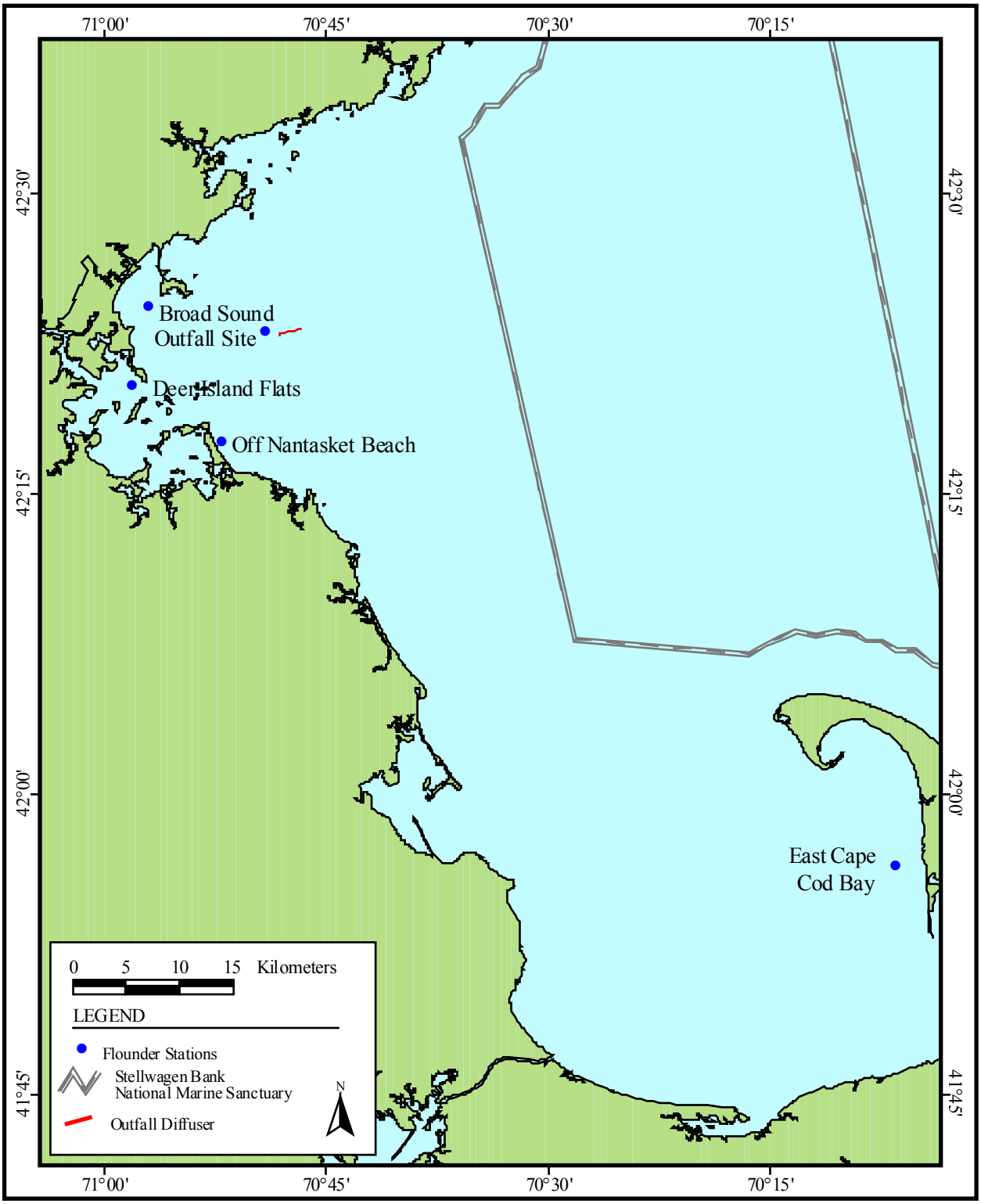

Figure 1. Flounder Monitoring Locations.

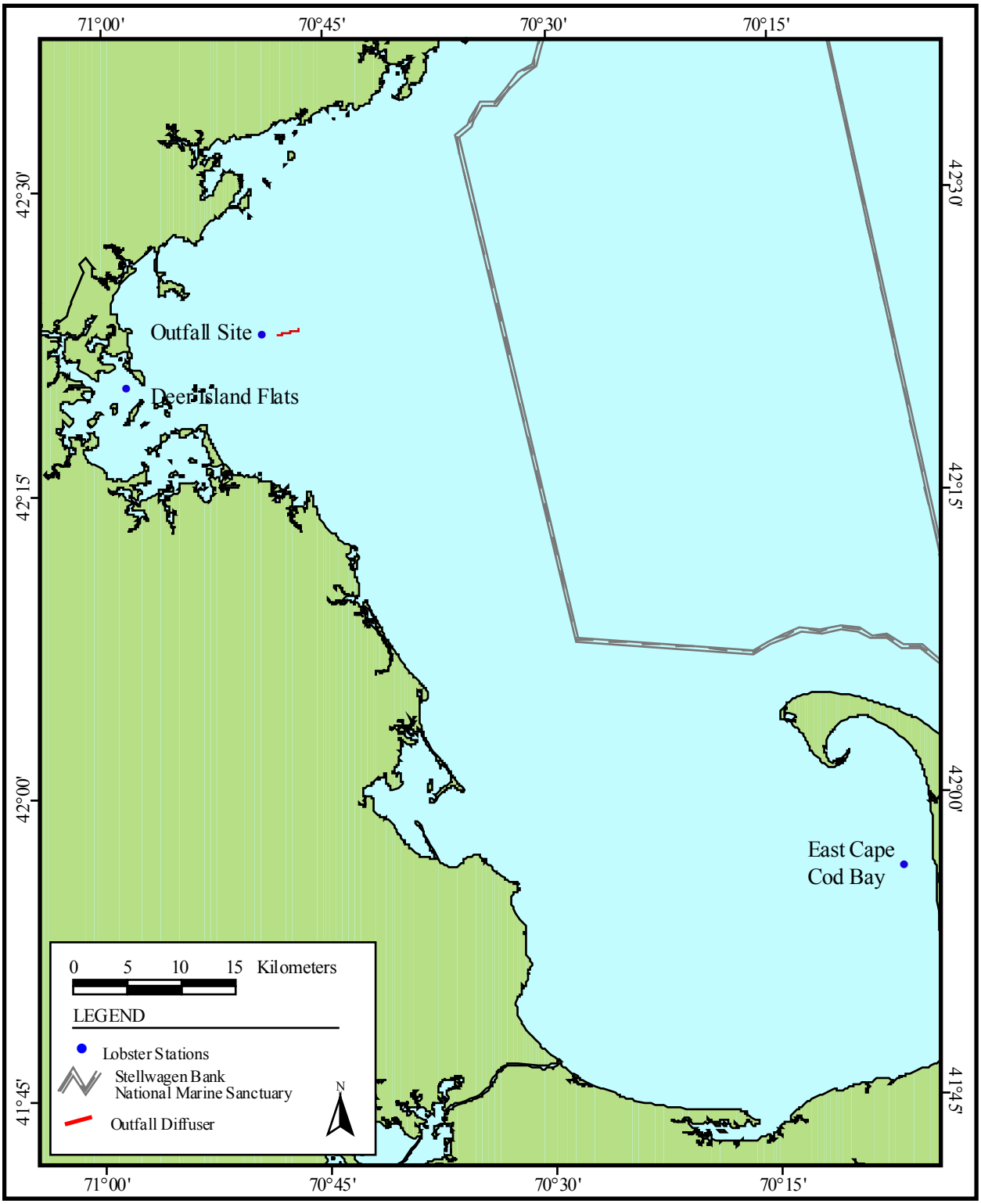

Figure 2. Lobster Monitoring Locations.

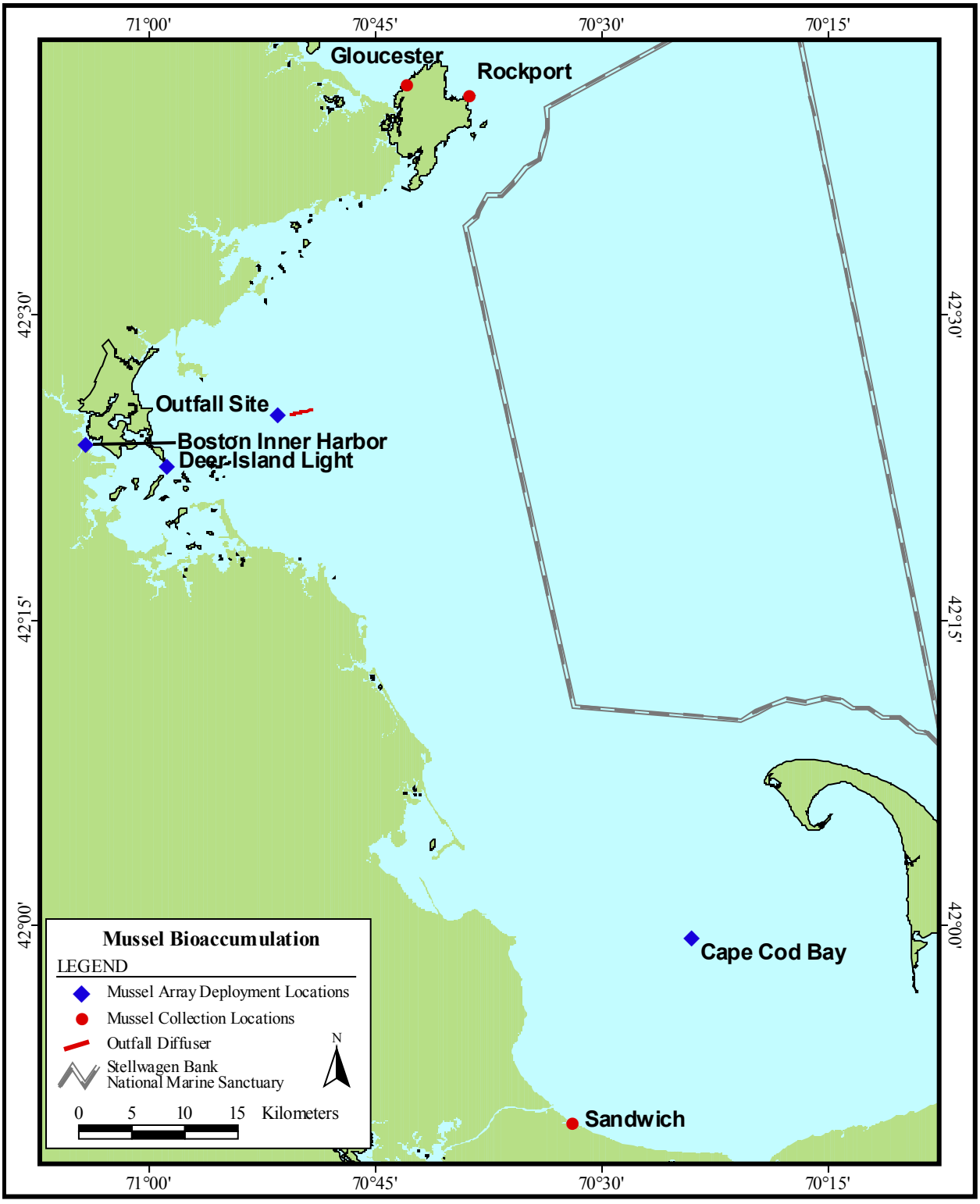

Figure 3. Mussel Collection and Deployment Locations.

7.1.1 Flounder Survey (Task 21)

The objective of the survey is to obtain specimens of winter flounder *(Pseudopleuronectes americanus)* from five sampling sites in Boston Harbor and the Bays for gross examination, histology, aging, and chemical analyses of tissue to determine sublethal effects of contaminant exposure and tissue burden. Specimens will be collected during surveys conducted in April 1998, 1999, 2000, and 2001. Data generated will be evaluated against established thresholds.

7.1.2 Lobster Survey (Task 22)

The objective of the survey is to obtain specimens of lobster *(Homarus americanus)* from three sampling sites in Boston Harbor and the Bays for gross examination and chemical analyses of tissues to determine health and tissue burden of contaminants. Specimens will be collected during surveys conducted in July 1998, 1999, 2000, and 2001.

7.1.3 Mussel Bioaccumulation Survey (Task 23)

The objectives of the survey are to obtain, deploy, and recover blue mussels *(Mytilus edulis)* for determination of biological condition and short-term accumulation of anthropogenic contaminants in soft tissues and to evaluate NPDES permit conditions for bioaccumulatable compounds. Caged mussel arrays will be deployed at four locations in Boston Harbor and the Bays. Specimens will be collected during surveys conducted in June-August 1998, 1999, 2000, and 2001.

7.1.4 Tissue Chemical Analyses (Task 24)

The objective of tissue chemical analyses is to determine the body burdens of toxic substances and potential elevations of these body burdens caused by relocation of the outfall. These observations will be made by measuring the concentrations of lipids and organic and inorganic (metal) substances in flounder, lobster, and mussels collected under Tasks 21-23. Data generated will be evaluated against established thresholds.

7.1.5 Flounder Histological and Mussel Condition Analysis (Task 25)

The objective of the histological analysis is to assess the health of the flounder populations in Boston Harbor and the Bays by performing microscopic examinations of tissue sections of the flounders' livers collected under Task 21. The bioeffects of contaminant exposure on the various flounder populations will be determined based on the prevalence and severity of various lesions in the tissues. The objective of the aging analysis is to determine the age composition of the specimens that are examined for histological and chemical analysis.

The objective of the mussel condition analysis is to determine the physiological and reproductive status of mussels deployed in Boston Harbor and the Bays and to determine if discharge causes unacceptable changes in status. Mussel condition will be performed at the discretion of the MWRA. This will be determined prior to mussel collection and deployment. Adequate amounts of mussels must be collected to perform both chemical analyses and mussel condition analysis.

7.2 Data Usage

7.2.1 Tissue Chemical Analyses (Task 24)

Chemistry data will be used to determine the concentrations of organic and inorganic (metals) contaminants in flounder liver, lobster hepatopancreas, and flounder, lobster, and mussel edible tissue (fillet; claw and tail meat; and meat respectively) prior to the relocation of the existing discharge of any effluent and during actual effluent discharge. The contaminant concentrations will also be related to any histological lesions observed or indices of physiological condition.

Results of these analyses will be used to evaluate the impact of discharging effluent into Massachusetts Bay, the recovery of Boston Harbor, and the impact of relocating the effluent on fish and shellfish. Chemical results collected after outfall relocation will be also be compared to caution and warning threshold values (MWRA in prep) to determine if the outfall relocation is causing accumulation of toxic substances in exceedence of human health criteria or unacceptable changes in liver condition of flounder.

Table 1. Summary of Trigger Parameters and Thresholds for Toxic Contaminants[1].

Toxic Contaminants			
Parameter Type/Location	**Parameter**	**Caution Level**	**Warning Level**

[1]NOTE: Table 1 is intentionally blank.

7.2.2 Flounder Histological and Mussel Condition Analysis (Task 25)

Histological data will be used to assess the sublethal effects of contaminant exposure and tissue burden of the flounder populations in the Boston Harbor and Bay areas prior to the relocation of the existing effluent discharge and during actual discharge. Age data will be used to determine the age of the adult population of winter flounder in the sampling areas prior to the discharge of the effluent. When measured, mussel condition (growth and reproductive) will be used to assess the biomarkers of contaminant impacts on mussel populations in the Boston Harbor and Bay areas prior to the relocation of the existing effluent discharge and during actual discharge.

Histological results collected after outfall relocation will be compared to baseline measurements and to threshold values (MWRA in prep) to determine if the outfall relocation has had a measurable effect on the health of these organisms.

7.3 Technical Approach

7.3.1 Flounder Surveys (Task 21)

A three-day flounder survey will be conducted annually during April 1998, 1999, 2000, and 2001. A Survey Plan will be prepared for each of the annual surveys. The Survey Plan will detail sampling dates, locations, vessel, personnel, any deviations from the CW/QAPP, and general survey operations. These plans will be delivered to MWRA no later than two weeks before the start of each survey.

Five sites will be sampled during each annual survey to collect winter flounder for histological and chemical analyses (Figure 1):

- Deer Island Flats (Boston Harbor),
- Off Nantasket Beach (chemical analyses in 1999 and 2001),
- Broad Sound (chemical analyses in 1999 and 2001),
- Outfall Site,
- East Cape Cod Bay.

Table 2 provides the sampling sites and locations, although there may be differences of 1 km or more between collection sites and the indicated position due to the trawling operations. Adjustments in location will be made to ensure that Flounder are captured.

At each of the five designated sampling sites, otter-trawl tows will be conducted to collect 50 sexually mature (4-5 years old) winter flounder. Each fish will be assigned a unique identification number to indicate the event, year, survey, and site of collection.

Fish destined for histological analysis only are killed at sea by cervical section and used for histological processing. These fish will be examined externally and their external condition will be noted prior to histological processing. The gross external condition of the flounder ("External Lesions") and fin rot will be subjectively scored on a scale of 0 to 4. The gonads of each flounder will be examined to determine sexual maturity. All specimens will be weighed, and standard and total length (Figure 6) will be determined by measuring fish length according to Battelle SOP 5-175-03. Scales will be taken from each specimen for age determination. In addition, the liver will be removed and examined for grossly visible abnormalities. The presence of gross lesions on the liver will be subjectively scored on a scale of 0 to 4 and recorded as "Gross Liver Lesion".

For stations where chemistry analyses are to be conducted, fifteen of the fifty fish will be randomly[1] selected for joint histological and chemical analysis. These fish will be placed alive on ice and transported to Battelle Duxbury Operations for on-shore processing for histological and chemical analysis. Fifteen unique sample identification numbers will be assigned to these fish, however, actual assignment of IDs to individual fish will not occur until the fish are sacrificed at the laboratory. At this time, these fish will also be examined externally, and their external condition will be noted (fin rot and external lesions).

Within 2 and 30 days after each flounder survey, a Survey Summary and Report, respectively, will be prepared and submitted to MWRA. The summary will contain a brief overview of the survey schedule, preliminary data summary, apparent violations of thresholds, and any deviations or problems encountered during the survey. The report will contain information on winter flounder collection operations, maps of actual survey tracks for each day of the survey, number of flounder collected, number of fish collected, any apparent violation of thresholds, and current status and disposition of histological and chemical samples. The report will detail any problems encountered or departures from stated protocols and their potential impacts on the program.

7.3.2 Lobster Survey (Task 22)

A lobster survey will be conducted annually during mid-July 1998, 1999, 2000, and 2001 or as soon as lobsters are available thereafter. A Survey Plan will be prepared for each of the annual surveys. The Survey Plan will detail sampling dates, locations, vessel, personnel, any deviations from the CW/QAPP, and general survey operations.

Three sites will be sampled to collect lobster for chemical analyses:

- Deer Island Flats (Boston Harbor),
- Outfall Site,
- East Cape Cod Bay.

[1]"Random" in the context of this document means not consciously choosing or excluding specific animals. It is not meant to imply that animals were selected using a random numbers program.

Table 2 provides the sampling sites and locations. Figure 2 illustrates the sampling locations in Boston Harbor and the Bays.

Table 2. Sampling and Locations for Flounder/Lobster/Mussel Surveys.

