Combined work/quality assurance project plan (QAPP) for fish and shellfish monitoring 2006-2007

Task 3 MWRA Harbor and Outfall Monitoring Project Contract OP-44C

Massachusetts Water Resources Authority
Environmental Quality Department
Report ENQUAD 2006-10

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COMBINED WORK/QUALITY ASSURANCE PROJECT PLAN (QAPP)
Fish and Shellfish Monitoring 2006 - 2007

Task 3

MWRA Harbor and Outfall Monitoring Project
Contract OP-44C

Prepared for

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Environmental Quality Department
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June 2006

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1.0 TITLE AND APPROVAL PAGE

Document Title: MWRA Harbor and Outfall Monitoring Quality Assurance Project Plan (QAPP) for Fish and Shellfish Monitoring 2006 - 2007

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Prepared by: Normandeau Team including: Ann Pembroke, Robert Hasevlat, and Eric Nestler, Normandeau Associates, Inc. (Normandeau), Susan D. Chapnick and Nancy R. Rothman, New Environmental Horizons, Inc. (NEH), Susan Kane Driscoll, Menzie-Cura & Associates, Inc. (MCA), Greg Salata, Columbia Analytical Services (CAS), Michael Moore, Woods Hole Oceanographic Institution (WHOI)

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Preparation Date: June 15, 2006

Normandeau Team Project Manager Signature/Date:

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Normandeau Team Project QA Officers Signature/Date:

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[Susan D. Chapnick, NEH and Robert Hasevlat, Normandeau]

MWRA Approval Signatures/Dates:

_____

[Maury Hall, MWRA]

_____

[Wendy Leo, MWRA]

Document Control Number: _____

2.0 QAPP IDENTIFYING INFORMATION

This QAPP has been developed following guidance provided in the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) manuals (EPA 2002 and 2005). Table 1 provides a crosswalk that can be used to map information in this QAPP to the required information in QAPP development guidance. The following list provides identifying information for this QAPP:

1. Guidance used to prepare QAPP: Part 1 of UFP-QAPP Manual (EPA 2002)l, Part 2A of UFP-QAPP Manual (EPA 2005)

2. Program: MWRA Harbor and Outfall Monitoring, Fish and Shellfish Monitoring Contract OP-44C

3. Approval entity: Massachusetts Water Resources Authority

4. Indicate whether QAPP is generic or project-specific: Project-Specific QAPP

5. Dates of scoping meeting(s): HOM Kick-Off Meeting 1/12/06

6. Dates and titles of QAPP documents written for previous site work:

   Combined Work/Quality Assurance Project Plan (CW/QAPP) for Fish and Shellfish Monitoring: 2002-2005, MWRA Harbor and Outfall Monitoring Project, Contract No. S366, Prepared by Battelle Duxbury Operations, June 2002 (Report No. ms-078)

   CW/QAPP for Fish and Shellfish Monitoring: 2004-2005, MWRA Harbor and Outfall Monitoring Project, Contract No. S366, Prepared by Battelle Duxbury Operations, August 2004 (Report No. ms-096)

   CW/QAPP Addendum 1 for Fish and Shellfish Monitoring: 2002-2005, MWRA Harbor and Outfall Monitoring Project, Contract No. S366, Concurrences and Approvals, Prepared by Battelle Duxbury Operations, August 2004

7. Organizational partners in connection with approval entity:

   EPA New England Region I, Massachusetts Department of Environmental Protection (MADEP)

8. Data users:

   Normandeau Team (including project manager, risk assessor from MCA, etc.)
   MWRA, EPA, MassDEP, Battelle Ocean Sciences (for preparation of the Outfall Monitoring Overview)

9. Required QAPP Elements (1-20), Worksheets and/or Required Information that are not applicable to the project, and have been omitted, are listed in Table 1 along with an explanation for their exclusion.

Table 1. Crosswalk from Required Elements in EPA QAPP Development Guidance (EPA 2005) to Information in this QAPP

Required QAPP Element(s)	Required Information	Worksheet No.	Crosswalk to Information in this QAPP
PROJECT MANAGEMENT AND OBJECTIVES			
2.1 Title and Approval Page	- Title and Approval Page	#1	Section 1.0
2.2 Document Format and Table of Contents			
2.2.1 Document Control Format			Section 3.0
2.2.2 Document Control Numbering System			Section 3.0
2.2.3 Table of Contents	- Table of Contents		Table of Contents
2.2.4 QAPP Identifying Information	- QAPP Identifying Information	#2	Section 2.0, Table 1
2.3 Distribution List and Project Personnel Sign-Off Sheet			
2.3.1 Distribution List	- Distribution List	#3	Section 3.0, Table 2
2.3.2 Project Personnel Sign-Off Sheet	- Project Personnel Sign-Off Sheet	#4	Section 3.0, Figure 1
2.4 Project Organization			
2.4.1 Project Organizational Chart	- Project Organizational Chart	#5	Figure 2
2.4.2 Communication Pathways	- Communication Pathways	#6	Table 3
2.4.3 Personnel Responsibilities and Qualifications	- Personnel Responsibilities and Qualifications Table	#7	Table 4
2.4.4 Special Training Requirements and Certification	- Special Personnel Training Requirements Table	#8	Section 4.0 (table replaced by text)
2.5 Project Planning/Problem Definition	- Project Planning Session Documentation (including Data Needs tables)		Section 5.0
2.5.1 Project Planning (Scoping)	- Project Scoping Session Participants Sheet	#9	Attachment B (Kick-Off meeting summary memo)
2.5.2 Problem Definition, Site History, and Background	- Problem Definition, Site History, and Background - Site Maps (historical and present)	#10	Section 5.0, Tables 5 & 6; Figures 3, 4, & 5
2.6 Project Quality Objectives and Measurement Performance Criteria			Section 7.0, Attachment A
2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process	- Site-Specific PQOs	#11 #15	Section 7.0; Tables 9, 10, 11, & 12; Attachment A-2
2.6.2 Measurement Performance Criteria	- Measurement Performance Criteria Table	#12	Attachment A-1