Station #	Sampling Site	Location		Survey Type		
		Latitude	Longitude	Flounder	Lobster	Mussel
1	Deer Island Flats (Boston Harbor)	42E20.4'	70E58.4'	*	*	
1M	Deer Island Light	42E20.4'	70E57.2'			*
2	Off Nantasket Beach	42E17.6'	70E52.2'	*		
3	Broad Sound	42E24.4'	70E57.2'	*		
4	Outfall Site	42E23.1'	70E49.3'	*	*	*
5	East Cape Cod Bay	41E56.2'	70E06.6'	*	*	
6	Boston Inner Harbor	42E21.5'	71E02.9'			*
7	Gloucester	42E40.2'	70E40.2'			R
8	Sandwich/Cape Cod	41E45.6'	70E28.5'			R
RP	Rockport	42E39.6'	70E35.7'			R
9	Cape Cod Bay	41E55.5'	70E20.0'			*
M7	Quincy Bay	42E17.3'	70E57.4'			*

* = Sampling Site for Survey
R = Reference Site for Collection of Mussels for Deployment During Bioaccumulation Survey This location will be determined by availability of mussels.

Fifteen commercially harvestable lobsters at each site will be purchased from commercial lobstermen. Individual lobsters retained for analysis will be assigned a unique identification number to indicate event, year, survey, and site of collection. The location of collection by a commercial lobsterman will be verified by the presence of a Battelle staff member during collection operations. Lobsters will be measured for carapace length and width (following SOP – 5-175-03) and gender determined. Lobster specimens will be visually examined and the condition noted (black gill, shell erosion, parasites and external tumors) on the lobster sample collection log. Processing of the hepatopancreas and edible tissue samples will be conducted in the laboratory.

Within 2 and 30 days after each lobster survey, a Survey Summary and Report, respectively will be prepared and submitted to MWRA. The summary will contain a brief overview of the survey schedule, preliminary data summary, and any deviations or problems encountered during the survey. Each report will contain information on lobster collection operations, the number of lobster collected, maps of the location of lobster pots, and current status and disposition of chemical samples. The report will detail any problems encountered or departures from stated protocols and their potential impacts on the program.

7.3.3 Mussel Bioaccumulation Survey (Task 23)

A mussel bioaccumulation survey will be conducted annually in June-August 1998, 1999, 2000, and 2001. A Survey Plan will be prepared for each of the annual surveys. The Survey Plan will detail sampling dates, locations, vessel, personnel, any deviations from the CW/QAPP, and general survey operations.

Each year, mussels will be collected from the reference sites (Rockport or Gloucester/Sandwich, depending on availability of mussels), and deployed and retrieved at four sites (at the discretion of MWRA):

- Deer Island Light (~2 m above bottom),
- Outfall Site - In vicinity of the effluent outfall, at a depth of 50-55 ft from surface, water depth ~ 30m (MLW),

- Boston Inner Harbor,
- Cape Cod Bay.

Table 2 provides the sampling sites and locations, although the exact location of the deployment may differ by 1 km (or more) from the indicated position. Figure 3 illustrates the sampling locations in Boston Harbor and Massachusetts Bay. Table 3 lists the minimum numbers of mussels that need to be collected from the reference site(s) and which will be deployed at each location. Note: If reference mussels are collected from Rockport, these mussels will be deployed and analyzed for both organics and metals. If reference mussels are collected from Gloucester and Sandwich, the Gloucester mussels will be deployed and analyzed for organics and the Sandwich mussels will be deployed and analyzed for metals.

Table 3. Minimum Number of Mussels to Collect and Deploy.

Site	Array	Organics	Metals
Reference Mussels (pre-deployment)		80	40
Boston Inner Harbor (40–day recovery)	1	80	40
Boston Inner Harbor (60–day recovery)	2	80	40
Boston Inner Harbor (extra)	3	80	40
Deer Island Light (40–day recovery)	1	80	40
Deer Island Light (60–day recovery)	2	80	40
Deer Island Light (extra)	3	80	40
Outfall Site (40–day recovery)	1	110	55
Outfall Site (60–day recovery)	2	110	55
Outfall Site (extra)	3	110	55
Outfall Site (extra)	4	110	55
Cape Cod Bay (40–day recovery)	1	110	55
Cape Cod Bay (60–day recovery)	2	110	55
Cape Cod Bay (extra)	3	110	55
Cape Cod Bay (extra)	4	110	55
Minimum required to Harvest		1440	720
10% additional for mortality		144	72
Total to be Harvested		1584	792

Mussels will be deployed in June in replicate arrays at four sites. Mussels will be retrieved on two occasions (i.e., partial deployment period; 40 day, and full deployment period; 60 day). Upon retrieval, a record of mortality will be made. Mussels will then be randomly split for examination of biological condition or frozen and set aside for chemical analysis.
Within 2 and 30 days after the final retrieval, a Survey Summary and Report, respectively, will be prepared and submitted to MWRA. The summary will contain a brief overview of the survey schedule, preliminary data summary, and any deviations or problems encountered during the survey. Each report will contain information on mussel deployment and collection operations, maps indicating locations of mussel arrays, number of mussel collected during mid-deployment and full deployment sampling, and current status and

disposition of biological and chemical samples. The report will detail any problems encountered or departures from stated protocols and their potential impacts on the program.

7.3.4 Tissue Chemical Analysis (Task 24)

Chemical analysis will be performed on composite samples of flounder, lobster, and mussel tissue. Composite samples will be prepared through random selection of samples and homogenization of tissue. Table 4 lists the types and numbers of tissue samples to be collected during each survey and the chemical analyses to be performed. The following number of samples will be prepared and used for chemical analysis.

Flounder - Chemical analyses will be performed on samples from three sites in 1998, 2000, and 2001 (Deer Island Flats, Outfall Site, and Cape Cod Bay), and for all sites in 1999. Three groups of 5 individual fish each will be pooled from the 15 collected to create three pooled samples per site. Two tissue types (fillet, liver) are to be analyzed. This will result in 30 pooled samples (3 pools x 5 sites x 2 tissue types) in 1999 and 18 pooled samples in 1998, 2000, and 2001. The same fish will be composited for both liver and fillet chemistry to ensure comparability. The additional flounder samples collected in 1998, 2000, and 2001 from Nantasket Beach and Broad Sound will be frozen and archived. The chemical analyses to be performed on sample and tissue types are indicated in Table 4.

Lobster – Three groups of 5 commercially marketable lobsters each will be pooled from the 15 collected to create 3 pooled samples per site. Two tissue types are to be analyzed per site (claw and tail meat, hepatopancreas), resulting in 18 pooled samples (3 pools x 3 sites x 2 tissue types). The chemical analyses to be performed on sample and tissue types are indicated in Table 4.

Mussels – Pre-deployed mussels will be analyzed for organic and inorganic parameters. For organic analyses of deployed mussels, ten mussels will be pooled from each site to create either 5 or 8 pooled samples per site, depending on the original number of mussels deployed. For inorganics (Hg and Pb) of deployed mussels, 5 mussels will be pooled from each site to create either 5 or 8 pooled samples per site, depending on the original number of mussels deployed. This results in 36 pooled samples (5 pools of pre-exposed mussels + 5 pools x 3 sites + 8 pools x 2 sites) for both organic and inorganic analyses. The chemical analyses to be performed on mussel samples are indicated in Table 4.

Table 4. Summary of Chemistry Parameters to be Measured by Organism.

Sample Type	Number of Samples	Metals (other than Hg and Pb)	Hg	Pb	PCBs	PAHs	Pesticides	Lipids
Flounder Meat	9[1]		*		*		*	*
Flounder Liver	9[1]	*	*	*	*	*	*	*
Lobster Meat	9		*		*		*	*
Lobster Hepatopancreas	9	*	*	*	*	*	*	*
Mussel Tissue								
Organic	36				*	*	*	*
Inorganic	36		*	*				

[1]- 15 samples during the 1999 survey.

7.3.5 Flounder Histological and Mussel Condition Analysis (Task 25)

Flounder Histology – The fifty flounder from each of the 5 sampling sites will be analyzed for the suite of histological analyses. One section, 5 μm thick, from each of three transversely cut portions of livers from each flounder collected at each of the 5 sites during each survey will be examined histologically. A total of 250 slides each containing 3 liver sections, will be prepared and examined each year (1998, 1999, 2000, 2001). Lesions to be scored include vacuolation (tubular hydropic, centrotubular, focal hydropic), macrophage aggregation, biliary duct proliferation, neoplasia and apoptotic lesions.

The age of each specimen will be determined by reading the number of annuli on a scale from that specimen.

Mussel Condition Analysis – At least thirty mussels will be selected from each of the sites and analyzed for the following parameters: shell length, shell weight, total tissue weight (wet and dry), gonadal tissue weight (wet and dry), and survival. From these analyses, two condition factors (gonad condition index and condition index) will be calculated (SOP 5-031).

7.4 Monitoring Parameters, Collection Frequency and Sample Collection Requirements

Table 4 summarizes the primary chemical parameters that will be measured for each organism or sample type (Task 24). Table 5 summarizes the number of organisms and the types of analyses that will be conducted on samples collected from each station as well as the sample container and preservation requirements. Table 6 lists the specific analytes that will be measured.

8.0 PROJECT FISCAL INFORMATION

This project is being carried out under the Harbor and Outfall Monitoring contract (Contract No. S274) between MWRA and Battelle.

9.0 SCHEDULE OF ACTIVITIES AND DELIVERABLES

The schedule of activities and deliverables for this project is tied to survey activities. Table 7 provides the 1998 - 2001 planned schedule for all survey plans, survey cruises, survey reports, and data reports required for Tasks 21, 22, 23, 24, and 25.

The deliverables for Tasks 21, 22, 23, 24, and 25 are survey plans and survey reports for each of the three surveys. Data synthesis will occur under Task 33. Draft and final Annual Fish and Shellfish Reports will be prepared for each year. The due dates for the data reports are shown in Table 7.

Table 5. Monitoring Parameters, Collection Frequency, Sample Containers and Preservation Requirements.

Organism	Parameter	Numbers of Sampling Units Total[a]/Sample[b]	Container	Shipboard or Laboratory Processing/Preservation	Holding Time from Collection
Winter flounder	Chemistry - liver - edible tissue	 15/3 15/3	Clean, labeled jar; Glass	Laboratory: Freeze, if not processed immediately	Organics: One year Hg: 28 days Inorganics: 6 months
	Histology	50/50	Clean, labeled jar	Laboratory, Shipboard: 10% neutral buffered formalin	NA
	Age (scales)	50/50	Age envelope	Shipboard: Clean mucous from sampling area of fish before taking scales	NA
	Visual	50/50	N/A	Shipboard: Describe qualitatively	NA
	Biometrics - weight - standard length - total length - sex	50/50	N/A	Shipboard: Describe quantitatively	NA
Lobster	Chemistry - hepatopancreas - edible tissue	 15/3 15/3	Clean, labeled jar; Glass	Laboratory: Freeze, if not processed immediately	Organics: One year Hg: 28 days Inorganics: 6 months
	Visual	15/15	N/A	Shipboard: Describe qualitatively	NA
	Biometrics - weight - carapace length - sex	15/15	N/A	Laboratory: Process immediately	NA
Mussel	Chemistry - soft tissue	50/5, 80/8[c] or 25/5, 40/8[c]	Clean, labeled jar; Glass	Laboratory: Freeze if not processed immediately	Organics: One year Hg: 28 days Inorganics: 6 months
	Biometrics - shell length and weight - shell volume - total tissue wt (wet/dry) - gonadal tissue wt (wet/dry) - condition index - gonad condition index - survival	30/30	Clean, labeled container	Laboratory: Process immediately	NA

a = total individual specimens collected per station.
b = total pooled (composite) samples to be analyzed per station.
c = total mussel numbers for Outfall and Cape Cod Bay stations only.

Table 6. Specific Chemical Analytes Included in Tissue Chemistry Analyses.

Chemical Analytes	
Trace Metals[a]	**Polynuclear Aromatic Hydrocarbons (PAHs)** (continued)
Ag Silver	C_1-Phenanthrenes/anthracene
Cd Cadmium	C_2-Phenanthrenes/anthracene
Cr Chromium	C_3-Phenanthrenes/anthracene
Cu Copper	C_4-Phenanthrenes/anthracene
Hg Mercury[b,e]	Dibenzothiophene
Ni Nickel	C_1-dibenzothiophenes
Pb Lead[e]	C_2-dibenzothiophenes
Zn Zinc	C_3-dibenzothiophenes
Polychlorinated biphenyls (PCBs)[c,d]	Fluoranthene
2,4'-Cl_2(8)	Pyrene
2,2N,5-Cl_3(18)	C_1-fluoranthenes/pyrene
2,4,4N-Cl_3(28)	C_2-fluoranthenes/pyrene
2,2N,3,5N-Cl_4(44)	C_3-fluoranthenes/pyrene
2,2N,5,5N-Cl_4(52)	Benzo[*a*]anthracene
2,3N,4,4N-Cl_4(66)	Chrysene
3,3N,4,4N-Cl_4(77)	C_1-chrysene
2,2N4,5,5N-Cl_5(101)	C_2-chrysene
2,3,3N,4,4N-Cl_5(105)	C_3-chrysene
2,3N,4,4N5-Cl_5(118)	C_4-chrysene
3,3N,4,4N,5-Cl_5(126)	Benzo[*b*]fluoranthene
2,2N,3,3',4,4N-Cl_6(128)	Benzo[*k*]fluoranthene
2,2N,3,4,4N,5-Cl_6(138)	Benzo[*a*]pyrene
2,2N4,4N,5,5N-Cl_6(153)	Dibenzo[*a,h*]anthracene
2,2N3,3',4,4N,5-Cl_7(170)	Benzo[g,h,i]perylene
2,2N,3,4,4N,5,5N-Cl_7(180)	Indeno[1,2,3-*c,d*]pyrene
2,2N,3,4',5,5N,6-Cl_7(187)	Perylene
2,2N,3,3N,4,4N,5,6-Cl_8(195)	Biphenyl
2,2N,3,3N4,4N,5,5N,6-Cl_9(206)	Benzo[*e*]pyrene
Decachlorobiphenyl-Cl_{10}(209)	Dibenzofuran
Polynuclear Aromatic Hydrocarbons (PAHs)[a,d]	Benzothiazole
Naphthalene	**Pesticides**[c,d]
C_1-naphthalenes	Hexachlorobenzene
C_2-naphthalenes	Lindane
C_3-naphthalenes	Heptachlor
C_4-naphthalenes	Endrin
1-methylnaphthalenes[f]	Aldrin
2-methylnaphthalenes[f]	Heptachlorepoxide
2,6-methylnaphthalenes[f]	cis-Chlordane
2,3,5-methylnaphthalenes[f]	trans-Nonachlor
Acenaphthylene	Dieldrin
Acenaphthene	Mirex
Fluorene	2,4N-DDD
C_1-fluorenes	4,4N-DDD
C_2-fluorenes	2,4N-DDE
C_3-fluorenes	4,4N-DDE
Phenanthrene	2,4N-DDT
1-methylphenanthrene[f]	4,4N-DDT
Anthracene	DDMU
	Lipids[c,d]

[a] Flounder liver; lobster hepatopancreas
[b] Flounder and lobster edible tissue
[c] Flounder edible tissue and liver; lobster edible tissue and hepatopancreas
[d] Mussel soft tissue (Gloucester or Rockport)
[e] Mussel soft tissue (Sandwich or Rockport)
[f] Compounds Monitored in 94-97; will be analyzed in 1998 - 2001, HOM 3.

10.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization is shown in Figure 4. Dr. Michael Mickelson is the MWRA Project Manager. Mr. Maury Hall is the MWRA Project Area Manager for all Fish and Shellfish activities. Mr. Ken Keay is the Deputy Project Manager and serves as backup to both Dr. Mickelson and Mr. Hall. They will be informed of all matters pertaining to work described in this CW/QAPP. Ms. Wendy Leo is the MWRA EM&MS Database Manager.

Dr. Carlton Hunt is the Battelle Project Manager responsible for the overall performance of this project. Ms. Jeanine Boyle is the Battelle Deputy Project Manager. Process managers, responsible for ensuring that the day to day activities necessary to achieve the goals of this task will be: Mr. Wayne Trulli is the Field Manager responsible for managing all field logistics and data collection aspects of HOM 3; Ms. Deirdre Dahlen is the Laboratory Manager responsible for coordinating all analytical aspects of HOM 3; and Dr. Carlton Hunt is the Reports Manager who will coordinate all data interpretation and synthesis activities as well as efforts to convey monitoring results to the technical community and the public. The Battelle Quality Assurance Officer for the project is Ms. Rosanna Buhl. For this task, Ms. Buhl is responsible for reviewing the data reports for completeness and adherence to the CW/QAPP. She is also responsible for reviewing the Final Reports for accuracy and completeness. Ms. Ellie Baptiste-Carpenter is Battelle's Database Manager.

Ms. Lisa Lefkovitz is the Battelle Senior Scientist responsible for the conduct of the fish and shellfish monitoring tasks described in this CW/QAPP. Ms. Lefkovitz will also manage the day to day analytical chemistry work including the flounder, lobster and mussel analyses.

Dr. Michael Moore (WHOI) is the Senior Scientist for the Flounder Survey. Histological slides will be prepared at Experimental Pathology Laboratories under subcontract to WHOI. Dr. Moore will analyze and reduce the histological data generated by Dr. Hillman (see below) and add them to the ongoing temporal and spatial data summaries.

Dr. Robert Hillman, Research Leader at Battelle Duxbury, will conduct the histological analyses, in Dr. Moore's absence.

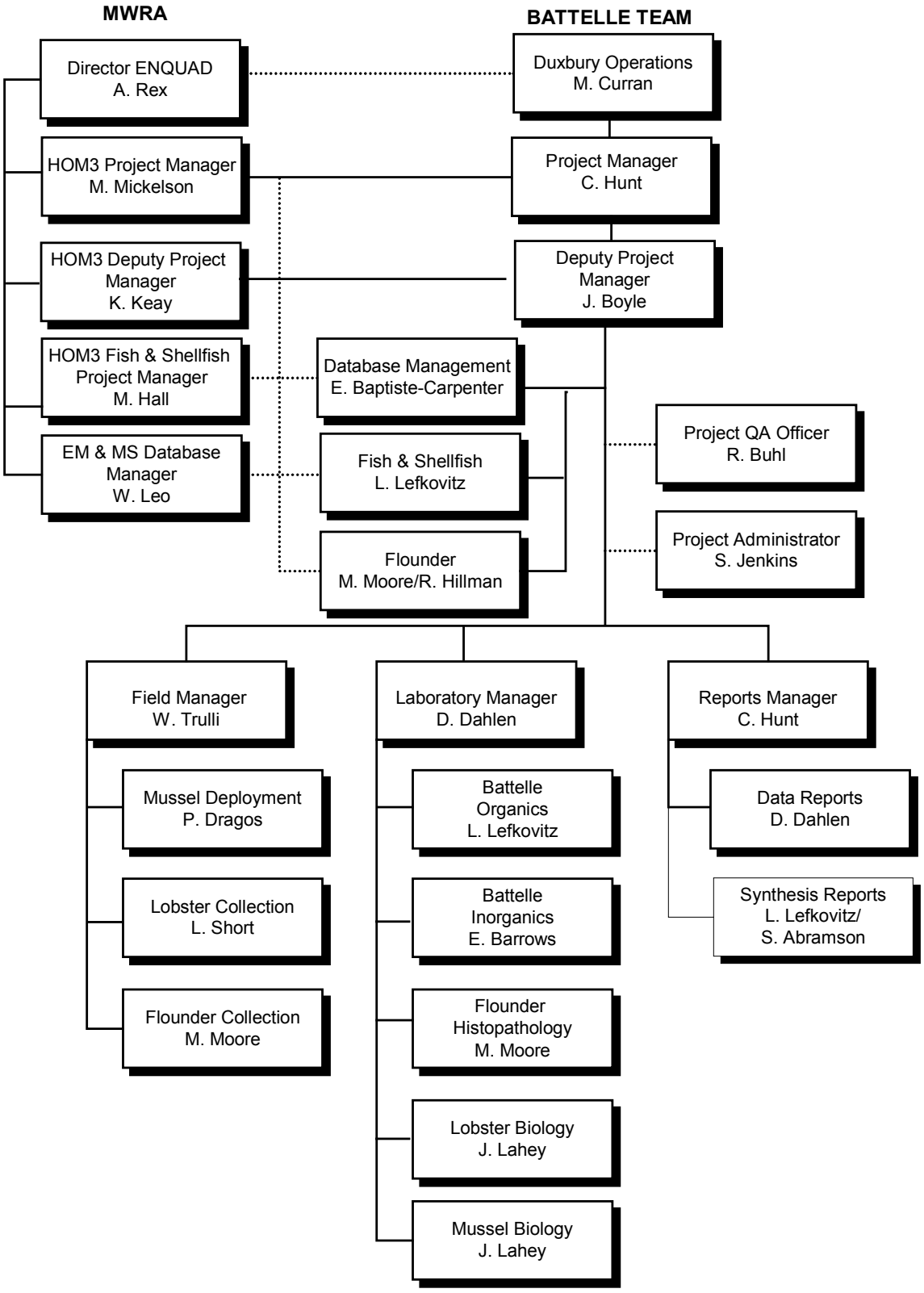

Figure 4. Organizational Chart.

Table 7. Schedule of Deliverables.

Task	Deliverable	Due Date
Flounder Survey (Task 21)	Survey Plan Survey Cruise Survey Report	March 28 April 28 May 28
Lobster Survey (Task 22)	Survey Plan Survey Cruise Survey Report	June 28 July 28 August 28
Bioaccumulation Study (Task 23)	Survey Plan Mussel Collection and Array Deployment Survey Survey E-mail Mussel Retrieval Survey 1 Mussel Retrieval Survey 2 Survey Report	May 28 June 28 2 days after each survey 40 days after deployment 60 days after deployment September 28
Tissue Chemical Analyses (Task 24)	Flounder Chemistry Data Report Lobster Chemistry Data Report Mussel Chemistry Data Report	July 28 (or 60 days after collection[1] Oct. 28 (or 60 days after collection Oct. 28 (or 60 days after collection[1]
Flounder Histology and Mussel Condition Analysis (Task 25)	Histology Data Report Mussel Biological Condition Report	August 28 October 28

[1] Whichever date is earlier.

11.0 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

To ensure that all data generated during the conduct of surveys, analyses, and reporting are of the highest quality, data will be examined in terms precision, accuracy, completeness, comparability, and representativeness. These terms are defined in the HOM3 Quality Management Plan (Battelle 1998). The application of these measures of data quality is described below.

Accuracy - the extent of agreement between the measured value and the true value
Precision - the extent of agreement among independent, similar, or related measurements
Completeness - measure of the amount of data acquired relative to the amount of data required to fulfill the objectives and statistical criteria for the intended use of the data
Comparability - the extent to which data from one study can be compared directly to similar studies
Representativeness - the extent to which sample locations and measurements represent true systems

11.1 Navigational and Hydrographic Data

11.1.1 Precision and Accuracy

Based on manufacturer specifications or Battelle's experience, precision and accuracy objectives for navigation are presented in Table 8. Section 12 provides details on relevant sampling procedures to ensure data quality, and Section 14 discusses instrument calibration methods.

Table 8. Accuracy and Precision of Instrument Sensors.

Sensor	Units	Range	Accuracy	Precision
Echosounder (depth)	m	0 to 200	2	0.1
DGPS Navigation	degree	Coastal	$9x10^{-5}$ deg (10 m)	$1.8x10^{-5}$ deg (2 m)

11.1.2 Completeness

Battelle's navigation software system outputs navigation positions at an interval of 2–s. The software system will display all position fixes and save these fixes in an electronic file during hydrocasts and sampling operations. The project's time interval requirement for obtaining positions during sampling is 1–min. Thus, even with a few bad data streams from the DGPS navigation system to the computer, the software will provide enough fixes within each 1-min period for 100% data collection. During transit between stations, the software system will save vessel coordinates in an electronic file every 5 min.

11.1.3 Comparability

Latitude/longitude positions will be recorded by the Chief Scientist. These stations are consistent with previous data under MWRA's HOM program.

11.1.4 Representativeness

The DGPS latitude/longitude positions are representative of the actual vessel coordinates, because position data are collected and reviewed at a frequency that ensures that the measured latitude/longitudes represent the actual vessel position.

11.2 Flounder Collection (Task 21)

At each station, 50 winter flounder specimens will be collected. Samples of liver will be taken from all 50 specimens for histological analysis. Samples of liver and edible tissue will be taken from 15 of the flounder from each site for chemical analyses.

11.2.1 Accuracy

To ensure that specimens are correctly identified, fish keys, such as *Guide to Some Trawl-Caught Marine Fishes from Maine to Cape Hatteras, North America* (Flescher, 1980) and field guides will be used. The guaranteed accuracy of the "Normark" fish scale is 50 g. The accuracy of the fish measuring board is 0.1 cm.

11.2.2 Precision

The precision of the weights of the fish will be enhanced by using a scale (Normark fish scale) with a maximum reading pointer (MRP) that retains the weight reading of the fish until another fish is put on the scale. If time allows, the first 15 specimens collected at each sampling site will be measured and weighed twice. If agreement between the length or weight measurements is within 1 cm or 0.05 kg, respectively, measurements will continue. If measurements or weights differ by more than the above-stated criteria, the specimen will be re-measured or re-weighed.

11.2.3 Completeness

The objective is to obtain 50 sexually mature specimens from each sampling site. Otter-trawl tows will be conducted until at least 50 specimens are collected at each sampling site. Sampling will be 100% complete when this is accomplished. In the event of sample loss or equipment malfunction, the Chief Scientist will determine the need for appropriate corrective action (e.g., re-sampling using a different otter trawl). The corrective action taken by the Chief Scientist will be recorded in the survey records. In the event of inadequate numbers of fish, three hours of bottom time will be the maximum effort expended at any one station. In the event of 3 hours bottom time failing to yield 50 fish, additional fish from other stations may, at the discretion of the MWRA, be sampled to generate a total of 250 fish for the survey.

11.2.4 Comparability

Winter flounder have been routinely used by other researchers working in Massachusetts Bay and similar environments to determine health and tissue burden of contaminants. Collection of winter flounder that are sexually mature will allow a comparison of the health of adult specimens at each sampling site. The methods of collection and visual analyses are comparable to methods used by Dr. Michael Moore for previous studies on winter flounder from these sampling sites. Otter trawls have been used by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and the Massachusetts Division of Marine Fisheries since the 1960s and 1970s, respectively, as a method to sample finfish. All otter-trawl tows will be conducted for approximately 30 minutes at a speed of 1.5 to 2 kt. The sampling design of this survey is comparable to the design of previous surveys.

11.2.5 Representativeness

Representativeness is primarily addressed through sample design. The sampling sites represent previously sampled locations and represent the population of winter flounder that may be found within Massachusetts and Cape Cod Bays.

11.3 Lobster Collection (Task 22)

At each station, 15 lobster specimens will be collected. Samples of hepatopancreas and edible tissue will be taken from each specimen for chemical analysis.

11.3.1 Accuracy

The guaranteed accuracy of the lobster scale is 50 g. The accuracy of the calipers is 1 mm.

11.3.2 Precision

If time allows, the first two specimens collected at each sampling site will be weighed and measured twice. If agreement between the measurements (length or weight) is within 1 mm or 0.05 kg, respectively, measurements will continue. If measurements or weights differ by more than the above-stated criteria, the specimen will be re-measured or weighed.

To ensure that only commercially harvestable specimens are retained, all specimens will be measured using a lobster gauge and females will be inspected for the presence of eggs. Calipers will be used to measure specimens after it is determined that they are of harvestable size. Any specimens that have a carapace length < 3.25 inches (the minimum legal size) or that contain eggs will immediately be returned to the environment. These measurements and inspections will be made immediately upon capture to improve chances of survival. [Note: The measurements and inspections are identical with commercial practice.]

11.3.3 Completeness

The sampling objective is to obtain 15 commercially harvestable specimens representative of their location. Lobsters will be purchased from commercial lobstermen. In the event of sample loss or equipment malfunction, the Battelle Chief Scientist will determine the need for appropriate corrective action. The corrective action taken will be recorded in the survey records. If every reasonable effort to acquire the required number of lobster has been made, the 100% completeness goal may be waived.

11.3.4 Comparability

Lobster have been routinely used by other researchers working in Massachusetts Bay and similar environments to determine health and tissue burden of contaminants. Lobster pots are routinely used by commercial fishermen to collect lobster. The sampling design of this survey is comparable to the design of previous surveys.

11.3.5 Representativeness

Representativeness is primarily addressed through sample design. The sampling sites represent previously sampled locations and represent the population of lobsters that may be found within Boston Harbor and the Bays.

11.4 Mussel Collection (Task 23)

At each station 80 or 110 mussels for organics and 40 or 55 mussels for inorganics will be collected from the deployed arrays (Table 3). The mussels will be used for biological analyses (30 mussels) and chemical analyses (50 or 80 mussels for organics and 25 or 40 mussels for inorganics).

11.4.1 Accuracy

Accuracy of mussel measurements is addressed under Task 25 (Section 11.6.1).

11.4.2 Precision

A minimum of 5% of the mussel shell dimensions will be measured in duplicate.

11.4.3 Completeness

The deployment arrays will contain excess numbers of mussels at the start of the incubation and a portion of mussels will be retrieved midway in the incubation period. Completeness will be 100% after recovery of the 60 day deployment. In the event of array or sample loss, the Senior Scientist, in consultation with MWRA, will determine the need for appropriate corrective action. The correction action taken by the Senior Scientist will be recorded in the survey records.

11.4.4 Comparability

The deployment and retrieval of caged mussels for short-term bioaccumulation is identical to the design of previous surveys. Mussels from established reference sites will be relocated to different environments (station locations). Various reference station locations are being used, depending on mussel availability: Rockport (organics and trace metals), or Gloucester (organics) and Sandwich (trace metals).

11.4.5 Representativeness

The sampling sites represent previously sampled locations and are representative of the expected short-term bioaccumulation conditions for mussels.

11.5 Tissue Chemical Analysis (Task 24)

Table 9 provides the data quality objectives for accuracy, precision, completeness and comparability for chemical analyses.

Table 9. **Data Quality Objectives.**

QC Type and Frequency	Acceptance Criteria	Corrective Action
Procedural Blanks Organics 1 per 20 samples Metals Lipids	 < 5X MDL < 5X MDL < 0.1 %	Results examined by project manager, task leader, or subcontractor lab manager. Reextraction, reanalysis ,or justification documented.
Accuracy		
Matrix Spike/ Blank Spikes Organics 1 per 20 samples Metals	50-150% recovery 70-130% recovery	Document, justify deviations.
Surrogate Internal Standards (SIS)	50-150% recovery	Document, justify deviations
SRMs Organics 1 per 20 samples Metals	 PD ± 30% vs. certified values, not to exceed 35% for more than 30% of analytes PD ± 20% vs. certified values	Results examined by project manager, task leader, or subcontractor lab manager. Re-extraction, re-analysis, or justification documented.
Precision		
Duplicates Organics (MS/MSD) 1 per 20 samples Metals (Lab Duplicates) Lipids	 ≤ 30% RPD RPD=± 25% individual analytes, ± 30% mean ≤ 25% RPD	Document, justify deviations.
FLOUNDER/LOBSTER/MUSSEL MEASUREMENTS AND HISTOLOGY		
Accuracy Weight and Length Measurements NA	 Fish Scale: ± 50 grams Electronic Scale: ± 0.01 grams (soft tissue measurements) Fish Measuring Board: ± 0.1 cm Calipers: ± 1 mm	 Check calibration of instrument if applicable. Perform re-measurement.
Precision Duplicate Measurements (performed in field if time allows) 5%	 Fish Weight: ± 50 grams Soft Tissue Weight: ± 0.01 grams Length: ± 1 mm	 Check calibration of instrument if applicable. Perform re-measurement.

MDL: Method Detection Limit: PD: Percent Difference: SIS: Surrogate Internal Standard: RSD: Relative Standard Deviation: SRM Standard Reference Material; RPD: Relative percent Difference

11.5.1 Accuracy

Analytical accuracy will be evaluated based on percent recoveries of analytes in National Institute of Standards and Technology (NIST) standard reference materials (SRM), blank and matrix spike samples, and the surrogate internal standards (SIS) that are added to every sample (organics only), as well as the results of the procedural blanks that will be analyzed with each batch of up to 20 field samples.

Deviations from the above analytical scheme will require approval by the Battelle Senior Scientist and will be reported with the analytical data. All QC data will be reported with the hard copy sample data. Accuracy will be measured by calculating the percent recovery of surrogate spikes (organics only), blank and matrix spikes, and standard reference materials (SRMs). Percent recovery will be calculated as shown in Section 15.2.3. Method detection limits (MDL) for analytes of interest have been calculated and are presented in Table 10 (PCB/Pests), Table 11 (PAH), and Table 12 (Metals). Specific accuracy goals are provided in Table 9.

All field samples, blanks, and matrix QC samples processed for organics analysis will be spiked with the appropriate SIS before extraction. Quantification of the SIS will be based on the recovery internal standards (RIS) added to the final extract just before instrumental analysis. Acceptable SIS ranges are provided in Table 9. It is considered acceptable if one of the PAH surrogate internal standards lies outside this range as long as the others are within the acceptable range. Because samples are quantified relative to the recovery of the SIS, which is added before extraction, any loss of analytes during processing should be corrected by a comparable loss of the SIS. Therefore, SIS recoveries outside of the data quality objectives listed in Table 9 may be considered acceptable. Each sample showing low recoveries will be individually examined by the laboratory manager or laboratory task leader to determine the necessity of re-extraction or reanalysis and the proposed action discussed with the Battelle Senior Scientist. All corrective actions will be documented. When a sample does not meet the acceptance criteria and is not reanalyzed, the justification for this decision will be documented. QC exceedences will be reported to MWRA in the QA/QC Corrective Action Log.

11.5.2 Precision

Analytical precision will be determined using the concentrations of duplicate samples (matrix spikes for organics samples, field or laboratory duplicates for metals samples), with the percent differences between duplicate analyses (RPD) serving as a measure of precision. Target RPDs are provided in Table 9. The RPD will be calculated by the formula given in Section 14.4.1.1.

11.5.3 Completeness

The completeness of chemical analyses will be ensured by comparing the chain-of-custody forms received by the laboratory with the list of samples analyzed. Samples will be analyzed for the parameters listed in Table 6.

Completeness of chemical analyses will depend directly upon the amount of sample available. A minimum of 5 g (wet weight) of tissue is normally necessary to perform all of the required analyses. If inadequate tissue biomass is available, then the MWRA Project Area Manager will be contacted prior to sample analyses for guidance. One possible solution to the inadequate sample amount is that analyses may be conducted on lower weights (with potentially higher MDLs). Three pools of 5 liver samples will be prepared. One hundred percent of the samples collected for tissue chemistry analysis are expected to be analyzed, either individually or as composites.

Table 10. Polychlorinated Biphenyls/Pesticides Method Detection Limits for Tissues.

Polychlorinated biphenyls (PCBs)	MDL (ng/g dry wt.)
2,4,-Cl_2(8)	0.604
2,2N,5-Cl_3(18)	0.151
2,4,4N-Cl_3(28)	0.104
2,2N,3,5N-Cl_4(44)	0.122
2,2N,5,5N-Cl_4(52)	0.090
2,3N,4,4N-Cl_4(66)	0.457
3,3N,4,4N-Cl_4(77)	0.770
2,2N4,5,5N-Cl_5(101)	0.987
2,3,3N,4,4N-Cl_5(105)	0.337
2,3N,4,4N5-Cl_5(118)	0.846
3,3N,4,4N,5-Cl_5(126)	0.247
2,2N,3,3,4,4N-Cl_6(128)	0.424
2,2N,3,4,4N,5-Cl_6(138)	1.061
2,2N4,4N,5,5N-Cl_6(153)	1.021
2,2N3,3,4,4N,5-Cl_7(170)	0.317
2,2N,3,4,4N,5,5N-Cl_7(180)	0.914
2,2N,3,4,5,5N,6-Cl_7(187)	0.372
2,2N,3,3N,4,4N,5,6-Cl_8(195)	0.222
2,2N,3,3N4,4N,5,5N,6-Cl_9(206)	0.210
Decachlorobiphenyl-Cl_{10}(209)	0.310
Pesticides	**MDL (ng/g dry wt.)**
Hexachlorobenzene	0.115
Lindane	0.070
Heptachlor	0.298
Endrin	0.328
Aldrin	0.073
Heptachlorepoxide	0.121
cis-Chlordane	0.582
trans-Nonachlor	0.164
Dieldrin	0.598
Mirex	0.142
2,4N-DDD	0.224
4,4N-DDD	0.399
2,4N-DDE	0.539
4,4N-DDE	0.957
2,4N-DDT	0.651
4,4N-DDT	0.424
DDMU	0.298

Note: MDL concentrations for PCBs and pesticides are based on surrogate corrected data. These MDLs are representative. MDLs are updated annually and are available on request.

Table 11. Polynuclear Aromatic Hydrocarbons Method Detection Limits for Tissues.

Polynuclear Aromatic Hydrocarbons (PAHs)	MDL (ng/g dry wt.)
Naphthalene	0.577
C_1-naphthalenes	0.787
C_2-naphthalenes	0.509
C_3-naphthalenes	0.408
C_4-naphthalenes	0.600
1-methylnaphthalenes	0.593
2-methylnaphthalenes	0.787
2,6-methylnaphthalenes	0.589
2,3,5-methylnaphthalenes	0.380
Acenaphthylene	0.537
Acenaphthene	0.612
Fluorene	0.444
C_1-fluorenes	0.444
C_2-fluorenes	0.444
C_3-fluorenes	0.444
Phenanthrene	0.351
1-methylphenanthrene	0.472
Anthracene	0.331
C_1-Phenanthrenes/anthracene	0.472
C_2-Phenanthrenes/anthracene	0.472
C_3-Phenanthrenes/anthracene	0.472
C_4-Phenanthrenes/anthracene	0.472
Dibenzothiophene	0.222
C_1-dibenzothiophenes	0.222
C_2-dibenzothiophenes	0.222
C_3-dibenzothiophenes	0.222
Fluoranthene	0.570
Pyrene	0.594
C_1-fluoranthenes/pyrene	0.594
C_2-fluoranthenes/pyrene	0.594
C_3-fluoranthenes/pyrene	0.594
Benzo[*a*]anthracene	0.806
Chrysene	0.497
C_1-chrysene	0.497
C_2-chrysene	0.497
C_3-chrysene	0.497
C_4-chrysene	0.497
Benzo[*b*]fluoranthene	0.678
Benzo[*k*]fluoranthene	0.556
Benzo[*a*]pyrene	0.924
Dibenzo[*a,h*]anthracene	0.461
Benzo[g,h,I]perylene	0.510
Indeno[1,2,3-*c,d*]pyrene	0.663
Perylene	0.356
Biphenyl	0.356
Benzo[*e*]pyrene	0.803
Dibenzofuran	0.260
Benzothiazole	0.500[a]

Note: MDL concentrations for PAHs are based on surrogate corrected data. These MDLs are representative. MDLs are updated annually and are available on request.

[a] Estimated based on response of low standard.

Table 12. Metals Method Detection Limits for Tissues.

Trace Metals	MDL (µg/g dry wt.)
Ag Silver	0.1
Cd Cadmium	0.07
Cr Chromium	0.1
Cu Copper	0.2
Hg Mercury	0.02
Ni Nickel	0.3
Pb Lead	0.1
Zn Zinc	0.1

11.5.4 Comparability

The SRM, when processed and analyzed with samples, will quantify the comparability characteristic for laboratory measurements.