(continued)

Table 1. (Continued)

Required QAPP Element(s)	Required Information	Worksheet No.	Crosswalk to Information in this QAPP
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table	#13	*Not Applicable to this CW/QAPP*
2.8 Project Overview and Schedule			
2.8.1 Project Overview	- Summary of Project Tasks - Reference Limits and Evaluation Table	#14	Section 6.0 (replaced by text); Tables 9, 10, 11, & 12, Attachment A-2
2.8.2 Project Schedule	- Project Schedule/Timeline Table	#16	Figure 6
MEASUREMENT / DATA ACQUISITION			
3.1 Sampling Tasks			
3.1.1 Sampling Process Design and Rationale	- Sampling Design and Rationale - Sample Location Map	#17	Sections 8.0 & 11.0 (replaced by text); Figures 3, 4, & 5
3.1.2 Sampling Procedures and Requirements			
3.1.2.1 Sampling Collection Procedures	- Sampling Locations and Methods/ SOP Requirements Table - Sampling SOPs - Project Sampling SOP Reference Table	#18 #21	Tables 5, 6, 7, 9, 10, & 14; Attachment C (Field SOPs); Table 16
3.1.2.2 Sample Containers, Volume, and Preservation	- Field Quality Control Sample Summary Table	#20	Attachment C (Field SOPs)
3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures			Attachment D (Lab SOPs)
3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures	- Field Equipment Calibration, Maintenance, Testing, and Inspection Table	#22	Section 11 (replaced by text)
3.1.2.5 Supply Inspection and Acceptance Procedures			Attachment C (Field SOPs), Attachment D (Lab SOPs)
3.1.2.6 Field Documentation Procedures			Table 17, Attachment C (Field SOPs)

(continued)

Table 1. (Continued)

Required QAPP Element(s)	Required Information	Worksheet No.	Crosswalk to Information in this QAPP
3.2 Analytical Tasks			
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3.2.2 Analytical Instrument Calibration Procedures	- Analytical Instrument Calibration Table	#24	Attachment D (Lab SOPs)
3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures	- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	#25	Attachment D (Lab SOPs), Attachment E (Lab QA Manual)
3.2.4 Analytical Supply Inspection and Acceptance Procedures			Attachment D (Lab SOPs)
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures			
3.3.1 Sample Collection Documentation	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification	#26	Section 9.0, Table 15
3.3.2 Sample Handling and Tracking System	- Sample Handling Flow Diagram		Section 9.0 (replaced by text)
3.3.3 Sample Custody	- Example Chain-of-Custody Form and Seal	#27	Section 9.0 (replaced by text); Attachment C (Field SOPs)
3.4 Quality Control Samples			Section 7.0
3.4.1 Sampling Quality Control Samples	- QC Samples Table	#28	Tables 11 & 12
3.4.2 Analytical Quality Control Samples	- Screening/Confirmatory Analysis Decision Tree		Attachment A-1
3.5 Data Management Tasks			Section 13.0
3.5.1 Project Documentation and Records	- Project Documents and Records Table	#29	Table 17
3.5.2 Data Package Deliverables	- Analytical Services Table	#30	Table 23; Table 8
3.5.3 Data Reporting Formats			Attachment G, Tables 18, 19, 20, 21, & 28
3.5.4 Data Handling and Management	- Data Management SOPs		Section 13.0
3.5.5 Data Tracking and Control			Section 13.0

(continued)

Table 1. (Continued)

Required QAPP Element(s)	Required Information	Worksheet No.	Crosswalk to Information in this QAPP
ASSESSMENT / OVERSIGHT			
4.1 Assessments and Response Actions			Section 14.0
4.1.1 Planned Assessments	- Planned Project Assessments Table	#31	Table 24
4.1.2 Assessment Findings and Corrective Action Responses	- Assessments and Response Actions - Audit Checklists - Assessment Findings and Corrective Action Responses Table	#32	Section 14.0 (replaced by text)
4.2 QA Management Reports	- QA Management Reports Table	#33	Table 25
4.3 Final Project Report			Section 16.0
DATA REVIEW			
5.1 Overview			
5.2 Data Review Steps			Section 15.0
5.2.1 Step I: Verification	- Verification (Step I) Process Table	#34	Table 26
5.2.2 Step II: Validation			
5.2.2.1 Step IIa Validation Activities	- Validation (Steps IIa and IIb) Process Table	#35	Table 27
5.2.2.2 Step IIb Validation Activities	- Validation (Steps IIa and IIb) Summary Table	#36	Table 29
5.2.3 Step III: Usability Assessment			
5.2.3.1 Data Limitations and Actions from Usability Assessment	- Usability Assessment	#37	Section 15.0 (replaced by text)
5.2.3.2 Activities			Section 15.0 (replaced by text)
5.3 Streamlining Data Review			
5.3.1 Data Review Steps To Be Streamlined			*Not applicable for this project*
5.3.2 Criteria for Streamlining Data Review			*Not applicable for this project*
5.3.3 Amounts and Types of Data Appropriate for Streamlining			*Not applicable for this project*

3.0 QAPP DISTRIBUTION LIST/ SIGN-OFF SHEET

3.1 QAPP DISTRIBUTION LIST

Table 2 lists recipients to whom the approved QAPP and related materials will be distributed.