The data generated for this project will be directly comparable to data generated for the NS&T Mussel Watch project because the same analytical protocols are being used. Additionally, the methods used by this project are directly comparable to the methods used for in earlier work on this MWRA study.

11.5.5 Representativeness

The monitoring program was designed to ensure that results will be representative (MWRA 1997b). Representativeness will also be ensured by adequate sample homogenization, where required, and appropriate sample storage.

11.6 Flounder Histological and Mussel Condition Analysis (Task 25)

11.6.1 Accuracy

Scales and otoliths will be read by NMFS scientists that are experienced in aging winter flounder. A percentage of the scales will be reread to verify age determinations.

Mussel shell dimensions will be determined with a Vernier caliper, which is accurate to 0.1 mm. Total soft tissue, gonadal tissue, and non-gonadal tissue will be measured on an electronic balance accurate to 0.01 g wet weight.

11.6.2 Precision

Histological observations of tissue abnormalities and scores assigned to these abnormalities are somewhat subjective based on the opinion of the pathologist reading the slides. Precision and accuracy of the measurements are therefore difficult to define quantitatively. However, an intercomparability exercise carried out in 1993 documented that 2 trained pathologists looking at the same material, identified roughly equivalent frequencies and severities of lesions (Hillman *et al.* 1994). Another comparability study was performed by Moore *et al.* (1993) in which a blind re-evaluation of 1989 slides was performed in 1993 showing 100% agreement. These findings suggest that, although quantification of the accuracy and precision of the protocols is difficult, it is measurable and has been demonstrated to be acceptable.

11.6.3 Completeness

For sufficient data for the statistical analyses needed to assess the health of the flounder populations, and to make inter-site comparisons of the lesion prevalence, lesion scores from three slides from each of 50 flounder livers from each site will be calculated.

Large numbers of mussels are deployed in arrays, which should provide sufficient mussels for biological and chemical analyses. An early (i.e., 40 day) retrieval is conducted to ensure sufficient material is available for each site.

11.6.4 Comparability

The lesions scored, the method of scoring, and the data reduction and analyses will be similar to what has been done in previous years under the HOM program. Scales will be read as a courtesy by NMFS scientists that have aged winter flounder during the previous studies. Comparability of flounder liver histology data has been confirmed in a number of studies described in section 11.6.2. Several slides will be studied with Dr. Robert Hillman to assure that observations are comparable to those made during studies conducted previously.

The determination of the shell dimensions, body and gonadal weight and reproductive condition of the mussels will be conducted in the same manner as in previous years.

11.6.5 Representativeness

The program design and objectives ensure representativeness.

12.0 SAMPLING AND ANALYTICAL PROCEDURES

Methods for collection and analysis of samples are described in the following sections.

12.1 Navigation

Vessel positioning during sampling operations will consist of a Northstar 941XD Navigation system. This system combines a 12-channel GPS satellite receiver with a Differential GPS (DGPS) receiver. The system is capable of tracking 12 GPS satellites and also monitoring land-based DGPS stations simultaneously. The output of the 941XD is interfaced with the NAVSAM Data Collection system to provide real-time position fixes for the NAVSAM electronic log. To correct the GPS calculations, the Northstar DGPS will receive correction data from one of three USCG DGPS broadcast sites: Montauk Point, NY; Chatham, MA; and Portsmouth Harbor, NH (see Figure 5 for coverage). This capability ensures strong signal reception, and accurate and reliable positioning with 2-s updates.

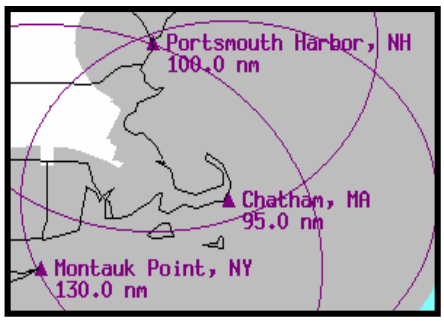

Figure 5. DGPS master stations coverage.

12.2 Winter Flounder Collection and Processing

Winter flounder specimens will be collected and processed as described in the sections that follow.

12.2.1 Collection

1. A commercial otter trawl will be towed by a commercial dragger beginning at the site center of each sampling site listed in Table 2. The tows will be conducted for 15-30 minutes at a speed of 1.5 to 2 kt in a direction parallel to lobster-pot trawls in the area to avoid interaction with lobster pots. Tows will be conducted until at least 50 specimens have been collected at each sampling site. At the start and completion of each tow, the time and vessel position will be recorded by non-differential GPS and Loran.

2. At the completion of each tow, the otter trawl will be brought on board using a mechanical winch and the contents of the trawl unloaded onto the aft deck of the vessel. It may be necessary to conduct more than one otter-trawl tow at a sampling site if the required number of specimens (50) is not collected during the first tow. If the required number of flounder is not collected after six 30-minute tows and two 1 hour tows at an appropriate adjacent site, collections at that site will be terminated for the survey period (though individual tows may be up to 1 hour if necessary. If the number of fish in the first hour of towing is less than five, the effort will be deferred for two to four weeks. This strategy has proven to be efficient in previous years.

3. All specimens will be sorted by species, however, only winter flounder will be retained; other species will be returned to the environment.

4. Fish held for chemical analysis will be kept on ice and shipped to Battelle Duxbury Operations. If a fish is collected and assigned a sample ID but then dies, a comment will be made on the flounder collection form (Figure 7).

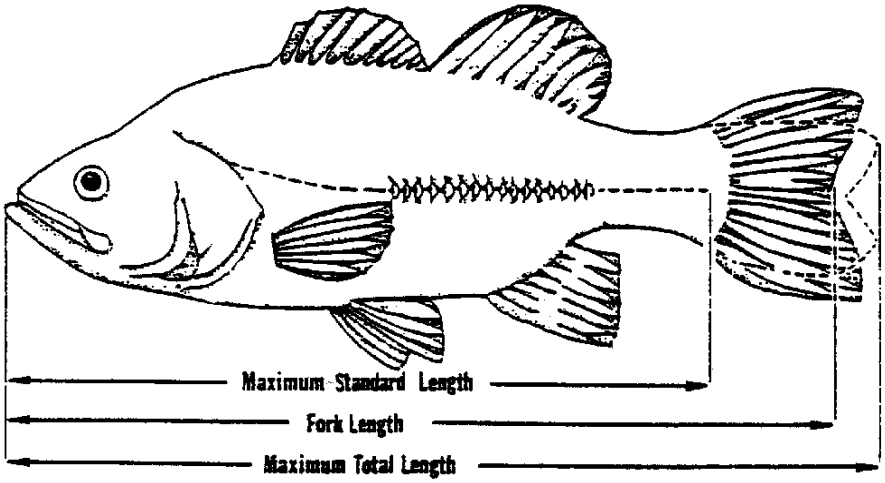

Figure 6. Length Measurements for Flounder.

12.2.2 Tissue Sample Processing

Processing will be conducted in the laboratory for the 15 fish for histology and tissue chemistry analysis and on board the collection vessel for the 35 or 50 fish for histology analyses.

12.2.2.1 Sample Processing for Histology Analyses

1. The fish from each site will be processed for histology analyses immediately, (this process may continue while proceeding to the next sampling site). The fish will be killed by means of a cervical section prior to processing.
2. The weight, standard length, and total length will be determined (see Figure 6 and SOP 5-175). Each flounder will be examined for external evidence of disease (fin rot and external lesions) and notes will be recorded on the flounder sampling log (Figure 7).
3. Scales will be collected from specimens >30 cm on board the vessel. Scales will be removed after first removing any mucus, debris, and epidermis from the dorsum of the caudal peduncle by wiping in the direction of the tail with a blunt-edged table knife. Scales will be collected from the cleaned area by applying quick, firm, scraping motions in the direction of the head. Scales will be placed in the labeled age-sample envelope by inserting the knife between the liner of the sample envelope and scraping off the scales.
4. The livers will be removed and examined for visible gross abnormalities (gross liver lesion). They will be preserved in 10% neutral buffered formalin for histological analysis. Liver samples from each fish will be placed in a separate clearly labeled sample container.

12.2.2.2 Sample Processing for Tissue Chemistry

Because it is unlikely that contaminant-free conditions will be found on board the vessel used for flounder collection, the fish used for chemical analysis will be returned to the laboratory for organ dissection. Of the 50 flounder collected from each site for histopathological analysis, 15 fish of the proper size will be designated for tissue chemical analysis. The fish will be held on ice, and stored in separate, site-specific coolers, until they are returned to the laboratory.

The flounder tissues will be removed in the laboratory under contaminant-free conditions. Tissue processing will be conducted in Class 100 clean room. Using a pre-cleaned (i.e., rinsed with 10% HCL, Milli-Q (18 megohm) water, acetone, DCM, and hexane) stainless steel knife, the fillets (muscle) will be removed from the flounder and the skin will be removed from the fillet. Composites will be made from the homogenate of 5 individual fish using approximately equal masses of top and bottom tissue. Homogenization will be performed using a stainless steel TEKMAR® tissuemizer. Each composite will be placed in a sample container clearly identified with the unique sample identifier.

At least one homogenization blank will be carried out for each batch to assess for sample contamination during the homogenization process. For the blank sample, a known quantity of (about 100 ml) Milli-Q water will be transferred to a clear glass jar and "tissuemized" for two minutes and analyzed for both PCB/Pests and Hg (fillet measurements only).

Livers from the 15 fish selected for chemical analyses will be removed using a titanium or ceramic knife and will also be analyzed for chemical parameters. Following the processing for histology analysis, the livers will be individually homogenized by finely chopping with the titanium or ceramic knife and divided into three separate composites to correspond to the composites made for the fillets. This is done to ensure comparability between fillet and liver chemical analyses. Each composite will be placed in a sample container clearly identified with the unique sample identifier. Note: The liver composite samples will contain approximately equal masses (5 grams) from each of the livers being used in the composite. For fish with extremely small livers (< 5g wet weight), all available liver tissue will be used from such fish.

Station #:_____
Station ID:_____
Collection Date/Time:_____

2000 Flounder Histology Data MWRA Harbor and Outfall Monitoring Program Phase 3.

			Chain of Custody:	Check applicable sample type	Scale: ____ Histology:	Chem Liv: ___ Fil:___	Relnq___ ___/__/__ Rec'd_____ __/__/__		Relnq_____ ___/__/__ Rec'd_____ __/__/__				
Event	ID	STN	Composite #	Total Length mm	Standard Length mm	Weight. (g)	Sex	Age	Liv. col.*	Fin (0 to 4)	Gross Liver Lesion (0 to 4)		Gross Score (0 to 4)
F00	1001	DIF											
F00	1002	DIF											
F00	1003	DIF											
F00	1004	DIF											
F00	1005	DIF											
F00	1006	DIF											
F00	1007	DIF											
F00	1008	DIF											
F00	1009	DIF											
F00	1010	DIF											
F00	1011	DIF											
F00	1012	DIF											
F00	1013	DIF											
F00	1014	DIF											
F00	1015	DIF											

Date Collected:__/__/__

Page __ of __

Scientist:_____

QA Officer:_____

Date:__/__/__

*Y: yellow, YB: Y Brown, B: Brown, DB: Dark B.

Figure 7. Sample Collection Log — Winter Flounder.

Following processing of livers for histology analysis, the homogenized tissue and liver samples will be frozen and stored. Any remaining tissue from each specimen will be archived frozen in case additional analysis is required under Task 24.13.

12.3 Lobster Collection and Processing

Lobster specimens will be collected and processed according to the procedures described in the sections below.

12.3.1 Collection

1. Following visual observation and documentation of the location of source lobster pots (within 2 km of target site), up to 15 legal-sized lobsters may be obtained from commercial lobstermen for a sampling site. Specimens will be processed as described below.

2. Upon retrieval, lobster pots will be brought alongside the vessel to the gunnel (side railing). Specimens will be removed and measured on the gunnel. No specimens will be brought on board the vessel until it is determined that they have a carapace length of at least 3.25 in (legal length). In addition, any specimens that are of legal length but also contain eggs (berried) will be returned to the environment immediately.

3. Fifteen specimens retained for processing will be banded with one band per claw. Sampling location information will be recorded from the GPS system. Lobster specimens will be stored away from commercial lobsters, in a separate container with site water. Lobster specimens will be stored on ice during transport from the dock to the laboratory for processing.

4. **Alternative Collection Method** A string of 25 to 30 lobster pots will be deployed for up to three days at each sampling site. The pots will be deployed in a direction parallel to other pots in the area. When the pots are deployed and retrieved, the time and vessel position will be recorded.

12.3.2 Lobster Processing for Chemistry

Lobsters will be collected from three sites. Once at the laboratory, specimens will be frozen until processing can begin. In the laboratory, carapace length will be determined by measuring the distance from the posterior of the eye socket to the midpoint of the posterior of the carapace with calipers (see Figure 8 and SOP 5-175-03). Measurements will be recorded to the nearest millimeter. Specimen weight will be recorded to the nearest gram. Specimens will be visually examined for the presence and severity of gross external abnormalities, such as black gill disease, shell erosion, parasites, and external tumors. Data for each specimen will be recorded on lobster sample collection logs (Figure 7), including site, project survey type, sample identification number, date and time, and sampler's initials. The hepatopancreas will be removed using titanium, ceramic, or Teflon implements and frozen for chemical analysis. The tail and claw meat (edible tissue) will be stored frozen in the shells until processed in the laboratory. Samples will be placed in sample containers that are clearly identified with a conventional label containing the information described above.

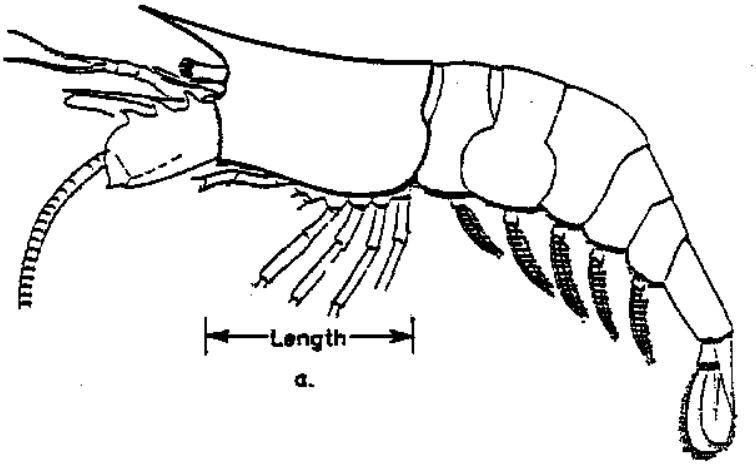

Figure 8. Length Measurement of Lobster.

The fifteen lobsters from each site will be randomly assigned to 3 pools of 5 lobster each. Homogenized samples of hepatopancreas or edible meat from each lobster in a pool will be quantitatively combined (±10% by weight) to provide two composite samples per pool, one each of hepatopancreas and edible meat. Each composite will be placed in a sample container clearly identified with the unique sample identifier.

12.4 Mussel Bioaccumulation Survey

Mussel specimens will be deployed and retrieved according to the procedures described in the sections below.

12.4.1 Mussel Deployment

In June, mussels will be collected for testing purposes from reference sites (Depending on availability: Gloucester, MA – organics, Sandwich, MA – inorganics, and Rockport, MA – both organics and inorganics). Mussels will be harvested during low tide and individually checked for length. Mussels that have a total average length of 55-65 mm will be used in the deployment. Mussels will be randomly distributed to plastic cages for deployment as an array (i.e., set of cages) in sufficient number to provide the necessary biological material. At least 10% additional mussels will be included to account for potential mortality. A subsample of 80 live mussels for organics and 40 live mussels for inorganics will be randomly selected and set aside for pre-deployment biological and chemical analyses.

Mussel array systems will be deployed at up to five locations (Table 2, Figure 3). At each location a minimum of 3 arrays will be deployed except for the offshore locations where 4 arrays will be deployed. Each array will be deployed on a separate mooring and each with enough mussels to provide sufficient tissue to complete the study. The locations of the arrays will be recorded using DGPS.

Event: _____
Station #: _____
Station ID: _____
Collection Date/Time: _____

Baattelle Duxbury
MWRA HOM3 — Fish and Shellfish
April 1998

Sample Collection Log — Lobster

Specimen No.	Carapace length (cm)	Weight (gm)	Sex (M/F)	Black Gill [a]	Shell Erosion [a]	Parasites [a]	External Tumors [a]	Samples Taken (check)
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___
								liver ___ tissue ___

Entered by: _____ **Date:** _____

[a] **Codes: 0 - 4 (absent - extreme)**

Figure 9. Sample Collection Log – Lobster.

12.4.2 Mussel Collection

Table 13 lists the minimum numbers of mussels that will be recovered from each location for each type of analysis at the 40 and 60-day collections.

Table 13. Minimum Numbers of Mussels Collected at Each Location.

Site	Organic Chemistry	Inorganic Chemistry	Biological Condition[a]
Reference Mussels (pre-deployment)	50	25	≥30
Boston Inner Harbor (40–day recovery)	50	25	≥30
Boston Inner Harbor (60–day recovery)	50	25	≥30
Deer Island Light (40–day recovery)	50	25	≥30
Deer Island Light (60–day recovery)	50	25	≥30
Outfall Site (40–day recovery)	80	40	≥30
Outfall Site (60–day recovery)	80	40	≥30
Cape Cod Bay (40–day recovery)	80	40	≥30
Cape Cod Bay (60–day recovery)	80	40	≥30

[a] When reference mussels from both Gloucester (organics) and Sandwich (inorganics) are used, 30 Gloucester mussels and 15 Sandwich mussels will be used for biological condition analyses.

After approximately 40 days, up to one half of the mussels (one array) will be recovered to provide biological material in the event of a failure of the 60-day collection. The amount of biofouling of the arrays will also be assessed at 40 days. If necessary, arrays will be retrieved, cleaned, and re-deployed at the site. At the end of 60 days, the remaining mussels (the additional array) will be collected. The mussels for chemical analysis will be placed in a clean container and frozen (prior to shucking).

12.4.3 Mussel Processing

A random subsample of mussels (see Table 13) will be selected from the pre-deployment mussels and from each of the 4 stations' 60-day mussel harvest (or 40-day harvest if the 60-day harvest is unavailable). Replicate organic chemical analysis samples will be prepared as composites of ten mussels. Replicate inorganic chemical analysis samples will be prepared as composites of five mussels. Each individual mussel will be cleaned of attached material, all byssal threads removed, and all soft tissue including fluids placed directly into an appropriate container (500-ml I-Chem Certified clean bottle for organics and a pre-cleaned 4 ounce plastic jar for metals). Mussel composite samples will be prepared for organic chemical analyses by homogenization using a stainless steel TEKMAR® "tissuemizer", rinsed with methanol and deionized water prior to use. Mussel composite samples for metal analyses will be prepared by freeze drying and subsequent ball milling, to achieve homogenization.

In the event that sufficient mussels are not retrieved at 60 days, the MWRA Project Area Manager will be immediately notified to determine if the 40 day deployed mussels will be analyzed. If sufficient mussels are not retrieved from either the 40 or 60 day deployments a revised approach to mussel analyses shall be determined following consultation of the MWRA Project Area Manager and Battelle.

12.5 Tissue Chemical Analyses (Task 24)

Table 14 summarizes the analyses of tissue samples collected under Tasks 21-23. Three pools each of flounder samples (liver and edible tissue) and lobster samples (hepatopancreas and edible tissue) and five or eight pools of mussel soft tissue will be analyzed per site (see Sections 12.2 and 12.3 for details on pooling). Samples assigned to each specific pool will be homogenized together prior to conducting analyses. The chemical analytes of interest for Task 24 are listed in Table 6. Table 14 lists the analysis methods, units of measurement and method reference.

Table 14. Fish and Shellfish Sample Analyses.

Parameter	Lab	Unit of Measurement	Method	Reference
Organic Analyses				
Organic Extraction	Battelle	NA	Peven and Uhler (1993)	Battelle SOP 5-190
Polynuclear Aromatic Hydrocarbons (PAH)	Battelle	ng/g dry wt.	GC/MS	Battelle SOP 5-157
Polychlorinated Biphenyls (PCB)/Pesticides	Battelle	ng/g dry wt.	GC/ECD	Battelle SOP 5-128
Metals Analyses				
Digestion: Ag, Cd, Cr, Cu, Ni, Pb	Battelle	NA	Aqua regia Nitric acid	Battelle SOP MSL-I-006 Battelle SOP MSL-I-005
Analysis: Cr Ni, Pb	Battelle	ug/g dry wt	ICP-MS GFAA (as required)	Battelle SOP MSL-I-022 Battelle SOP MSL-I-029
Analysis: Ag, Cd, Cu, Zn	Battelle	ug/g dry wt	ICP-AES	Battelle SOP MSL-I-027
Analysis: Hg	Battelle	ug/g dry wt.	CVAA-FIAS (Hg)	Battelle SOP MSL-I-016
Ancillary Parameters				
Lipids	Battelle	% by dry weight	gravimetric	Battelle SOP 5-190
Wet Weight/Dry Weight Ratio	Battelle	NA	gravimetric	Battelle SOP 3-160 (balance) Battelle SOP 5-190
Flounder Length Weight	WHOI/Battelle	mm grams	calipers gravimetric	Battelle SOP 5-175
Lobster Length Weight	Battelle	mm grams	calipers gravimetric	Battelle SOP 5-175
Mussel Biological Condition	Battelle	mm grams	calipers gravimetric	Battelle SOP 5-031

12.5.1 Organic Analyses

Sample Extraction - Tissues will be extracted and cleaned following procedures in Battelle SOP 5-190. Approximately 30-g of tissue homogenate will be weighed into a Teflon extraction jar, spiked with the appropriate surrogate internal standard (SIS), combined with 75 mL DCM and sodium sulfate, macerated with a Tissumizer and centrifuged. An aliquot of the original sample will also be taken for dry weight determination. The extract will be decanted into a Erlenmeyer flask. This process is repeated once using 75 mL DCM. After each maceration (total of two solvent additions) the centrifuged solvent extracts will be combined in the Erlenmeyer flask. An additional extraction will be performed using 50 mL DCM and shaking techniques, the sample centrifuged a third time, and the extract combined with the other two. A 10-mL aliquot of the combined extracts will be removed for lipid weight determination (as described in SOP 5-190). The combined extract will be dried over sodium sulfate, processed through an alumina cleanup column, and concentrated to approximately 900-µL for additional HPLC cleanup. Raw extracts (post-alumina) will be fractionated by HPLC (BOS SOP 5-191). The post-HPLC extract will be concentrated under nitrogen to approximately 0.5 mL, and spiked with recovery internal standards (RIS).

The flounder liver, lobster hepatopancreas, or mussel tissue final extract will be split for analysis, one half remaining in DCM for PAH analysis, and the other half solvent-exchanged with hexane for PCB and pesticide analysis. The entire final extract of flounder or lobster edible tissue will be solvent-exchanged with hexane for PCB and pesticide analysis only.

Dry weight determinations will be performed by drying a portion of each composite sample.

Lipid results will be gravimetrically measured by evaporating an aliquot of the organic extract and weighing the remaining residue. Results will be reported in percent dry wt.

PAH Analysis - Trace level organic compounds (PAH) are identified using electon impact gas chromatography/mass spectrometry (GC/MS). Target compounds are separated using an HP 5890 Series II gas chromatograph or HP 6890 equipped with a 60-m x 0.25-mm-inner diameter (0.25-um film thickness) DB-5 column (J&W Scientific) and measured using a HP 5972a or HP 6890 mass selective detector operated in the selective ion monitoring (SIM) mode following Battelle SOP 5-157. Concentrations for all target analytes will be determined by the method of internal standard, using surrogate internal standards (SISs) for quantification. All PAH results will be reported in ng/g dry wt.

PCB/Pesticide Analysis - Pesticides and PCB congeners will be analyzed and quantified using gas chromatography/electron capture detection (GC/ECD) (Hewlett Packard 5890 Series 2 GC or HP 6890) using a 60-m DB-5 column and hydrogen as the carrier gas following Battelle SOP 5-128, including a second column for confirmation. Concentrations for all target analytes will be determined by the method of internal standard, using surrogate internal standards (SISs) for quantification. All PCB and pesticide results will be reported in ng/g dry wt.

12.5.2 Metal Analyses

For lobster tissue in 1998 and all fish and shellfish tissue since 1999, metals analyses are conducted by Battelle's Marine Sciences Laboratory in Sequim, WA. The methods described below refer to Sequim's procedures (see Lefkovitz and Moore, 1998 for methods employed under contract S274 prior to these changes).

Tissue Digestion - Mussel tissue; flounder liver and fillet; and lobster hepatopancreas and edible tissue will be digested using an aqua regia procedure according to Battelle SOP MSL-I-006 *Aqua Regia Sediment and Tissue Digestion*. To prepare tissue samples for metals analysis, samples are first freeze-

dried and homogenized in a ball-mill. A 200- to 300-mg aliquot of each dried, homogeneous sample is combined with aqua regia (nitric and hydrochloric acids at a ratio of 5.0 mL:3.5 mL) in a Teflon bomb and heated in an oven at 130 ºC (±10 ºC) overnight. After heating and cooling, deionized water is added to the acid-digested tissue to achieve analysis volume and the digestates are submitted for analysis.

Alternatively, in cases where hydrochloric acid in the digestion procedure can be found to cause chloride interferences with certain metals during ICP-MS analysis, tissue samples may be processed using a nitric acid-only digestion procedure, Battelle SOP MSL-I-005 *Hot Nitric Acid Digestion of Sediments and Tissues*. An approximately 300-mg aliquot of each dried, homogeneous tissue sample and nitric acid are combined in a glass vial. The vials are loosely capped and heated on a hot plate at a temperature just high enough to boil the acid, without boiling over or evaporating the sample to dryness. After heating and cooling, deionized water is added to the acid-digested tissue to achieve analysis volume and the digestates are submitted for analysis.

CVAA Analysis of Hg - Sample digestates will be analyzed for Hg using cold-vapor atomic absorption spectroscopy (CVAA) according to Battelle SOP MSL-I-016 *Total Mercury in Tissues and Sediments by Cold Vapor Atomic Absorption*, which is based on EPA Method 245.6 *Determination of Mercury in Tissues by Cold Vapor Atomic Absorption Spectrometry* (EPA 1991a). Results are reported in units of µg/g on a dry-weight basis.

ICP-MS Analysis of Ag, Cd, Cr, Cu, Ni, Pb, and Zn - For analysis of multiple metals simultaneously, sample digestates will be analyzed for Ag, Cd, Cr, Cu, Ni, Pb, and Zn using inductively coupled plasma - mass spectrometry (ICP-MS) according to Battelle SOP MSL-I-022 *Determination of Elements in Aqueous and Digestate Samples by ICP/MS*. This procedure is based on two methods modified and adapted for analysis of solid sample digestates, EPA Method 1638 *Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma - Mass Spectrometry* (EPA 1996) and EPA Method 1640 *Determination of Trace Elements in Water by Preconcentration and Inductively Coupled Plasma - Mass Spectrometry* (EPA 1997). Results are reported in units of µg/g on a dry-weight basis.

GFAA Analysis of Selected Metals - Sample digestates may also be analyzed by graphite furnace atomic absorption (GFAA) for a single element (except Hg), when samples are found to have particularly high metals concentrations or if results of QC samples do not meet data quality objectives. GFAA analysis will be conducted according to Battelle SOP MSL-I-029 *Determination of Metals in Aqueous and Digestate Samples by GFAA*. This procedure is based on EPA Method 200.9 *Determination of Trace Elements by Stabilized Temperature Graphite Furnace Atomic Absorption Spectrometry* (EPA 1991b). Results are reported in units of µg/g on a dry-weight basis.

ICP-AES Analysis of Selected Metals - Sample digestates may also be analyzed by inductively coupled plasma-atomic emission spectrometry (ICP-AES) for a single element (except Hg), when samples are found to have particularly high metals concentrations or if results of QC samples do not meet data quality objectives. ICP-AES analysis will be conducted according to Battelle SOP MSL-I-027 *Determination of Metals in Aqueous and Digestate Samples by ICP-AES*. This procedure is based on EPA Method 200.7 *Determination of Metals and Trace Elements by Inductively Coupled Plasma-Atomic Emission Spectrometry* (EPA 1994) and SW-846 Method 6010B *Inductively Coupled Plasma-Atomic Emission Spectrometry* (update 12/96). Results are reported in units of µg/g on a dry-weight basis.

12.6 Flounder Histological and Mussel Condition Analysis (Task 25)

Flounder histology and mussel biological analyses will follow the procedures described in the section below.

12.6.1 Flounder Histology

Livers of 50 flounder from each site will be examined for histological analysis by Experimental Pathology Laboratories in Herndon, VA. as described below. The age of each flounder will be determined by NMFS scientists through analysis of growth rings (annuli) on the scales removed during the conduct of the Flounder Collection (Task 21) as described in CW/QAPP Section 12.2.2.

Transverse sections of flounder livers fixed as part of Tissue Sample Processing (see CW/QAPP Section 12.2.2) will be removed from the buffered formalin after at least 24 hours, rinsed in running tap water, dehydrated through a series of ethanols, cleared in xylene, and embedded in paraffin. Paraffin-embedded material will be sectioned on a rotary microtome at a thickness of 5 μm. Each block will be sectioned at one level, resulting in one slide per fish and a total of 250 slides per year. The sections will be stained in hematoxylin and eosin.

Each slide will be examined under bright-field illumination at 25x, 100x, and 200x to quantify the presence and extent of:

- Three types of vacuolation (centrotubular, tubular hydropic, and focal hydropic)
- Macrophage aggregation
- Biliary duct proliferation
- Neoplasia
- Apoptotic lesions (i.e. balloon cells)

The severity of each of the above listed lesions will be rated on a scale of 0 to 4, where: 0 = absent; 1 = minor; 2 = moderate; 3 = severe; and 4 = extreme. For each lesion and each fish, a histopathological index will then be calculated as a mean of scores from three slices on one slide.

12.6.2 Mussel Biological Condition

For biological analyses, a random subsample of 15 or 30 mussels (see Table 13) will be selected from the predeployment mussels and from each of the four stations' 60-day collection. Mussels for biological analyses will be processed to obtain total shell length (Figure 10), total wet weight and reproductive condition, following Battelle SOP 5-031.

In the laboratory, each mussel will be cleaned of attached material (barnacles, byssal threads, etc.). The total shell length (umbo to distal portion of valve gape) will be measured with a Vernier caliper (to the nearest 0.1mm). The total soft tissue, gonadal tissue, and the non-gonadal tissue weights will be measured on an electronic balance to the nearest 0.01g wet weight.

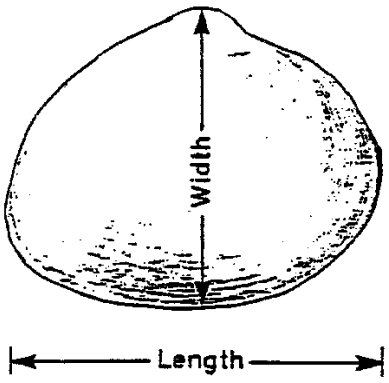

Figure 10. Length and Width Measurements of Mussels.

13.0 SAMPLE CUSTODY

A unique eight character *Sample ID,* will identify samples collected in the field. The *Sample ID* will identify the sample collected (i.e. a single flounder, or a single lobster, or a mussel composite). The five character *Event ID* will be unique to each survey, such as "FF981", with "FF" indicating that it is a Flounder survey, "98" indicating the survey year, and "1" signifying the first survey of the year. For individual flounder and lobster, the *Sample ID* will consist of the *Event ID*, the Station Number and a three digit sequential number (001-050 for flounder and 001-015 for lobster). For mussels, the *Sample ID* will consist of the *Event ID*, the Station Number, and the *Composite ID*. The *Composite ID* is a four place alphanumeric laboratory ID (XX00) that also serves as the *Bottle ID*. Unique *Bottle ID*s are assigned to edible tissue and hepatopancreas/liver tissue from each fish or lobster.

13.1 Custody of Electronic Data

13.1.1 Navigation Data

Custody of navigation data will be the responsibility of the Chief Scientist during the field activity and of Wayne Trulli, Battelle's Field Manager, at the laboratory. This navigation data, including survey ID, date, time, trawl number, and vessel position at start and completion of each sampling event, will be recorded in the survey logbook.

13.1.2 Laboratory Data

Battelle and WHOI will produce electronic data generated under this task. At Battelle, the electronic files for chemical data will remain in the custody of the analysts until all analyses are completed and data have gone through the Battelle Quality Assurance Unit. Two copies of each type of electronic file will be made. Set 1 will remain in custody of the Senior Scientist in the Task notebook. Set 2 will be transferred the HOM3 Database Manager for entry into the MWRA database.

13.2 Flounder, Lobster, and Mussel Samples

During field collection, COC forms will be completed. Manual entries will be recorded in indelible ink in the data section of the chain-of-custody. Based on the types of samples that will be collected, chain-of-custody forms will be generated for each sample type to track samples from collection to laboratory. Figure 11 shows an example of a chain-of-custody form that will be used.

The samples will remain in the custody of the Field Sample Custodian (designated for each survey) while in the field. COC forms will accompany the samples when transferred from the field to the laboratory. All samples will be distributed to the appropriate laboratory personnel by hand or by Federal Express. When samples arrive at the laboratory, custody will be relinquished to the Laboratory Custodian. Upon receipt of the samples at Battelle or WHOI, the Sample Custodian will examine the samples, verify that sample-specific information recorded on the COC is accurate and that the sample integrity is uncompromised, log the samples into the laboratory tracking system, complete the custody forms, and sign the COC form so that transfer of custody of the samples is complete. Any discrepancies between sample labels and transmittal forms, and unusual events or deviations from the project CW/QAPP will be documented in detail on the COC and the Senior Scientist and Laboratory Manager notified. The original COC forms will be submitted to the Battelle MWRA Laboratory Manager and maintained in the MWRA project files. Due to the complexity of the field IDs, unique laboratory specific sample IDs may be assigned to individual composite samples during sample Log-in.

Before the field surveys, a checklist of all samples to be collected for Tasks 21 – 23 in the field will be prepared and included in the survey plan.

13.3 Histology Samples

The laboratory custodian of samples for histologic analyses will be Dr. Michael Moore, of WHOI. He will be responsible for shipping the samples to be histologically processed to Experimental Pathology Laboratories in Herndon, VA., where chain-of-custody forms will be signed by the receiving histology technician Keith Rogers. The tissue slices will be embedded in the same tissue cassettes labeled at the time of collection. Sample numbers will be copied from the cassettes to the slides at the time of sectioning the embedded blocks. The blocks and slides will be returned to Dr. Moore, chain-of-custody forms signed again and all histology material thereafter will be archived at WHOI.

13.4 Samples for Tissue Chemistry

The laboratory custodian of samples for chemical analyses will be Mr. James Hatch of Battelle. He will be responsible for receiving samples (by signing the chain-of-custody) for tissue chemical analysis. Unique laboratory sample identification numbers will be used to track samples through the chemistry laboratory. If samples are composited, a compositing form will be completed (see Figure 12). Tissue samples for inorganic analysis will be shipped to Battelle's Marine Sciences Laboratory in Sequim, Washington and will be accompanied by a chain-of-custody form to be signed by the receiving laboratory custodian at Sequim.

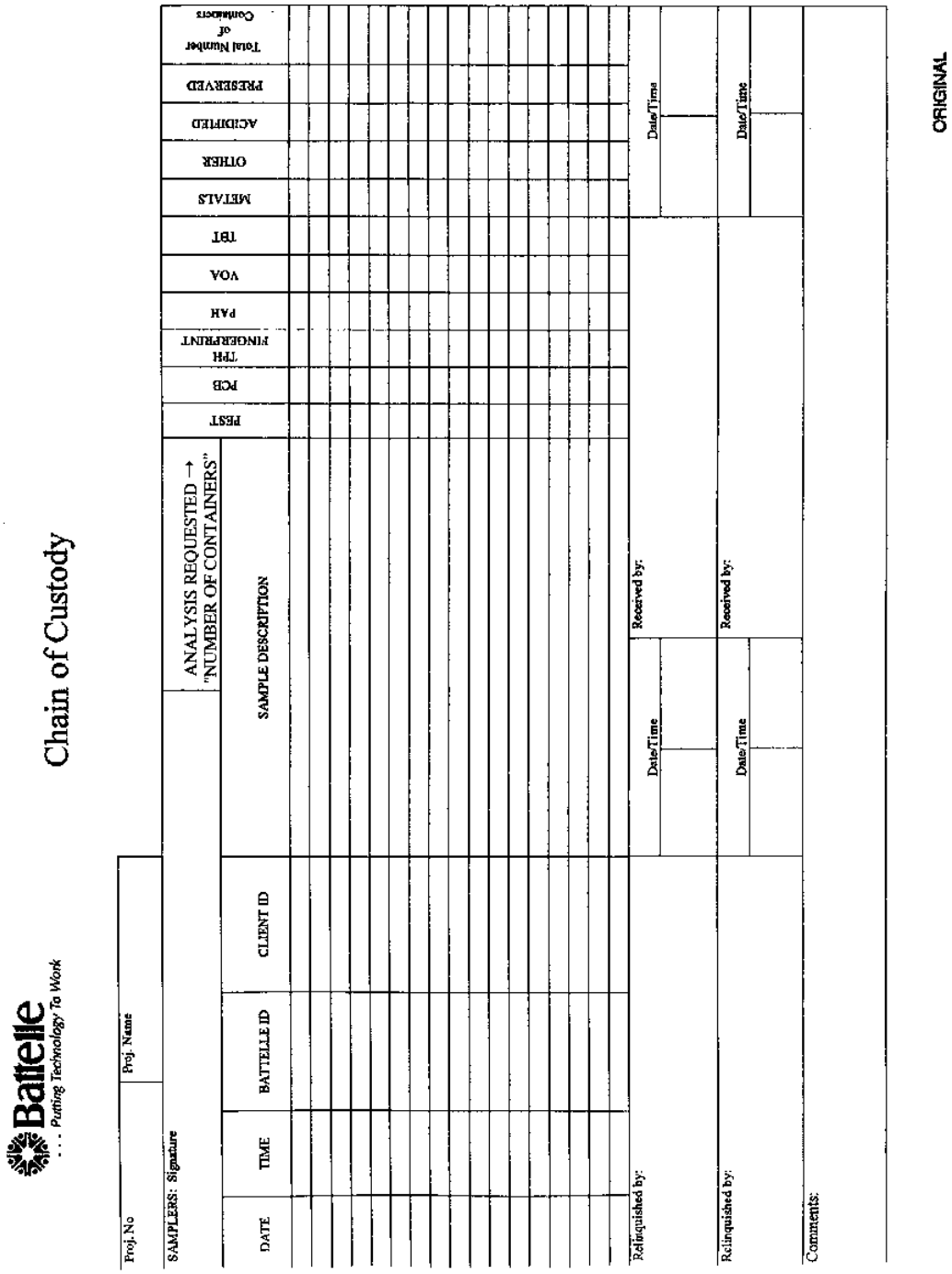

Figure 11. Field Chain of Custody Record.