Table 2. QAPP Distribution List

QAPP Recipients	Title	Organization	Telephone No.	Document Control No.
Maury Hall	HOM Fish and Shellfish Project Manager	MWRA	617-788-4721	06-1
Wendy Leo	HOM Data Management & QA	MWRA	617-788-4743	06-2
Ann Pembroke	Project Manager	Normandeau	603-472-5191	06-3
Robert Hasevlat	Project QA/QC	Normandeau	603-472-5191	06-4
Erik Fel'dotto	Field Management	Normandeau	603-926-7661	06-5
Eric Nestler	Data Management	Normandeau	603-472-5191	06-6
Susan D. Chapnick	Project QA/QC	NEH	781-643-4294	06-7
Nancy C. Rothman	Project QA/QC	NEH	781-643-4294	06-8
Michael Moore	Fish Pathologist	WHOI	508-289-3228	06-9
Susan Kane Driscoll	Risk Assessor	MCA	781-756-1600	06-10
Greg Salata	Laboratory Project Chemist	CAS	360-577-7222	06-11

3.2 PROJECT PERSONNEL SIGN-OFF SHEET

Key project personnel will sign and date the Project Personnel Sign-Off Sheet (Figure 1) to indicate that they have read applicable sections of the QAPP, and will perform the tasks as described. Completed sheets will be submitted to the Normandeau Project Team Manager, and retained in the central project file.

Project Personnel Sign-Off Sheet

Organization: _____

Project Personnel	Title	Telephone No.	Signature	Date QAPP Read

Key project personnel must sign and date this form to indicate that they have read the applicable sections of the QAPP and will perform the tasks described. Return signed sheets to the project manager.

Figure 1. Project Personnel Sign-off Sheet.

4.0 PROJECT ORGANIZATION

The Fish and Shellfish Monitoring tasks will be accomplished through the coordinated efforts of the Normandeau Team, including experienced personnel from Normandeau Associates, Inc. (Normandeau), Woods Hole Oceanographic Institution (WHOI), New Environmental Horizons, Inc. (NEH), Menzie-Cura & Associates, Inc. (MCA), Columbia Analytical Services (CAS), and EnviroSystems (ESI).

4.1 PROJECT ORGANIZATION CHART

Figure 2 presents the Project Team Organizational Chart and the major tasks necessary to complete the scope of work.

The tasks required to perform the Harbor and Outfall Monitoring (HOM5) for Fish and Shellfish will be accomplished under the direction of MWRA. Dr. Andrea Rex is the Director of the MWRA Environmental Quality Department. Dr. Michael Mickelson is the overall MWRA Project Manager. Ken Keay is the Deputy Project Manager at MWRA for this project. Maury Hall is the MWRA Project Manager for the Fish and Shellfish Monitoring. Wendy Leo is the MWRA Data Manager and Quality Assurance Officer.

4.2 COMMUNICATION PATHWAYS

The major communication pathways for the project are shown in Table 3. Due to the complex nature of the project, it is not possible to illustrate all communication pathways in a single table. However, the primary lines of routine communications are depicted.

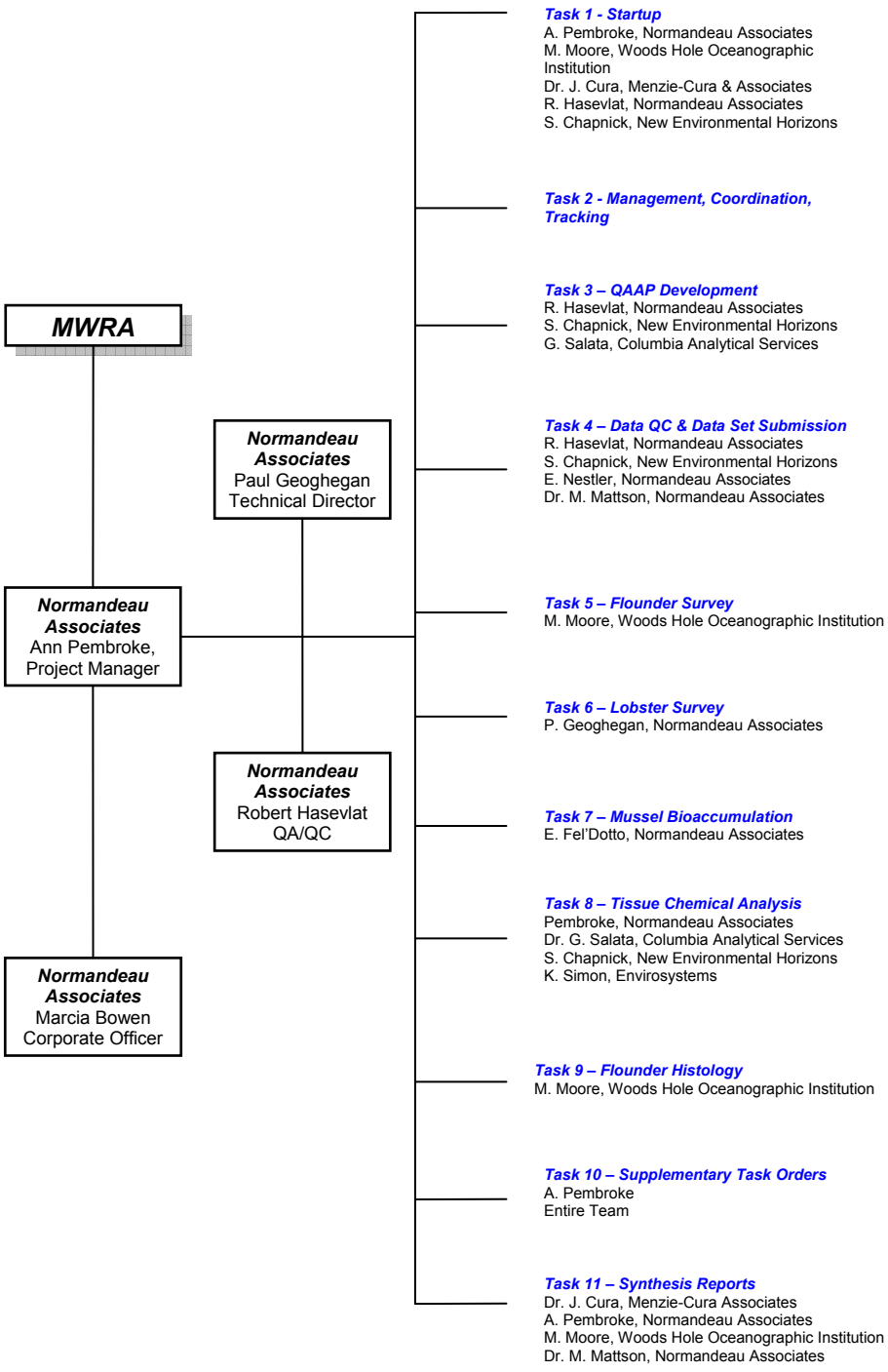

Figure 2. Project Team Organizational Chart

Table 3. Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Project Management	Normandeau	Ann Pembroke	603-472-5191	All project correspondence will be forwarded to Ms. Pembroke.
Quality Management	Normandeau	Bob Hasevlat	603-472-5191	Quality changes and issues will be forwarded to Mr. Hasevlat and Ms. Chapnick for required action.
Data Validation	NEH	Susan Chapnick	781-643-4294	Ms. Chapnick will report and complete corrective actions to project management.
Laboratory Quality – Chemical Analysis	CAS	Gregg Salata	360-577-7222	Dr. Salata will report and complete corrective actions to project management.
Laboratory Management – Tissue Analysis	WHOI	Michael Moore	508-289-3228	Dr. Moore will report and complete corrective action to project management.
Field Management – Sampling	Normandeau	Erik Fel'dotto	603-926-7661	Corrective action for field activities will be determined by Mr. Fel'dotto.
QAPP Amendments	Normandeau	Bob Hasevlat	603-472-5191	Mr. Hasevlat will report changes to the QAPP to Ms. Pembroke.

4.3 PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

Key project personnel and their responsibilities are documented in this section. A summary of qualifications of key personnel is presented in Table 4.

Table 4. Key Personnel Project Role and Qualifications

Name	Project Role	Task Number	Years of Experience
Ann Pembroke, M.S.	Program Manager	All	31
Robert Hasevlat, M.S.	Quality Assurance Director/H&S officer	1,3,4,10,11	34
Paul Geoghegan, M.S.	Technical Advisor	All	23
Mark Mattson, Ph.D	Statistical Review	1,10,11	26
Michael Moore, Ph.D	Fish Pathology	1,5,9,10,11	26
Susan Driscoll, Ph.D	Aquatic Toxicologist	1,10,11	30
Susan Chapnick, M.S.	Chemistry Data QA	1,3,4,8,10,11	25
Greg Salata, Ph.D.	Tissue Analyses	1,3,8,10,11	16

Normandeau Project Manager

Ann Pembroke, M.S., is the Normandeau Project Team Manager for the Fish and Shellfish Monitoring activities. She is responsible for ensuring that products and services are delivered in a timely and cost-effective manner that meets MWRA's expectation, and for the overall performance of this project. She is responsible for assessing and monitoring the overall project progress; serving as the focal point for day-to-day team member and regulatory interactions; approving project plans and reports; making conclusions/recommendations; and conducting/attending meetings. In addition, she is responsible for project scheduling, budget monitoring, technical task integration, and communications and coordination of team leaders and field efforts. Ms. Pembroke will work closely with the QA Officer to monitor the project for adherence to the QAPP.

Project Quality Assurance

Susan D. Chapnick, M.S., of New Environmental Horizons, Inc. (NEH) and Robert Hasevlat, M.S., of Normandeau are the QA Officers for the project team. They report directly to the Project Manager. Mr. Hasevlat, Normandeau's Quality Assurance Director, will oversee the QA program and the Health & Safety procedures during field sampling efforts. Ms. Chapnick provides independent oversight and technical assistance to the field and laboratory personnel in support of the implementation of QAPP procedures. Ms. Chapnick, along with her partner Nancy C. Rothman, Ph.D., will provide independent data validation review to document that data meet project objectives. They will also provide independent data usability assessments for the multiple data uses, including risk assessment.

Flounder Histology Senior Scientist

Dr. Michael Moore of WHOI, an experienced fish pathologist who has been associated with prior monitoring efforts for Fish and Shellfish under the MWRA HOM, will be responsible for the flounder collection and histopathological analysis of the liver tissue. Dr. Moore will examine the histological slides, analyze and reduce the histological data, and add them to the ongoing temporal and spatial data summaries.

Project Risk Assessor

Dr. Susan Kane Driscoll of MCA, will assist in QAPP development and review and interpret the Fish and Shellfish Monitoring results. She will review the flounder, lobster, and mussel body burdens in terms of both human and ecological health risk. She will expand upon the current Toxics Issues Review report with an evaluation of the current data as well as an evaluation of the monitoring program with respect to multiple other sources influencing the Massachusetts Bay ecosystem.

Project Technical Advisor

Paul Geoghegan, M.S., a fisheries biologist at Normandeau, will assist the Project Manager in a technical advisory capacity.

Statistical Review

Dr. Mark Mattson of Normandeau will assist in evaluating the sampling design and statistical analysis of data in support of the Fish and Shellfish Monitoring tasks.

Data Management

Eric Nestler of Normandeau will provide data management for the project. He will coordinate closely with the field and laboratory personnel, as well as the QA Officers, Project Manager, and the Data Manager at MWRA to ensure that the data are accurate, complete, and comparable to prior data generated in support of MWRA HOM activities.

Analytical Subcontractors

The fixed laboratory analytical subcontractor for the tissue chemistry analysis is Columbia Analytical Services located in Kelso, Washington. Dr. Greg Salata will be the project manager for analytical services at CAS. He understands the complexities of the analytical techniques defined in this QAPP for tissue chemistry. Dr. Salata will be responsible at CAS for implementing QC measures and documentation required by this QAPP during the analyses of MWRA HOM tissue samples. EnviroSystems, Inc. located in Hampton, New Hampshire will provide flounder tissue sample preparation services.