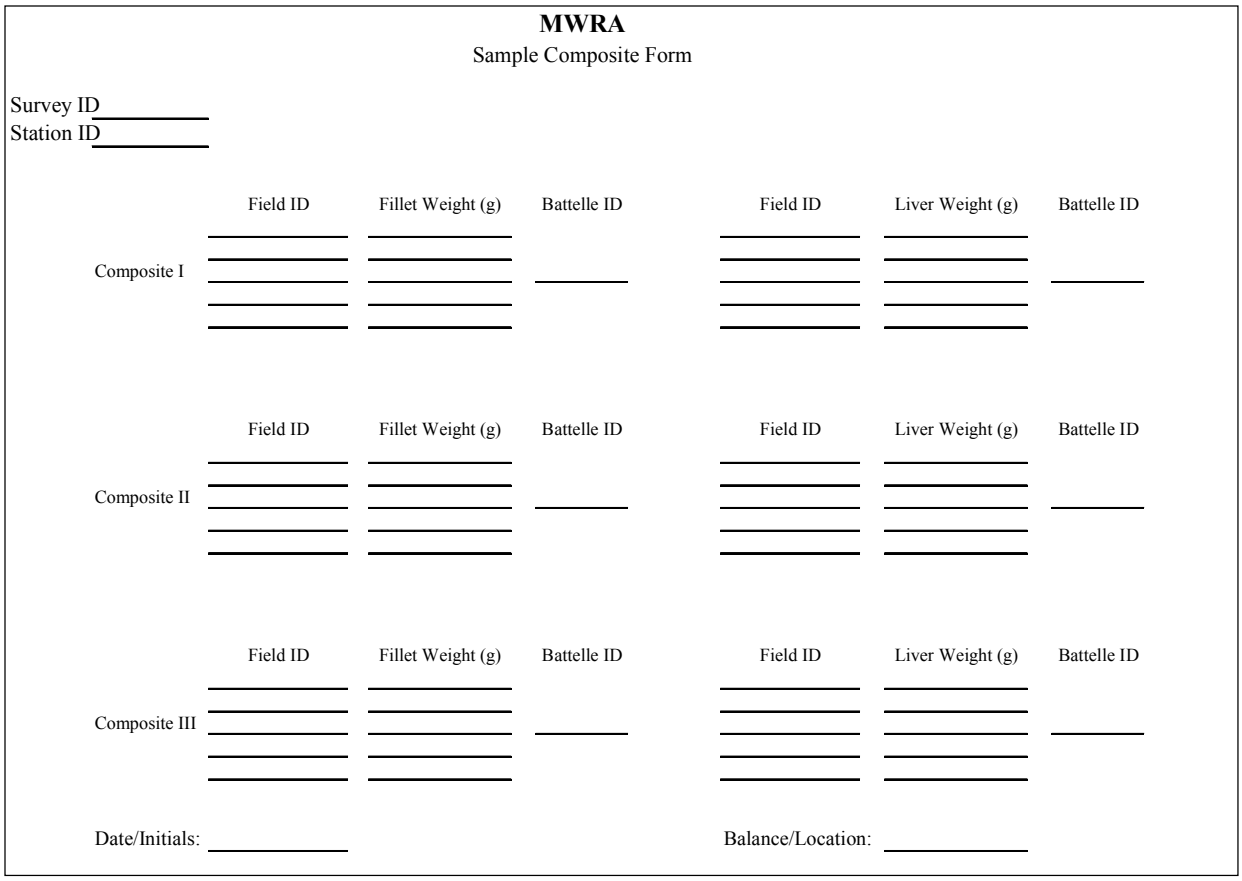

Figure 12. Sample Compositing Log – Lobster

14.0 CALIBRATION PROCEDURES AND PREVENTIVE MAINTENANCE

Logs of maintenance, calibrations, and any repairs made to instruments will be maintained by the respective subcontractors. Maintenance of and repairs to instruments will be in accordance with manufacturers' manuals and facility SOPs.

14.1 Navigation Equipment

Once the 12 VDC power supply for the Northstar 941XD navigation system has been switched on, there is typically no other setup interaction necessary between the Seasoft operator and the navigation system. The GPS will conduct an automatic self-test, and then begin acquiring satellites and a beacon. This process normally takes 2 to 5 minutes. An error message will be displayed if the system has trouble acquiring satellites or a beacon. For each survey, the GPS position will be verified by comparing it to previously located benchmarks. At a minimum, the position will be verified once, at the dock. In addition, the geometry and number of satellites will be checked periodically throughout the survey. Cable connections and antenna mounts and brackets will be inspected and secured at regular intervals. The navigation system calibration will be checked twice per day at a land-based location.

14.2 Field Equipment

Instruments will be calibrated according to the following methods:

- Measuring boards used to measure flounder will be wiped dry after measuring every 10th specimen and will be rinsed after sampling has been completed at each sampling site.
- The Normark fish scale, Model No. 70-2030, will be dried after weighing every 10th fish and will be calibrated with a known weight after sampling has been completed at each sampling site. The scale will be inspected prior to measuring each fish to ensure that it reads zero.
- The knife used to remove scales from flounder will be wiped clean after collecting samples from each specimen.

Calipers used to measure the carapace length of specimens will be wiped dry after sampling has been completed at each sampling site.

14.3 Histological Equipment

The primary analytical instrument used for the histological analyses is a Zeiss photomicroscope. No calibrations are required. When not in use, the microscope will be covered to prevent excess dust from settling on it. The lenses will be cleaned periodically with lens cleaning fluid.

14.4 Chemical Analytical Equipment

All laboratory equipment will be calibrated and maintained according to Battelle Standard Operating Procedures (SOPs). Procedures are described below. Table 15 summarizes the calibration requirements for laboratory equipment.

Table 15. Laboratory Instrument Calibration Procedures.

		Initial Calibration			Continuing Calibration		
Parameter	Instrument Type[a]	No. Stds	Acceptance Criteria	Frequency	Acceptance Criteria	Frequency	Corrective Action
PAH	GC/MS	∃5	RSD #25% mean RSD #15%	prior to analytical run	PD from initial #25%; mean PD #15%	every 10 samples	Remedial maintenance, new initial calibration, or reanalyze samples. Document and justify.
PCB/ Pesticide	GC/ECD	∃5	r ∃ 0.995	prior to analytical run	PD from true value #25%; mean PD #15% (for concentrations)	every 10 samples	Remedial maintenance, new initial calibration, or reanalyze samples. Document and justify.
Metals-Tissue	ICP-MS (other than Hg)	∃3 (4)	r ∃ 0.995	prior to analytical run	PD #15% of initial	every 10 samples	Remedial maintenance, new initial calibration, or reanalyze samples. Document and justify.
	ICP-AES	∃3	r ∃ 0.995		PD #15% of initial	every 10 samples	
	GFAA (as required)	∃3	r∃0.995		PD #15% of initial	every 10 samples	
	CVAA (Hg);	∃3 (5)	r ∃ 0.995		PD #15% of initial	every 10 samples	

NA: Not Available.
[a] Analytical procedures are described in Section 12.0 and listed in Table 14.

14.4.1 Organic Analysis

14.4.1.1 GC/MS

Instrumental calibration, operation, maintenance, and QC procedures for the GC/MS analysis of samples for PAH will be performed according to Battelle SOPs 3-092 and 5-157, a modification of NOAA status and trends methodology. The GC/MS will be tuned with perfluorotributylamine (PFTBA) before the initiation of the sample sequence. Analytical instruments will be calibrated before sample analysis and response factors (RF) will be generated for each PAH target analyte (Table 6).

The GC/MS system calibrations will be verified using a mid-range calibration check. Using the mean RF of each analyte from the initial calibration, the percent difference between those mean values and the RFs from the midrange calibration checks will be calculated. If the percent difference between the RFs is greater than the acceptability criteria, remedial maintenance will be performed on the instrument, and a new calibration check standard analyzed. If the check standard then meets the acceptance criteria, the affected samples will be reanalyzed. If the check standard still does not meet the acceptance criteria then a new initial calibration will be performed, and the affected batch of samples will be reanalyzed, at the discretion of the Task Leader. Because GC/MS analysis is a multi-component analysis, it may not be necessary to reanalyze all bracketed samples if a mid-range calibration check standard does not meet the acceptability criteria. This decision will be based on a comparison of the analytes detected in the samples vs. the target analytes, which did not meet the mid-check acceptability criteria. Reanalysis will only be necessary if RFs for the analytes that are detected in a sample did not meet the criteria. Reanalysis will be performed at the discretion of the Senior Scientist. Deviations from calibration or data objectives will be documented in the project files.

Samples analyzed by GC/MS will be bracketed by two acceptable calibrations, initial or check. Analytes will be quantified by using the average RFs for that individual PAH analyte generated from the initial calibration following the method of internal standards, using surrogate internal standard (SIS) compounds.

Response factors (RF) will be generated for each target analyte using the following equation:

$$RF = \frac{A_x}{A_{is}} x \frac{C_{is}}{C_x}$$

where:
- A_x = peak area of the analyte in the calibration standard
- A_{is} = peak area of the appropriate internal standard in the calibration standard
- C_x = concentration of the analyte in the calibration standard
- C_{is} = concentration of the appropriate internal standard in the calibration standard.

Using the mean RF of each analyte from the initial calibration, the percent difference between those mean values and the RFs from the midrange calibration checks will be calculated. The relative percent difference (RPD) is calculated by:

$$RPD = [(RF_i - RF_r) / RF_i] \; x \; 100$$

where
- RF_i = average response factor from the initial calibration, and
- RF_r = response factor from the midrange calibration check.

14.4.1.2 GC/ECD

Instrumental calibration, operation, maintenance, and QC procedures for gas chromatography with electron capture detection (GC/ECD) will be performed in accordance with Battelle SOPs 3-116 and 5-128, a modification of NOAA status and trends methodology. Dual-column analysis will be performed. Data acquired from the second column will be used qualitatively. Analytical instruments will be calibrated before sample analysis and a calibration curve using the quadratic equation method will be generated for each PCB and pesticide target analyte (Table 6).

A mid-level calibration check standard will be analyzed to verify the GC/ECD system calibration during analysis. This check standard will be quantified in the same manner as field and QC samples. If the percent difference between the detected and true concentrations of the target pesticides and PCB congeners is greater than the acceptability criteria, remedial maintenance will be performed on the instrument, and a new calibration check standard analyzed. If the check standard then meets the acceptance criteria, the affected samples will be reanalyzed. If the check standard still does not meet the acceptance criteria then a new initial calibration will be performed, and the affected batch of samples will be reanalyzed, at the discretion of the Task Leader. Because GC/ECD analysis is a multi-component analysis, it may not be necessary to reanalyze all bracketed samples if a mid-range calibration check standard does not meet the acceptability criteria. This decision will be based on a comparison of the analytes detected in the samples vs. the target analytes, which did not meet the mid-check acceptability criteria. Reanalysis will only be necessary if percent differences for the analytes that are detected in a sample did not meet the criteria. Reanalysis will be performed at the discretion of the Senior Scientist. Deviations from calibration or data objectives will be documented in the project files.

Samples analyzed by GC/ECD will be bracketed by two acceptable calibrations, initial and check. Analytes will be quantified using the calibration curve generated from the initial calibration following the method of internal standards, using surrogate internal standard (SIS) compounds. All target analytes run by GC/ECD will be qualitatively confirmed by a second column.

14.4.2 Metal Analysis

14.4.2.1 CVAA

Instrument calibration, operation, and maintenance procedures for CVAA analysis of tissue samples for Hg will be conducted according to Battelle SOP MSL-I-016-02 *Total Mercury in Tissues and Sediments by Cold Vapor Atomic Absorption*. The instrument is maintained by the analyst, with the assistance of service personnel from Thermo-Separation Products. The soda lime trap and reagents (stannous chloride, 3% nitric acid, and rinse water) are checked daily and changed weekly under constant use. The carbon trap and filters are checked weekly and changed bimonthly under constant use. The sample injection syringe, tubing, connectors, and lamp are checked weekly and changed as needed, and the autosampler arm should be cleaned and lubricated bimonthly.

14.4.2.2 ICP-MS

Instrument calibration, operation, and maintenance procedures for ICP-MS analysis of tissue samples for metals will be conducted according to Battelle SOP MSL-I-022 *Determination of Elements in Aqueous and Digestate Samples by ICP/MS*. The instrument is maintained by the analyst, with the assistance of a service engineer from Perkin-Elmer, under a maintenance agreement. The argon supply pressure, base and operating vacuum, temperature of cooling chiller, and nebulizer flow are checked daily by the analyst. Instrument sensitivity and stability are checked each day of operation.

14.4.2.3 GFAA

Instrument calibration, operation, and maintenance procedures for GFAA analysis of tissue samples for metals will be conducted according to Battelle SOP MSL-I-029 *Determination of Metals in Aqueous and Digestate Samples by GFAA*. The instrument is maintained by the analyst, with the assistance of a service engineer from Perkin-Elmer on an as-needed basis. Argon supply pressure is checked by the analyst daily. Other daily maintenance includes inspection of the furnace tube, contact rings, and optical windows.

14.4.2.4 ICP-AES

Instrument calibration, operation, and maintenance procedures for ICP-AES analysis of tissue samples for metals will be conducted according to Battelle SOP MSL-I-027 D*etermination of Metals in Aqueous and Digestate Samples by ICP-AES*. The instrument is maintained by the analyst, with the assistance of a service engineer from Perkin-Elmer on an as-needed basis. Maintenance of the ICP-AES instrumentation will include complete cleaning of sample and skimmer cones, replacing sampling tubes, and optimizing the instrument sensitivity by adjusting and cleaning the lenses. The base vacuum, operating vacuum, and gas flow rates will also be checked and adjusted as necessary.

15.0 DOCUMENTATION, DATA REDUCTION, AND REPORTING

15.1 Documentation Data Recording

Documentation will include sample collection logs, chain-of-custody forms, and laboratory records. Sample collection information will be recorded on standard forms that, at a minimum, should include sample location, time and date, sampler's identification, and sample ID number. Examples of sample collection logs are given in Section 12.0. Chain-of-custody records are discussed in Section 13.0.

All data will be initially recorded either (1) electronically onto computer storage media from BOSS or other laboratory systems or (2) manually into bound laboratory notebooks or onto established data forms. All notes will be written in black ink. Corrections to hand-entered data will be initialed, dated, and justified. Completed data forms or other types of hand-entered data will be signed and dated by the individual entering the data. Direct-entry and electronic data entries will indicate the person collecting or entering the data. It will be the responsibility of the laboratory managers to ensure that all data entries and hand calculations are verified in accordance with procedures described in Section 16 (below). In addition to these documentation procedures, station logs associated with field custody forms will be kept in a survey notebook for each survey. These notebooks will be stored under the supervision of Ms. Jeanine Boyle. Laboratory tracking forms will be kept with the analytical data packages for each batch.

15.2 Data Reduction

Data reduction involves the process of converting raw numbers into data that have direct physical, biological or chemical meaning and can be compared statistically.

15.2.1 Navigation Data

All sample IDs and sample collection information will be recorded by hand and transferred to an electronic format (i.e. MS Excel) with date, time, and concurrent GPS/LORAN vessel-position data.

15.2.2 Histopathological and Morphological Data

Flounder Field Data – The Catch Per Unit Effort (CPU) will be calculated at each flounder sampling station. CPU is calculated as the total number of flounder caught per unit of bottom trawl time. The gross external condition ("External Lesions") of each flounder is rated on a scale of 0 to 4. The severity of fin rot and gross liver lesions are scored from 0 to 4, where: 0 = absent; 1 = minor; 2 = moderate; 3 = severe; and 4 = extreme. A histopathological index will then be calculated as a mean of scores from fish at each station.

Flounder Liver Histology – From the prepared liver sections, the severity of each flounder liver lesion will be rated on a scale of 0 to 4, where: 0 = absent; 1 = minor; 2 = moderate; 3 = severe; and 4 = extreme. For each lesion and each fish, a histopathological index will then be calculated as a mean of scores from three slides. For each lesion type, the percent prevalence will be calculated based on the three liver sections from each fish. The equation for percent prevalence is the number of fish showing any one lesion (in any of the three liver sections) divided by the number of fish examined and multiplied by 100. The percent prevalence of centrotubular hydropic vacuolation (CHV) is calculated as the number of fish showing any degree of CHV (in any of the three liver sections) divided by the number of fish examined and multiplied by 100. Data resulting from the assignment of scores to the various lesions will be transferred in electronic format to database personnel. Analyses of variance will be used to compare lesions from site to site and annually from 1998 to 2001.

15.2.3 Mussel Biological Condition Data

Mussel biological condition data will be recorded manually in laboratory notebooks. Data will then be entered into a standard format Excel spreadsheet for reduction that includes calculating the shell volume, gonadal condition index, and the condition index. For the mussel biological condition data, the effective density of the mussel cavity contents is assumed to be 1 g/cm^3, based on the work of Lawrence, *et al*. (1982).

$$\text{Shell Volume (cm}^3\text{)} = \text{Total Weight (g)} - \text{Shell Weight (g)}$$

$$\text{Gonad Condition Index} = \text{Dry Gonad Weight (g)/Total Dry Weight of Meat (g)} \times 100$$

$$\text{Condition Index} = \text{Total Dry Weight of Meat (g)/Shell Volume (cm}^3\text{)} \times 100$$

These standardized Excel spreadsheets will be submitted for entry into the database.

15.2.4 Tissue Chemistry Data

15.2.4.1 Chemical Data Acquisition

The GC/ECD data is collected and processed on the Labsystems X-Chrom data system. This system allows data acquisition from the instruments with either analog or digital signals. The data are calibrated and processed with either a linear or quadratic equation. The data tables are generated in Excel from electronically transferred data from the X-Chrom system.

GC/MS data is collected and processed using the HP EnviroQuant Environmental Data Analysis software. Processed data is electronically transferred to an Excel database program for custom report generation.

Data for metals analysis by GVAA, ICP-MS, ICP-AES, and GFAA are collected and processed by the instruments' software systems. Processed data are electronically transferred to Excel spreadsheet format for report generation.

15.2.4.2 Statistical Evaluation of Chemical Data

Statistical evaluations will be performed on all QC samples. Percent recoveries of the spiked analytes will be calculated for all matrix spike and matrix spike duplicate samples, SRMs, and surrogates as follows:

$$\%Recovery = \frac{Amount\ Detected(ng)}{Amount\ Expected(ng)} x100$$

Additionally, RPD between the MS and MSD samples will be calculated as follows:

$$RPD = \frac{2x(A_{MS} - A_{MSD})}{A_{MS} + A_{MSD}} x100$$

where A_{MS} = amount of analyte detected in MS sample
A_{MSD} = amount of analyte detected in MSD sample.

The RPD between sample duplicates will be calculated as follows:

$$RPD = \frac{2x(C_1 - C_2)}{(C_1 + C_2)} x100$$

where C_1 = concentration (ng/g) of analyte detected in sample 1
C_2 = concentration (ng/g) of analyte detected in sample 2

Data quality objectives for these calculations are presented in Table 9.

The surrogate (SIS) recovery data are placed in the QC_RESULTS table in the EM&MS database. This table has the same structure as the Analytical Results table.

15.3 Reporting Data to Be Loaded Into the Data Base

All field and laboratory data to be loaded into the EM&MS will be submitted to Battelle in electronic format. The laboratories will supply their results electronically to database personnel, who will use proprietary software to prepare it for loading.

15.3.1 Navigation and Sample Collection Data

Navigation and sample collection data will be collected on-board the survey vessel. Field personnel will submit the sample collection data electronically to data personnel. The data will be loaded into the EM&MS database by using a proprietary software. All database constraints developed by MWRA will be applied to the tables so that the data are checked during the insert.

15.3.2 Analytical, Morphological, and Histopathological Data

Laboratories will submit their final spreadsheets to database personnel who will use proprietary software to automatically load them. The laboratory will have to use a prescribed spreadsheet format, provided by Battelle database personnel, for the data to load successfully. Loading the data directly from the instrument output spreadsheets prevents the introduction of transcription errors. If a fish is collected and assigned a sample ID but then dies, a comment will be made to the Station Table. The Sample ID will not be added to the Sample Table.

MWRA has the responsibility for maintaining the code list for the EM&MS. Tables 16, 17, 18, and 19 show the analytical, morphological, and histopathological parameters and related database codes for the fish and shellfish surveys. The Study ID for all fish and shellfish monitoring surveys is "BFISH". Any modifications or corrections of these codes will be addressed jointly by the Battelle database manager and the MWRA EM&MS manager.

Table 16. Analytical Parameters and Database Codes for Fish and Shellfish Monitoring.

PARAM_CODE	DESCR	METH_CODE	INSTR_CODE
1022-22-6	4,4 DDD OLEFIN (DDMU)	BSOP5-128DUAL	GCECD
118-74-1	HEXACHLOROBENZENE	BSOP5-128DUAL	GCECD
120-12-7	ANTHRACENE	BSOP5-157	GCMS
127330-66-9	DIBENZOTHIOPHENE	BSOP5-157	GCMS
129-00-0	PYRENE	BSOP5-157	GCMS
132-64-9	DIBENZOFURAN	BSOP5-157	GCMS
191-24-2	BENZO(G,H,I)PERYLENE	BSOP5-157	GCMS
192-97-2	BENZO(E)PYRENE	BSOP5-157	GCMS
193-39-5	INDENO(1,2,3-C,D)PYRENE	BSOP5-157	GCMS
198-55-0	PERYLENE	BSOP5-157	GCMS
205-99-2	BENZO(B)FLUORANTHENE	BSOP5-157	GCMS
2051-24-3	DECACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
206-44-0	FLUORANTHENE	BSOP5-157	GCMS
207-08-9	BENZO(K)FLUORANTHENE	BSOP5-157	GCMS
208-96-8	ACENAPHTHYLENE	BSOP5-157	GCMS
218-01-9	CHRYSENE	BSOP5-157	GCMS
2245-38-7	2,3,5-TRIMETHYLNAPHTHALENE	BSOP5-157	GCMS
2385-85-5	MIREX	BSOP5-128DUAL	GCECD
24143-69-9	TRANS_NONACHLOR	BSOP5-128DUAL	GCECD
309-00-2	ALDRIN	BSOP5-128DUAL	GCECD
31508-00-6	2,3',4,4',5-PENTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
32598-10-0	2,3',4,4'-TETRACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
32598-13-3	3,3',4,4'-TETRACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
32598-14-4	2,3,3',4,4'-PENTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
34883-43-7	2,4'-DICHLOROBIPHENYL	BSOP5-128DUAL	GCECD
35065-27-1	2,2',4,4',5,5'-HEXACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
35065-28-2	2,2',3,4,4',5-HEXACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
35065-29-3	2,2',3,4,4',5,5'-HEPTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
35065-30-6	2,2',3,3',4,4',5-HEPTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
35693-99-3	2,2',5,5'-TETRACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
37680-65-2	2,2',5-TRICHLOROBIPHENYL	BSOP5-128DUAL	GCECD
37680-68-5	2',3,5-TRICHLOROBIPHENYL	BSOP5-128DUAL	GCECD
37680-73-2	2,2',4,5,5'-PENTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
38380-07-3	2,2',3,3',4,4'-HEXACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
40186-72-9	2,2',3,3',4,4',5,5',6-NONACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
41464-39-5	2,2',3,5'-TETRACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
50-29-3	P,P-DDT	BSOP5-128DUAL	GCECD
50-32-8	BENZO(A)PYRENE	BSOP5-157	GCMS
5103-71-9	CIS-CHLORDANE	BSOP5-128DUAL	GCECD
52663-68-0	2,2',3,4',5,5',6-HEPTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
52663-78-2	2,2',3,3',4,4',5,6-OCTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
53-70-3	DIBENZO(A,H)ANTHRACENE	BSOP5-157	GCMS
56-55-3	BENZ(A)ANTHRACENE	BSOP5-157	GCMS

PARAM_CODE	DESCR	METH_CODE	INSTR_CODE
56558-16-8	2,2',4,6',6-PENTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
57465-28-8	3,3',4,4',5-PENTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
58-89-9	LINDANE	BSOP5-128DUAL	GCECD
581-42-0	2,6-DIMETHYLNAPHTHALENE	BSOP5-157	GCMS
60-57-1	DIELDRIN	BSOP5-128DUAL	GCECD
7012-37-5	2,4,4'-TRICHLOROBIPHENYL	BSOP5-128DUAL	GCECD
72-20-8	ENDRIN	BSOP5-128DUAL	GCECD
72-54-8	P,P-DDD	BSOP5-128DUAL	GCECD
7439-92-1	LEAD	MSL-I-022	ICPMS
7439-97-6	MERCURY	MSL-I-016	CVAA
7440-02-0	NICKEL	MSL-I-022	ICPMS
7440-22-4	SILVER	MSL-I-027	ICPAES
7440-43-9	CADMIUM	MSL-I-027	ICPAES
7440-47-3	CHROMIUM	MSL-I-029	GFAA
7440-50-8	COPPER	MSL-I-027	ICPAES
7440-66-6	ZINC	MSL-I-027	ICPAES
74472-36-9	2,3,3',5,6-PENTACHLOROBIPHENYL	BSOP5-128DUAL	GCECD
75-55-9	P,P-DDE	BSOP5-128DUAL	GCECD
789-02-6	O,P-DDT	BSOP5-128DUAL	GCECD
83-32-9	ACENAPHTHENE	BSOP5-157	GCMS
832-69-9	1-METHYLPHENANTHRENE	BSOP5-157	GCMS
85-0108	PHENANTHRENE	BSOP5-157	GCMS
86-73-7	FLUORENE	BSOP5-157	GCMS
90-12-0	1-METHYLNAPHTHALENE	BSOP5-157	GCMS
91-20-3	NAPHTHALENE	BSOP5-157	GCMS
91-57-6	2-METHYLNAPHTHALENE	BSOP5-157	GCMS
92-52-4	BIPHENYL	BSOP5-157	GCMS
95-16-9	BENZOTHIAZOLE	BSOP5-157	GCMS
D10-85-0108	PHENANTHRENE-D10 (surrogate)	BSOP5-157	GCMS
D12_218-01-9	CHRYSENE-D12 (surrogate)	BSOP5-157	GCMS
D8_91-20-3	NAPTHALENE-D8 (surrogate)	BSOP5-157	GCMS
LIPID	Lipids	BSOP5-190	BAL
MWRA10	C3-NAPHTHALENES	BSOP5-157	GCMS
MWRA11	C4-NAPHTHALENES	BSOP5-157	GCMS
MWRA24	HEPTACHLOREPOXIDE	BSOP5-128DUAL	GCECD
MWRA25	HEPTACHLOR	BSOP5-128DUAL	GCECD
MWRA33	O,P-DDD	BSOP5-128DUAL	GCECD
MWRA34	O,P-DDE	BSOP5-128DUAL	GCECD
MWRA4	C2-CHRYSENES	BSOP5-157	GCMS
MWRA5	C2-DIBENZOTHIOPHENES	BSOP5-157	GCMS
MWRA52	C3-PHENANTHRENES/ANTHRACENES	BSOP5-157	GCMS
MWRA54	C4-PHENANTHRENES/ANTHRACENES	BSOP5-157	GCMS
MWRA57	C2-PHENANTHRENES/ANTHRACENES	BSOP5-157	GCMS
MWRA6	C2-FLUORENES	BSOP5-157	GCMS
MWRA64	C1-NAPHTHALENES	BSOP5-157	GCMS

PARAM_CODE	DESCR	METH_CODE	INSTR_CODE
MWRA65	C1-FLUORENES	BSOP5-157	GCMS
MWRA66	C3-FLUORENES	BSOP5-157	GCMS
MWRA67	C1-PHENANTHRENES/ANTHRACENES	BSOP5-157	GCMS
MWRA68	C1-DIBENZOTHIOPHENES	BSOP5-157	GCMS
MWRA69	C1-FLUORANTHRENES/PYRENES	BSOP5-157	GCMS
MWRA7	C2-NAPHTHALENES	BSOP5-157	GCMS
MWRA70	C1-CHRYSENES	BSOP5-157	GCMS
MWRA71	C3-CHRYSENES	BSOP5-157	GCMS
MWRA72	C4-CHRYSENES	BSOP5-157	GCMS
MWRA83	C2-FLUORANTHENES/PYRENES	BSOP5-157	GCMS
MWRA84	C3-FLUORANTHENES/PYRENES	BSOP5-157	GCMS
MWRA9	C3-DIBENZOTHIOPHENES	BSOP5-157	GCMS
PCTDRYWT	Percent weight of the sample which is dry	BSOP5-190	BAL

Table 17. Morphological Parameters and Database Codes for Fish and Shellfish Monitoring.

SPECIES	PARAM_CODE	DESCR	UNIT_CODE	METH_CODE
HOMARUS AMERICANUS	CARAP_LEN	Carapace Length	mm	CLM
HOMARUS AMERICANUS	SEX	Sex		VISUAL
HOMARUS AMERICANUS	WEIGHT*	Weight	g	LWEIGHT
MYTILUS EDULIS	COND_IDX	Condition Index		BSOP5-031
MYTILUS EDULIS	GON_COND_IDX	Gonad Condition Index		BSOP5-031
MYTILUS EDULIS	GONWT_M_D	Gonad Dry Weight	g	BSOP5-031
MYTILUS EDULIS	GONWT_M_W	Gonad Wet Weight	g	BSOP5-031
MYTILUS EDULIS	NGON_WT_D	NonGonad Dry Weight	g	BSOP5-031
MYTILUS EDULIS	NGON_WT_W	NonGonad Wet Weight	g	BSOP5-031
MYTILUS EDULIS	SHEL_WT_D	Shell Weight	g	BSOP5-031
MYTILUS EDULIS	SHELL_LEN	Shell Length	mm	BSOP5-031
MYTILUS EDULIS	SHELL_VOL	Shell Volume	cm3	BSOP5-031
MYTILUS EDULIS	TSTW_D	Total Soft Tissue Dry Weight	g	BSOP5-031
MYTILUS EDULIS	TSTW_W	Total Soft Tissue Wet Weight	g	BSOP5-031
MYTILUS EDULIS	WEIGHT*	Weight	g	BSOP5-031
PSEUDOPLEURONECTES AMERICANUS	SEX	Sex		VISUAL
PSEUDOPLEURONECTES AMERICANUS	STAN_LEN	Standard Length	mm	TLM
PSEUDOPLEURONECTES AMERICANUS	TOTAL_LEN	Total Length	mm	TLM
PSEUDOPLEURONECTES AMERICANUS	WEIGHT*	Weight	g	PWEIGHT

*Note: WEIGHT is defined as Wet Weight.

Table 18. Histopathological Parameters and Database Codes for Fish and Shellfish Monitoring.

SPEC_CODE	DESCR	FRACTION_CODE	PARAM_CODE
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	BALLOONS
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	BIL_PROLIF
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	CENTRO_HV
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	FOCAL_HV
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	MACROPHAGE
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	NEOPLASM
8857041504	PSEUDOPLEURONECTES AMERICANUS	LIVER_SECTION	TUBULAR_HV
8857041504	PSEUDOPLEURONECTES AMERICANUS	WHOLE_BODY	FIN_ROT
8857041504	PSEUDOPLEURONECTES AMERICANUS	WHOLE_BODY	GROSS_LIV_LES
8857041504	PSEUDOPLEURONECTES AMERICANUS	WHOLE_BODY	EXT_LESIONS
8857041504	PSEUDOPLEURONECTES AMERICANUS	WHOLE_BODY	LIVER_COL
6181010201	HOMARUS AMERICANUS	WHOLE_BODY	BLACK_GILL
6181010201	HOMARUS AMERICANUS	WHOLE_BODY	EXT_TUMORS
6181010201	HOMARUS AMERICANUS	WHOLE_BODY	PARASITES
6181010201	HOMARUS AMERICANUS	WHOLE_BODY	SHELL_EROS

Table 19. Database Codes For Fish and Shellfish Monitoring.

FIELD NAME	CODE	DESCRIPTION
ANAL_LAB_ID	BOS	Battelle Ocean Sciences
ANAL_LAB_ID	BSQM	Battelle Marine Sciences Laboratory
ANAL_LAB_ID	WHO4	Woods Hole Oceanographic-M. Moore
FRACTION_CODE	FILLET	Fillet of fish (edible tissue)
FRACTION_CODE	HEPATOPANC	Hepatopancreas
FRACTION_CODE	INDIVIDUAL	Measurement was made on an individual animal
FRACTION_CODE	LIVER	Analysis done on liver only
FRACTION_CODE	LIVER_SECTION	Analysis done on section of liver
FRACTION_CODE	MEAT	Edible meat from lobster (tail or claw)
FRACTION_CODE	SOFT_TISSUE	Entirety of organisms soft tissue
FRACTION_CODE	WHOLE_BODY	Entire body or part of body described at PARAM_CODE level
GEAR_CODE	ARRAY	Mussel deployment array
GEAR_CODE	OTT	Otter trawl tow
GEAR_CODE	TRAP	Lobster trap
INSTR_CODE	BAL	Balance
INSTR_CODE	CVAA	Cold vapor atomic absorption
INSTR_CODE	GCECD	Gas chromotograph electron capture detector
INSTR_CODE	GCMS	Gas chromotograph/mass spectometer
INSTR_CODE	GFAA	Graphite furnace atomic absorption
INSTR_CODE	ICPAES	Inductively coupled plasma atomic emission spectrometer
INSTR_CODE	ICPMS	Inductively coupled plasma mass spec
MATRIX_CODE	5507010101	Mytilus edulis
MATRIX_CODE	5507010101_C	Composite of Mytilus edulis
MATRIX_CODE	6181010201	Homarus americanus
MATRIX_CODE	6181010201_C	Composite of Homarus americanus
MATRIX_CODE	8857041504	Pseudopleuronectes americanus
MATRIX_CODE	8857041504_C	Composite of Pseudopleuronectes americanus
METH_CODE	BSOP5-128DUAL	Battelle Ocean Sciences SOP No. 5-128, PCB/pesticides by GCECD, dual column
METH_CODE	BSOP5-157	Battelle Ocean Sciences SOP No. 5-157, PAH by GCMS
METH_CODE	BSOP5-190	Battelle Ocean Sciences SOP No. 5-190, Lipids by gravimetric means
METH_CODE	BSOP5-031	Battelle Ocean Sciences SOP No. 5-031, Determining Biol. Condition Index and Gonad Condition Index of Mollusks
METH_CODE	CLM	Caliper measurement as mentioned in CW/QAPP for Fish and Shellfish Monitoring, Sec.11.3. ENSR 1997
METH_CODE	FSF98	Method for pathology parameters described in Fish and Shellfish CW/QAP
METH_CODE	LWEIGHT	Lobster weight to the nearest gram using conventional scale (model 70-2030)
METH_CODE	MSL-C-003	Percent dry weight
METH_CODE	MSL-I-016	Total mercury in tissues and sediments by CVAA
METH_CODE	MSL-I-022	Determination of elements in aqueous and digestate samples by ICP/MS
METH_CODE	MSL-I-027	Determination of metals in aqueous and digestate samples by ICP-AES
METH_CODE	MSL-I-029	Determination of metals in aqueous and digestate samples by graphite furnace atomic absorption spectrometer

METH_CODE	PWEIGHT	Flounder wt measurement mentioned in CW/QAPP for Fish and Shellfish Monitoring Sec 11.2.ENSR 1997
FIELD NAME	**CODE**	**DESCRIPTION**
METH_CODE	SCALE	Aging by scales
METH_CODE	SLM	Standard fish length, from tip of head to base of caudal peduncle.
METH_CODE	TLM	Total length measurement using fish measuring board
METH_CODE	VISUAL	Visual inspection mentioned in CW/QAPP for Fish and Shellfish Monitoring Sec 11.2/11.3.ENSR 1997
QC_CODE	COMP	Normal sample, composited prior to analysis
QC_CODE	FDUP	Duplicate sample taken in the field
QC_CODE	LDUP	Inter-lab duplicate
QC_CODE	QC	Qc sample
QC_CODE	SAMP	Normal sample
SPEC_CODE	5507010101	Mytilus edulis
SPEC_CODE	6181010201	Homarus americanus
SPEC_CODE	8857041504	Pseudopleuronectes americanus
UNIT_CODE	cm3	Cubic centimeters
UNIT_CODE	g	grams
UNIT_CODE	mm	millimeters
UNIT_CODE	ng/g	nanograms per gram
UNIT_CODE	PCT	PERCENT
UNIT_CODE	PCTDRYWT	Percent dry weight
UNIT_CODE	ug/g	micrograms per gram
UNIT_CODE	y	years
VAL_QUAL	0	Absent
VAL_QUAL	1	Present
VAL_QUAL	A	Value above maximum detection limit, e.g. too numerous to count or beyond range of instrument
VAL_QUAL	a	Not detected - value reported as negative or null
VAL_QUAL	aG	Not detected, value is null, co-eluting compound
VAL_QUAL	aGs	Not detected, value is null, co-eluting compound, suspect/invalid, not fit for use
VAL_QUAL	aGx	Not detected, value is null, co-eluting compound, matrix interference
VAL_QUAL	aL	Below MDL; value reported as negative or null, analytical conc. reported from dilution
VAL_QUAL	aLs	Not detected, analytical conc. reported from dilution, suspect/invalid, not fit for use.
VAL_QUAL	aLT	Not detected, analytical conc. reported from dilution, holding time exceeded
VAL_QUAL	aq	Not detected - value reported as negative or null. May be invalid, under investigation (Do not use).
VAL_QUAL	As	Value above maximum detection limit and suspect/invalid, not fit for use
VAL_QUAL	as	Not detected - value reported as negative or null, and not fit for use
VAL_QUAL	asT	Not detected - value reported as negative or null, not fit for use, and holding time exceeded
VAL_QUAL	aT	Not detected - value reported as negative or null, and holding time exceeded
VAL_QUAL	ax	not detected, value is null, matrix interference
VAL_QUAL	B	Blank corrected, blank >= 5x MDL
VAL_QUAL	b	Not blank corrected, blank>=5x MDL
VAL_QUAL	Bf	Blank corrected, blank >= 5x MDL, value reported < detect_limit
VAL_QUAL	bs	Not blank corrected, blank >=5x MDL, suspect/invalid, not fit for use