5.0 PROJECT PLANNING / PROJECT DEFINITION

5.1 PROJECT PLANNING MEETINGS

The HOM5 Kickoff meeting (HOM Task 1) was held at MWRA, Charlestown Navy Yard, MA, on January 12, 2006. During this meeting, presentations were made by MWRA and consultants involved in all three HOM projects: 1) Fish and Shellfish Monitoring, 2) Water Column and Nutrient Flux Monitoring, and 3) Benthic Monitoring. A summary of the issues discussed pertaining to the Fish and Shellfish Monitoring are provided as Attachment B of this QAPP, as prepared by Ann Pembroke, Project Manager, Normandeau, January 2006.

5.2 PROBLEM DEFINITION / SITE HISTORY AND BACKGROUND

The Massachusetts Water Resources Authority (MWRA) is continuing a long-term biomonitoring program for fish and shellfish for the MWRA effluent outfall that is located in Massachusetts Bay (see Figures 3 through 5). The goal of the biomonitoring is to provide data that may be used to assess potential environmental impact of effluent discharge into Massachusetts Bay.

Discharge from MWRA's ocean outfall has the potential to introduce various contaminants to the Massachusetts Bay ecosystem. Effects may be apparent as increased body burdens in marine organisms or as increased susceptibility to diseases as evidenced by lesions or tumors. The purpose of the Fish and Shellfish Monitoring is to document conditions in the vicinity of the outfall and in farfield areas, to aid in the evaluation of outfall impact assessment. Health of key marine biota, as represented by winter flounder, American lobster, and blue mussel, has ramifications both to the ecosystem and to human use and health. 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.

Key objectives of this monitoring effort include evaluation of the following:

- Spatial and temporal patterns of external and internal physical abnormalities and meristics in flounder
- Spatial and temporal patterns of external physical abnormalities and meristics in lobsters
- Spatial and temporal patterns of biological (flounder, lobster, and mussel) uptake of chemical constituents that may be linked to the outfall, and
- Relationship of body burdens to environmental and human health thresholds.

Further background and overview of previous monitoring activities can be referenced in the following documents:

Lefkovitz, LF, L Palas, and MJ Moore. 2004. Combined work/quality assurance project plan (CW/QAPP) for fish and shellfish monitoring: 2004-2005. Boston: Massachusetts Water Resources Authority. Report 1-ms-096. 34 p.

Lefkovitz, LF, SL Abramson, and MJ Moore. 2002. Combined work/quality assurance project plan (CW/QAPP) for fish and shellfish monitoring: 2002-2005. Boston: Massachusetts Water Resources Authority. Report 1-ms-078. 71 p.

Wisneski, C., LF Lefkovitz, MJ Moore and G Schaub. 2004. 2003 annual fish and shellfish report. Boston: Massachusetts Water Resources Authority. Report 2004-11. 192. p.

This Combined Work Plan/Quality Assurance Project Plan (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 in support of the MWRA Harbor and Outfall Monitoring Program (HOM5 Contract OP-44). This document also describes the specific protocols that will be followed for sampling, sample handling and storage, chain of custody, laboratory and field analyses, data review and validation, document management, data management, and data usability assessment. This QAPP was prepared in accordance with EPA guidance documents as described in Section 2 and is also based on the prior HOM QAPP that guided previous monitoring activities (Lefkovitz et al., 2002 and Lefkovitz et al., 2004). Separate survey plans developed for each survey will supplement this QAPP. The survey plans will provide the operational details required to conduct each survey, and will describe participating staff, schedule details, and specific equipment.

Figures 3 through 5 represent site map locations for flounder, lobster, and mussel monitoring activities. A summary of sampling locations for each of the three surveys is provided as Table 5. Table 6 includes a summary of chemical analyses for each tissue type.

Figure 3. Flounder Monitoring Locations.

Figure 4. Lobster Monitoring Locations.

Figure 5. Mussel Collection and Deployment Locations.

Table 5. Summary of Sampling Locations for Flounder, Lobster, & Mussel Surveys.

Station ID	Station #	Sampling Site	Location		Survey Type		
			Latitude	Longitude	Flounder	Lobster	Mussel
DIF	1	Deer Island Flats (Boston Harbor)	42°20.4'	70°58.4'	*	*	
DIL	1M	Deer Island Light	42°20.4'	70°57.2'			*
NB	2	Off Nantasket Beach	42°17.6'	70°52.2'	*		
OS	4	Outfall Site	42°23.1'	70°49.3'	*	*	
OSM	M4	Outfall Site (60 m at OS)	42°23.15'	70°47.92'			*
ECCB	5	East Cape Cod Bay	41°56.2'	70°06.6'	*	*	
IH	6	Boston Inner Harbor	42°21.5'	71°02.9'			*
CCB	9	Cape Cod Bay	41°55.5'	70°20.0'			*
SP	SP	Stover's Point, ME	43º45.1'	69º59.9'			R
LNB	B	"B" Buoy	42°22.67'	70°47.13'			*

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

Table 6. Summary of Chemical Analyses by Tissue Type

Tissue Type	Project-Specific List of Metals (other than mercury & lead)	Mercury	Lead	PCBs	Project-Specific List of SVOCs including PAHs	Pesticides	Lipids
Flounder Fillet (Meat)		*		*		*	*
Flounder Liver	*	*	*	*	*	*	*
Lobster Meat (claws & tail)		*		*		*	*
Lobster Hepatopancreas	*	*	*	*	*	*	*
Mussel (composites)		*	*	*	*	*	*

6.0 PROJECT DESCRIPTION AND SCHEDULE

6.1 PROJECT OVERVIEW

To determine the body burden of toxic substances and to assess the physiological status of winter flounder (*Pseudopleuronectes americanus*) and lobster (*Homarus americanus*), surveys will be conducted in Boston Harbor, Massachusetts Bay, and Cape Cod Bay (hereafter: Boston Harbor and Offshore) to collect specimens for analysis. One survey per species will be conducted during 2006. During 2007, only winter flounder will be collected, and chemical analyses will not be run. The bioaccumulation of toxic substances in blue mussel (*Mytilus edulis*) will also be investigated. During 2006, arrays of mussels from reference locations will be deployed for 60 days in Boston Harbor and Offshore. The following five tasks will be performed:

1. Flounder Survey (2006 and 2007) – Task 5
2. Lobster Survey (2006) – Task 6
3. Mussel Bioaccumulation Survey (2006) – Task 7
4. Tissue Chemical Analysis (2006) – Task 8
5. Flounder Histology Analysis (2006 and 2007) – Task 9

The MWRA Contingency Plan (MWRA 2001) specifies numerical or qualitative thresholds that may suggest that environmental conditions offshore 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 2001). Specific objectives for each of the five tasks included in this program are described below.

Normandeau will conduct Tasks 5-9 associated with the fish and shellfish monitoring following the protocols defined in the contract scope in order to maintain the integrity of the historical database. Specific objectives for each of the five tasks included in this program are described below.

Survey plans will be submitted to MWRA a minimum of two weeks prior to scheduled work to ensure that any questions that may arise about the plans can be addressed.

6.1.1 Flounder Survey (Task 5)

The objective of the survey is to obtain specimens of winter flounder *(Pseudopleuronectes americanus)* from four sampling sites in Boston Harbor and Offshore 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 2006 and 2007. Data generated will be evaluated against established thresholds.

Dr. Michael Moore, WHOI, will manage the flounder survey during 2006 and 2007. A minimum of two weeks prior to the flounder field collection, Normandeau will submit a survey plan (Task 5.1) that provides specific details such as planned survey dates and personnel as well as foreseeable deviations from this QAPP. Historically, sufficient flounder have not been available at all stations during April. The survey plan will detail sample collection protocols and describe the appropriate level of effort for

sampling before deferring to the contingency plan (i.e., delayed sampling). A Survey Plan for Winter Flounder is provided as Attachment C-1.

Four sites will be sampled during each annual survey to collect winter flounder for histological and chemical analyses:

- Deer Island Flats (Boston Harbor),
- Off Nantasket Beach,
- Outfall Site (offshore effluent outfall), and
- East Cape Cod Bay.

Normandeau will use the services of the FV Odessa, operated by Captain William Crosser, for collection of the winter flounder (Task 5.2). Fifteen flounders per site will be set aside for chemical analysis as well as histopathology. Further details on sampling of winter flounder can be found in Section 8 and Attachment C-1. Table 5 and Figure 3 provide the sampling sites and locations. Adjustments in location will be made in the field to ensure that flounder are captured. Flounders will be processed (Task 5.3 through 5.6) by visual inspections, following protocols and standards that have been established in previous surveys by Dr. Moore, and scales removed for age and growth processing by NMFS Age and Growth unit, Woods Hole (Jay Burnett). Flounders for histology only will be dissected on the day of collection, at sea, following protocols in the previous QAPP (Lefkovitz et al. 2002). Flounders for histology and chemistry will be transported on wet ice to EnviroSystems Inc. (ESI) in Hampton, NH. Further details on flounder dissection, handling, and shipment for tissue analysis and histology are provided in Section 10.

Within two days of the completion of the flounder survey, Normandeau will submit a brief summary of the survey to MWRA. The purposes of this summary (preliminary report) are to confirm the successful completion of the field survey (including number/species of specimens collected at each station, number of specimens dissected, observations made during sampling and dissection, and the disposition of the tissue samples), briefly document any problems encountered, and identify instances when monitoring thresholds would be triggered or nearly triggered. There are no monitoring thresholds listed in the Contingency Plan (MWRA 2001) for the current Fish and Shellfish Program that are detectable based on field observations.

The survey report will be submitted in May and will provide a detailed account of the activities during the field effort.

Deliverables

- 1 flounder survey plan per year, to be completed in April 2006 and March 2007 (Task 5.1)
- 1 flounder preliminary survey summary per year, to be completed within two days of the flounder survey in April 2006 and April 2007 (Task 5.7)
- 1 flounder survey report per year, to be completed in May 2006 and May 2007 (Task 5.8)

6.1.2 Lobster Survey (Task 6)

The objective of the survey is to obtain specimens of lobster *(Homarus americanus)* from three sampling sites in Boston Harbor and Offshore 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 2006.

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

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

Table 5 provides the sampling sites and locations. Figure 4 illustrates the sampling locations in Boston Harbor and Offshore.

In June 2006, Normandeau will submit a survey plan (Task 6.1) detailing the proposed survey dates, personnel and methods for the lobster collection. The survey plan will reiterate contingency plans described in the QAPP to be implemented if sufficient lobsters are not available during the planned sampling period.

To conduct the survey (Task 6.2), commercial lobstermen will deploy traps at specified coordinates (see Table 5) to procure the lobsters for chemical analysis. Lobsters will be kept alive during the collection. A Normandeau fisheries technician will use a portable d-GPS unit to confirm the locations where the traps are retrieved and will process the lobsters for physical characteristics (carapace length, weight, sex, and gross external abnormalities). Each lobster will be given a unique sample control number.

Commercial lobster boats are unlikely to provide contamination-free conditions for processing the lobsters (Tasks 6.3 to 6.5) so tissue sampling will take place at Columbia Analytical Services (CAS) laboratory. After initial physical data are collected, the field technician will package the lobsters on ice for shipping to CAS, where tissue samples will be prepared in a clean room environment.

A brief, preliminary survey report will be submitted to MWRA within two business days of the initial lobster survey, regardless of whether sufficient lobsters are collected at all stations. If the quota has not been met at one or more stations, the preliminary report will provide information on plans for further sampling. The formal survey report will be prepared following the completion of all field work.

Deliverables

- 1 lobster survey plan, to be completed in June 2006 (Task 6.1)
- 1 lobster preliminary survey summary, to be completed within two business days of the initial lobster survey in July 2006 (Task 6.6)
- 1 lobster survey report, to be completed in September 2006 (Task 6.6)

6.1.3 Mussel Bioaccumulation Survey (Task 7)

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 potentially due to the outfall.