VAL_QUAL	D	Surrogate recovery < 50% or > 150%
VAL_QUAL	Ds	Surrogate recovery < 50% or > 150%, suspect/invalid, not fit for use
FIELD NAME	**CODE**	**DESCRIPTION**
VAL_QUAL	E	Calibration Level Exceeded
VAL_QUAL	e	Results not reported, value given is NULL. Explanation in COMMENTS field
VAL_QUAL	ELs	Calibration exceeded, concentration reported from dilution, suspect/invalid, not fit for use
VAL_QUAL	eq	Not reported, may be invalid, under investigation (Do not use).
VAL_QUAL	Es	Calibration exceeded, suspect/invalid, not fit for use
VAL_QUAL	f	Value reported is below method detection limit
VAL_QUAL	fG	Reported value below MDL and co-eluting compound interferes with peak of interest
VAL_QUAL	fL	Value reported is between zero and MDL, analytical conc. reported from dilution
VAL_QUAL	fq	VALUE reported is below method detection limit. May be invalid, under investigation (Do not use).
VAL_QUAL	fs	VALUE reported is below method detection limit, not fit for use
VAL_QUAL	fsT	Reported value is below MDL, suspect/invalid, not fit for use, and holding time is exceeded
VAL_QUAL	fsx	Value reported below detection limit, matrix interference, suspect/invalid, not fit for use
VAL_QUAL	fT	Reported value below MDL and holding time is exceeded
VAL_QUAL	fx	Below method detect limit, matrix interference
VAL_QUAL	G	Co-eluting compound interferes with peak of interest
VAL_QUAL	g	Recovery outside data objectives
VAL_QUAL	gq	Recovery outside data objectives. May be invalid, under investigation (Do not use).
VAL_QUAL	Gs	Co-eluting compound, suspect/invalid, not fit for use
VAL_QUAL	Gsx	Co-eluting compound, matrix interference, suspect/invalid, not fit for use
VAL_QUAL	h	Below the standard curve 0
VAL_QUAL	I	Interferant from standard
VAL_QUAL	L	Analytical Concentration Reported From Dilution
VAL_QUAL	LE	Analytical concentration reported from dilution, calibration level exceeded
VAL_QUAL	Lq	Analytical concentration reported from dilution. May be invalid, under investigation (Do not use).
VAL_QUAL	Ls	Analytical concentration reported from dilution, suspect/invalid, not fit for use
VAL_QUAL	Lsx	Diluted, matrix interference, suspect/invalid, not fit for use
VAL_QUAL	LT	Analytical concentration reported from dilution, holding time exceeded
VAL_QUAL	o	Value out of normal range judged fit for use by principal investigator
VAL_QUAL	P	Present but uncountable, value given is NULL
VAL_QUAL	p	Lab sample bottles mislabeled - caution data use
VAL_QUAL	q	Possibly suspect/invalid and not fit for use. Investigation pending.
VAL_QUAL	r	Precision does not meet data quality objectives
VAL_QUAL	S	Not surrogate corrected
VAL_QUAL	s	Suspect/Invalid. Not fit for use.
VAL_QUAL	sT	Suspect/invalid, not fit for use and holding time is exceeded
VAL_QUAL	sv	Value is suspect/invalid and not fit for use, arithmetic mean of multiple results
VAL_QUAL	sW	Suspect/invalid, not fit for use. Use only for attenuation coeff. calculation.
VAL_QUAL	sx	Matrix interference, suspect/invalid, not fit for use
VAL_QUAL	T	Holding time exceeded
VAL_QUAL	v	Arithmetic mean

VAL_QUAL	x	Matrix interference

15.4 Reporting of Composite Samples

Flounder, lobster, and mussel components will be composited and tracked in the COMPOSITE table. A conceptual procedure is outlined (Figure 10) to show the logic behind the treatment of composites in the EM&MS database. In this example, lobsters are collected from the field and the chemical contaminants from their tissues are analyzed. To get enough material for the analysis, and to minimize the effect of random variation among lobsters, the tissues from 5 lobsters are pooled. Because the concentrations of chemical contaminants are known to vary substantially among the different organs of a lobster, different organs are analyzed separately.

Each lobster collected is assigned a SAMPLE_ID in the SAMPLE table (Step 1) with a matrix code identifying them as individual lobsters (6181010201) and then a BOTTLE_ID in the BOTTLE table (Step 2) denoting that each lobster is intact (WHOLE_BODY).

Even though the hepatopancreas and tail and claw meat are dissected from the five lobsters individually (two are shown in figure 13) and then composited by fraction, we treat the processes in the database as if the five lobsters were composited before the various fractions are removed. A single composite SAMPLEC_ID is created in the COMPOSITE table (Step 3) that represents all the lobsters in the composite sample. There will be one record in the COMPOSITE table for each individual in the composite (five in this example, two shown in the figure).

A new record is added to the SAMPLE table with SAMPLE.SAMPLE_ID equal to COMPOSITE.SAMPLEC_ID with a MATRIX_CODE indicating that this sample is a composite lobster (6181010201_C) (Step 4). The other fields in the SAMPLE table are filled with information best describing the composite sample. For example, DEPTH would have the deepest of the five individual sample depths while DEPTH_TOP would have the most shallow.

The composite sample can now be subsampled, creating new bottles for each fraction. Since we need a bottle from which to subsample, a new bottle is created for the composite sample with a fraction code of WHOLE_BODY (Step 5). Bottles are created from this bottle for each of the fractions that will be analyzed, the fractions being recorded in the FRACTION_CODE (Step 6). In this example, fraction codes of HEPATOPANC and MEAT are used.

Using this method for creating composites with fractioned sub-samples, the analytical results from different fractions from the same group of bottles will all have the SAMPLE_ID. This facilitates queries that bring together results from different fractions coming from the same pooled bottles.

Flounder are composited in the same way. The MATRIX_CODEs for flounder are 8857041504 and 8857041504_C. The FRACTION_CODEs for flounder bottles are WHOLE_BODY, FILLET, LIVER, and LIVER_SECTION.

Mussels are treated differently. Several samples are obtained from each cage of mussels, the cage of mussels itself is not considered a sample in the database. The MATRIX_CODE for mussels always indicates that it is a composite sample (5507010101_C). Since it is uncommon for data to be stored on individual mussels, the composite table is not used. Bottles from mussel samples will have fraction codes of WHOLE_BODY or SOFT_TISSUE. SOFT_TISSUE is used for chemical analyses of the soft tissue. Although it is not a current practice to store individual mussel data, there is some historical data on individual mussels. For these, the MATRIX_CODE indicates a composite sample as above, but the FRACTION_CODE is INDIVIDUAL.

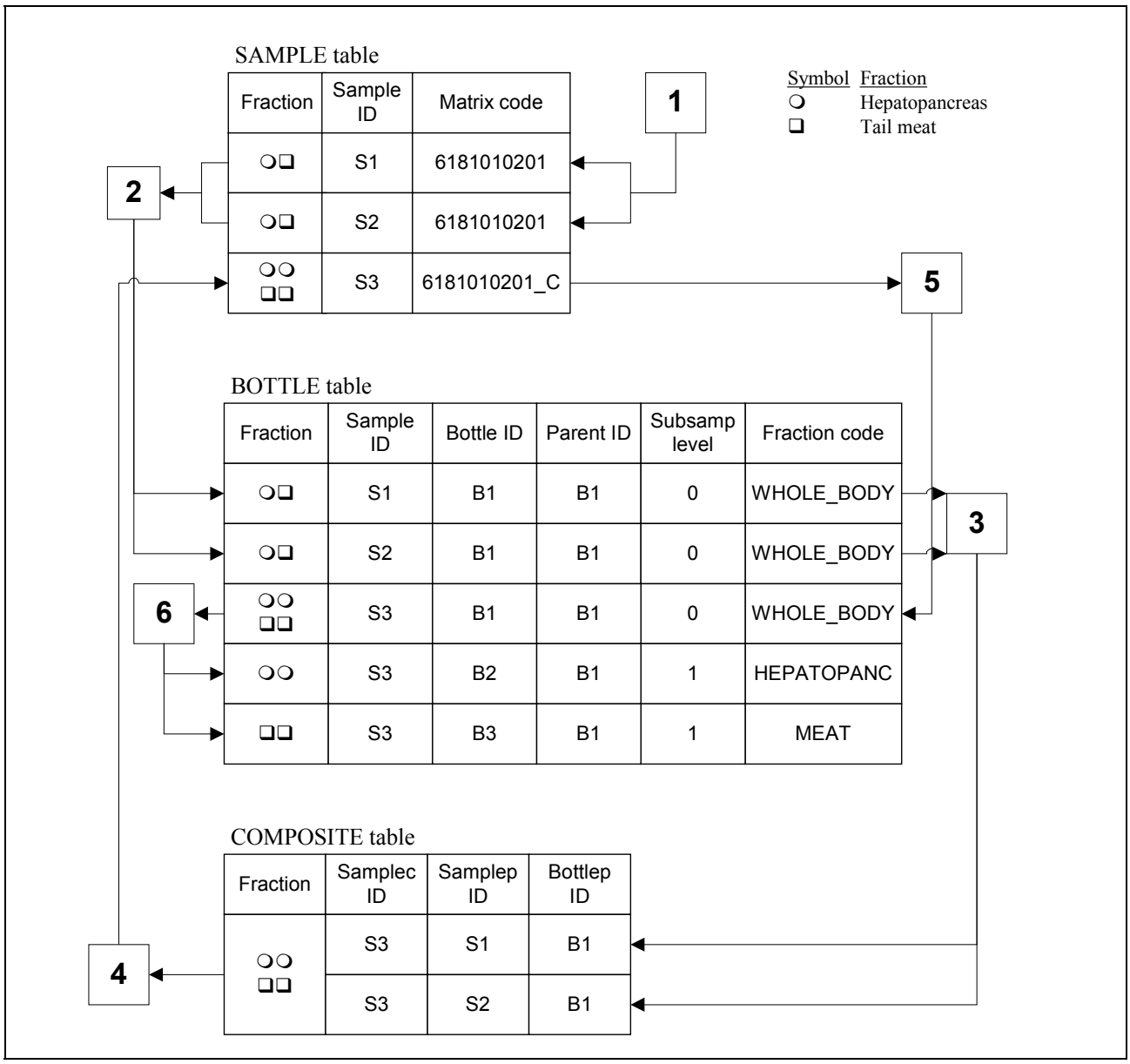

Figure 13. Conceptual Procedure for Reporting of Composite Samples.

15.5 Reporting of Chemistry Data Totals

Several chemistry data parameters are reported as totals, including Total Polychlorinated Biphenyls (PCBs), Total DDT, Total Chlordane, and Total Polynuclear Aromatic Hydrocarbons (PAHs). Values for data totals are not stored in the EM&MS database but are calculated by querying and summing the appropriate individual analytes (Table 20). These totals are reported in the Fish and Shellfish Monitoring Annual Synthesis Report (Section 19.4).

Table 20. Individual Chemistry Analytes Included in the Chemistry Data Totals.

CHEMICAL ANALYTE TOTALS AND INDIVIDUAL ANALYTES		
Total Polychlorinated Biphenyls (PCBs)	**Total Low Molecular Weight PAHs (cont.)**	**Total Historical Low Molecular Weight PAHs**
2,4'-Cl_2(8)	C1-Naphthalenes	1-Methylnaphthalene
2,2N,5-Cl_3(18)	C1-Phenanthrenes/Anthracenes	1-Methylphenanthrene
2,4,4N-Cl_3(28)	C2-Dibenzothiophenes	2,3,5-Trimethylnaphthalene
2,2N,3,5N-Cl_4(44)	C2-Fluorenes	2,6-Dimethylnaphthalene
2,2N,5,5N-Cl_4(52)	C2-Naphthalenes	2-Methylnaphthalene
2,3N,4,4N-Cl_4(66)	C2-Phenanthrenes/Anthracenes	Acenaphthene
3,3N,4,4N-Cl_4(77)	C3-Dibenzothiophenes	Acenaphthylene
2,2N4,5,5N-Cl_5(101)	C3-Fluorenes	Anthracene
2,3,3N,4,4N-Cl_5(105)	C3-Naphthalenes	Biphenyl
2,3N,4,4N5-Cl_5(118)	C3-Phenanthrenes/Anthracenes	Fluorene
3,3N,4,4N,5-Cl_5(126)	C4-Naphthalenes	Naphthalene
2,2N,3,3',4,4N-Cl_6(128)	C4-Phenanthrenes/Anthracenes	Phenanthrene
2,2N,3,4,4N,5-Cl_6(138)	Dibenzofuran	**Total Historical High Molecular Weight PAHs**
2,2N4,4N,5,5N-Cl_6(153)	Dibenzothiophene	Benz(a)Anthracene
2,2N3,3',4,4N,5-Cl_7(170)	Fluorene	Benzo(a)Pyrene
2,2N,3,4,4N,5,5N-Cl_7(180)	Naphthalene	Benzo(b)Fluoranthene
2,2N,3,4',5,5N,6-Cl_7(187)	Phenanthrene	Benzo(e)Pyrene
2,2N,3,3N,4,4N,5,6-Cl_8(195)	**Total High Molecular Weight PAHs**	Benzo(g,h,i)Perylene
2,2N,3,3N4,4N,5,5N,6-Cl_9(206)	Benz(a)Anthracene	Benzo(k)Fluoranthene
Decachlorobiphenyl-Cl_{10}(209)	Benzo(a)Pyrene	Chrysene
Total DDT	Benzo(b)Fluoranthene	Dibenzo(a,h)Anthracene
2,4N-DDD	Benzo(e)Pyrene	Fluoranthene
4,4N-DDD	Benzo(g,h,i)Perylene	Indeno(1,2,3-c,d)Pyrene
2,4N-DDE	Benzo(k)Fluoranthene	Perylene
4,4N-DDE	C1-Chrysenes	Pyrene
2,4N-DDT	C1-Fluoranthrenes/Pyrenes	
4,4N-DDT	C2-Chrysenes	
Total Chlordane	C2-Fluoranthenes/Pyrenes	
Heptachlor	C3-Chrysenes	
Heptachlorepoxide	C3-Fluoranthenes/Pyrenes	
cis-Chlordane	C4-Chrysenes	
trans-Nonachlor	Chrysene	
Total Low Molecular Weight PAHs	Dibenzo(a,h)Anthracene	
Acenaphthene	Fluoranthene	
Acenaphthylene	Indeno(1,2,3-c,d)Pyrene	
Anthracene	Perylene	
Biphenyl	Pyrene	
C1-Dibenzothiophenes		
C1-Fluorenes		

16.0 DATA VALIDATION

The data validation procedures for this project are defined in the HOM3 Quality Management Plan. As a part of data validation, each Laboratory Manager ensures that:

- Any data that are hand-entered (*i.e.,* typed) are 100% validated by qualified personnel prior to use in calculations or entry into the database.

- All manual calculations are performed by a second staff member to verify that calculations are accurate and appropriate.

- Calculations performed by software are verified at a frequency sufficient to ensure that the formulas are correct, appropriate, and consistent, and that calculations are accurately reported. All modifications to data reduction algorithms are verified prior to submission of data to the Authority.

Electronic data loading and transfer are swift and routine; data fields and formats are defined in the CW/QAPPs. Electronic submissions are loaded to temporary files prior to incorporation into the database, and are analyzed selectively using methods such as scatter plots, univariate and multivariate analyses, and range checks to identify suspect values. Routine system back-ups are performed daily.

Once data have been generated and compiled in the laboratory, senior project scientists review data to identify and make professional judgments about any suspicious values. All suspect data are reported with a qualifier. This data may not be used in calculations or data summaries without the review and approval of a knowledgeable Senior Scientist. No data measurements are eliminated from the reported data or database and data gaps are never filled based on other existing data. If samples are lost during shipment or analysis, it is documented in the data reports to the Authority and noted in the database. The methods used to identify suspect values for each type of data are defined in the CW/QAPP.

17.0 PERFORMANCE AND SYSTEM AUDITS

The Battelle QA Officer for the Harbor and Outfall Monitoring Project is Ms. Rosanna Buhl. She will direct the conduct of at least one systems audit to ensure that Tasks 21-25 are carried out in accordance with this CW/QAPP. A systems audit will verify the implementation of the Quality Management Plan and this CW/QAPP for the work conducted in the Water Quality monitoring.

Tabular data reported in deliverables, and associated raw data generated by Battelle will be audited under the direction of the Project QA Officer. Raw data will be reviewed for completeness and proper documentation. For electronically acquired data (e.g., navigational data), Ms. Buhl will verify that computer software used to process the data has been validated. Errors noted in data audits will be communicated to analysts and corrected data verified.

Audits of the data collection procedures at subcontractor laboratories will be the responsibility of the Subcontractor. Each subcontractor is fully responsible for the QA of the data it submits. Data must be submitted in CW/QAPP-prescribed formats; no other will be acceptable. During the time work is in progress, an inspection will be conducted by the subcontractor QA Officer or their designee to evaluate the laboratory data-production process. All data must be reviewed by the subcontractor QA Officer prior to submission to the Battelle Database Manager and must be accompanied by a signed QA statement that

describes the types of audits and reviews conducted and any outstanding issues that could affect data quality and a QC narrative of activities.

The Battelle QA Officer will conduct an initiation audit and, as needed, a laboratory inspection to access compliance with the Quality Management Plan and this CW/QAPP. Performance audits, in the form of SRMs, will be used to determine quantitatively the accuracy of the total measurement system or its components, will be in addition to internal performance evaluation samples and participation in external certification programs.

18.0 CORRECTIVE ACTION

All technical personnel share responsibility for identifying and resolving problems encountered in the routine performance of their duties. Dr. Carlton Hunt, Battelle's Project Manager, will be accountable to MWRA and to Battelle management for overall conduct of the Harbor and Outfall Monitoring Project, including the schedule, costs, and technical performance. He is responsible for identifying and resolving problems that (1) have not been addressed timely or successfully at a lower level, (2) influence multiple components of the project, (3) necessitate changes in this CW/QAPP, or (4) require consultation with Battelle management or with MWRA.

Identification of problems and corrective action at the laboratory level (such as meeting data quality requirements) will be resolved by laboratory staff and Senior Scientist with the Laboratory Manager. Issues that affect schedule, cost, or performance of Tasks 21-25 will be reported to the Senior Scientist or to the Battelle Project Manager. They will be responsible for evaluating the overall impact of the problem on the project and for discussing corrective actions with the MWRA Project Manager.

Problems identified by the QA Officer will be reported and corrected as described in Section 17.0 and the Quality Management Plan (Battelle, 1998).

19.0 REPORTS

Reports that will be generated under Tasks 21 - 25 include survey plans and survey reports for each of the three surveys conducted under Tasks 21-23 and data and synthesis reports (described below). Each survey plan will follow the new guidelines established by EPA for use of the OSV *Anderson.* Two copies of the final survey plan will be submitted to MWRA at least two weeks prior to the survey. No draft survey plans will be prepared. Survey reports will be submitted to MWRA (two copies) within two weeks after each survey demobilization. Survey plans and reports will be produced double-sided and 3-hole punched.

19.1 Tissue Chemistry Data Reports (Task 24)

The data report will be a tabular summary of results, produced as a EM &MS database output, and a brief discussion of any deviations from this CW/QAPP. The chemical surrogate data is reported in a separate QC data table.

Data from chemical analyses of tissues will also be used in reports to be prepared under Task 33, specifically the fish and shellfish monitoring annual synthesis report (Task 33.8) and the annual toxics review (Task 33.11).

19.2 Histology Data Reports (Task 25)

Histological data reports (Task 25) will be a tabular summary of results and a brief discussion of any deviations from this CW/QAPP. The histopathology will be discussed under the annual fish and shellfish monitoring synthesis report (Task 33.8).

19.3 Mussel Biological Condition Data Reports (Task 25)

Mussel Biological Condition Data Reports (Task 25) will be a tabular summary of results and a brief discussion of any deviations from this CW/QAPP. The mussel condition data will be discussed under the annual fish and shellfish monitoring synthesis report (Task 33.8).

19.4 Fish and Shellfish Monitoring Annual Synthesis Report (Task 33.8)

This annual report will include all data collected as part of the fish and shellfish program. This report will contain a detailed evaluation of the year's results against all relevant monitoring thresholds (Table 1), and, following outfall start-up, will devote particular attention to thresholds exceedences as described in the contract (page 152 of 164). The goals and data evaluations for the synthesis report are laid out in further detail in the Scope of Services for Task 33.8.

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