A survey plan (Task 7.1) that describes how the mussel bioaccumulation study will be implemented from collection of mussels through delivery of samples to the laboratory has been submitted to MWRA and is

included as Attachment C-3. Caged mussel arrays will be deployed at five locations, within Boston Harbor and Offshore.

Collection of mussels (Task 7.2) will be accomplished in late June 2006. In addition to the minimum number of mussels required for analysis, 15% more will be included at each location to account for loss due to mortality during the deployment so that sufficient mussel tissue is available for chemical analysis. Table 7 lists the minimum number of mussels required for each sampling location. Mussels will be measured to ensure that the average length is approximately 6 cm.

Table 7. Minimum Number of Mussels Required per Location

Site	Number of Replicates	Minimum Number of Mussels
Deer Island (DIL)	5 x (2 retrievals + 1 backup array)	345
Inner Harbor (IH)	5 x 2 retrievals	230
Outfall (OS)	8 x (2 retrievals + 2 backup arrays)	644
Cape Cod Bay (CCB)	4 x 2 retrievals + 2-3 additional replicates	264
"B" Buoy (LNB)	4 x 1 retrieval	92
Pre-survey condition Stovers Point, ME	5 + 3 (splits)	160
Total	**72**	**1735**

Knowledge of baseline levels of contaminants in mussels deployed for this survey is critical to assessing MWRA outfall effects. Baseline conditions (Task 7.3) will be evaluated through the collection of mussels at Stovers Point, ME. From this baseline location, 160 mussels (eight replicates of 20 individuals) will be randomly selected, assigned unique sample control numbers, and placed on ice for shipment to CAS for tissue analysis.

Sufficient mussels at each of the five locations identified in Table 5 will be deployed to allow for collection of 20 mussels per replicate at 40-day and 60-day deployments for chemical analysis. Section 8 details the steps to be incorporated into the mussel deployment (Task 7.4) to minimize the possibility of losing mussels and thereby minimize potential data gaps.

Mussels will be retrieved from each location after 40 days (Task 7.5), in early August, to be held in contingency in the event that arrays are lost or mortality is unusually high between 40 and 60 days. Condition of cages and mussels will be determined. A sample control number will be assigned to each replicate group of 20 mussels, and samples will be shipped on ice to CAS.

In late August 2006, 60 days after deployment (Task 7.6), Normandeau will retrieve mussels from the remaining arrays. As in the 40-day retrieval, condition of the cages and mussels will be determined. Live mussels will be selected to make up the requisite number of replicate samples from each location. A sample control number will be assigned to each replicate and samples will be shipped on ice to CAS.

A summary preliminary report of the field survey will be prepared and delivered to MWRA within two business days following the 60-day collection. The complete survey report will be provided within one month of the final sampling effort.

Deliverables

- 1 mussel bioaccumulation survey plan, to be completed in May 2006 (Task 7.1)
- 1 mussel bioaccumulation summary preliminary report, to be completed in August 2006 (Task 7.7)
- 1 mussel bioaccumulation survey report, to be completed in September 2006 (Task 7.8)

6.1.4 Tissue Chemical Analyses (Task 8)

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 liver, lobster hepatopancreas, and flounder, lobster, and mussel edible tissue (fillet; claw and tail meat; and meat, respectively) collected under Tasks 5, 6, and 7. Table 8 summarizes the analytical services that will be performed in support of the fish and shellfish monitoring program. Data generated will be evaluated against established MWRA thresholds and historical concentrations (see Attachment A-2). As appropriate, the contaminant concentrations will also be evaluated against data collected under other project tasks.

Flounder samples (Task 8.1) will consist of fillets and liver tissue, prepared (dissected) at EnviroSystems and shipped frozen to CAS for compositing and analysis of the chemicals of concern listed in Attachment A-2. Upon compositing, a new sample ID number will be generated to track the composite, maintaining a record of which specific fish are included in each composite.

Whole live lobsters will be shipped to CAS where the hepatopancreas and meat (claws and tail) will be removed. Three composites of five lobsters will be made for each site. Lobster tissue will be analyzed (Task 8.2) for the parameters identified in Attachment A-2.

Samples containing 20 or more whole mussels will be shipped on ice to CAS for shucking, tissue homogenization, and analysis of the chemicals of concern (Task 8.3) listed in Attachment A-2. Each 20-mussel composite sample will be treated as an individual replicate for analysis.

Excess tissue samples for flounder, lobster, and mussels, not required for initial analysis will be archived frozen at CAS.

Analytical methods will be comparable to prior methods used to generate HOM data (see Sections 7 and 12 for further details) and be of sufficient accuracy, precision, and sensitivity for project objectives.

The Normandeau project team will review the chemistry results (Task 8.4), on a wet-weight basis, to evaluate whether any contaminant in a tissue sample from the Outfall site exceeds Contingency Plan threshold (as listed in Table 9), exceeds an FDA “action level” (as listed in Table 10), or if there is any other anomalous result. Contingency Plan thresholds are listed in Table 9. Normandeau will report any such result to MWRA immediately.

Table 8. Analytical Services.

Tissue Type / Matrix	Analytical Group (s)	Data Package Due Date	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Flounder	Histology	September 2006 and 2007	Woods Hole Oceanographic Institution Michael Moore, Phd. Mail Stop 50 Woods Hole, MA. 02543 Phone: 508-289-3228 Email: mmoore@whoi.edu
Flounder – Fillet	Mercury PCB Congeners Pesticides Lipids	July 2006	CAS – Kelso Laboratory Greg Salata, Ph.D. 1317 South 13th Ave., Kelso, WA 98626; phone: 360-577-7222 x3376; email: gsalata@kelso.caslab.com
Flounder – Liver	8 Metals SVOCs (including PAHs) PCB Congeners Pesticides Lipids	July 2006	CAS – Kelso Laboratory Greg Salata, Ph.D. 1317 South 13th Ave., Kelso, WA 98626; phone: 360-577-7222 x3376; email: gsalata@kelso.caslab.com
Lobster – Meat	Mercury PCB Congeners Pesticides Lipids	October 2006	CAS – Kelso Laboratory Greg Salata, Ph.D. 1317 South 13th Ave., Kelso, WA 98626; phone: 360-577-7222 x3376; email: gsalata@kelso.caslab.com
Lobster – Hepatopancreas	8 Metals SVOCs (including PAHs) PCB Congeners Pesticides Lipids	October 2006	CAS – Kelso Laboratory Greg Salata, Ph.D. 1317 South 13th Ave., Kelso, WA 98626; phone: 360-577-7222 x3376; email: gsalata@kelso.caslab.com
Mussel	Mercury & Lead SVOCs (including PAHs) PCB Congeners Pesticides Lipids	November 2006	CAS – Kelso Laboratory Greg Salata, Ph.D. 1317 South 13th Ave., Kelso, WA 98626; phone: 360-577-7222 x3376; email: gsalata@kelso.caslab.com

Table 9. Summary of Threshold Values for Fish and Shellfish

Organism	Threshold ID	Parameter	Unit of Measure*	Threshold Value		Baseline Years
				Caution	Warning	
Flounder	FFFCHL	lipid-normalized chlordane	ng/g lipid	484	-	1993-2000**
	FFFDDT	lipid-normalized DDT	ng/g lipid	1552	-	1993-2000**
	FFFDIEL	lipid-normalized dieldrin	ng/g lipid	127	-	1993-2000**
	FFFHG	mercury	ug/g wet	0.5	0.8	N/A
	FFFPCB	PCB	ng/g wet	1000	1600	N/A
	FFLIVDIS	liver disease incidence	%	44.94	-	1991-2000
Lobster	FLMCHL	lipid-normalized chlordane	ng/g lipid	150	-	1992-2000
	FLMDDT	lipid-normalized DDT	ng/g lipid	683	-	1992-2000
	FLMDIEL	lipid-normalized dieldrin	ng/g lipid	322	-	1992-2000
	FLMHG	mercury	ug/g wet	0.5	0.8	N/A
	FLMPCB	PCB	ng/g wet	1000	1600	N/A
Mussel	FMUCHL	lipid-normalized chlordane	ng/g lipid	205	-	1992-2000***
	FMUDDT	lipid-normalized DDT	ng/g lipid	483	-	1992-2000***
	FMUDIEL	lipid-normalized dieldrin	ng/g lipid	50	-	1992-2000***
	FMUPAH	lipid-normalized PAH	ng/g lipid	2160	-	1992-2000***
	FMUHG	mercury	ug/g wet	0.5	0.8	N/A
	FMUPB	lead	ug/g wet	2	3	N/A
	FMUPCB	PCB	ng/g wet	1000	1600	N/A

* = Lipid normalized thresholds are based on dry weights.
** = 1992 flounder data excluded because compositing scheme not compatible with other years.
*** = Data for 1995 not available because mussel cages could not be recovered at baseline site.
N/A = Threshold not calculated using baseline data.

Table 10. FDA Action Levels in Wet Weight

Total PCB	Total DDT	Total Chlordane	Dieldrin	Mercury	Lead
2000 ng/g	5000 ng/g	300 ng/g	300 ng/g	1 μg/g	3.75 μg/g

Deliverables:

- Comments on 2006 flounder Tissue Chemistry Data Report (TCDR), due the later of August 31, 2006 or 120 days after survey completion
- Comments on 2006 lobster TCDR, due the later of November 30, 2006 or 120 days after survey completion
- Comments on 2006 mussel TCDR, due the earlier of December 31, 2006 or 120 days after survey completion

6.1.5 Flounder Histological Analysis (Task 9)

The histological analysis is designed to assess the health of the flounder populations in Boston Harbor and Offshore by performing microscopic examinations of tissue sections of the flounders' livers (Task 9). 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.

Age determination (Task 9.1) of flounder will be performed by NMFS using the scales removed at sea through analysis of growth rings (annuli). The flounder will be examined and dissected at the Hampton, NH laboratory of EnviroSystems within 24 hours of collection to ensure that the quality of the liver does not deteriorate before fixing for histological analysis. Liver samples will be prepared (Task 9.2) following the same procedures used in past surveys (see Section 10.1 for further details). Histological sample analysis (Task 9.3) of flounder liver tissue from 50 fish at each site will be performed by Dr. Moore using the same procedures as in past surveys (see Section 10.1 for further details).

Following quality control checking, data from flounder histology samples collected at the Outfall station will be provided first in a temporary (preliminary) histology report. The results will be used to calculate the relative (per cent) incidence of liver disease in winter flounder near the Outfall. MWRA will be notified immediately if the value exceeds the caution threshold value of 44.94 %.

The temporary (preliminary) data report will be replaced with the complete data report. The complete data set will include all the histology and morphology (age, length, weight, sex, external abnormalities) data for each flounder. The data will be put through all the required quality control checks prior to submittal to MWRA for incorporation in the database and preparation of a tabular summary of the annual results. Dr. Moore will review the summary results, including all QC data checks made by MWRA.

Deliverables

- Temporary (preliminary) Outfall Site Histology Data Report annually (due 60 days after survey completion) (Task 9.4)
- Comments on annual (complete) Histology Data Report (due September 30, 2006 and 2007) (Task 9.4)

6.2 PROJECT SYNTHESIS REPORTS (TASK 11)

The synthesis reports will evaluate whether the study design and data are fully capable of answering the research questions and supporting the project data quality objectives defined in this QAPP. An annotated outline, draft report, and final report will be generated for each synthesis report. The following sections detail these reports.

6.2.1 Fish and Shellfish Report (Task 11.1)

The annual Fish and Shellfish report will summarize age, length, weight, sex, CPUE, and external conditions parameters for flounder. Size, sex, and external conditions will also be summarized for lobsters, as well as external and biological conditions and survival rates for deployed blue mussels. The report will provide tabular and graphical summaries of contaminants found in fish and shellfish collected during the 2006 sampling event and the previous monitoring dates, including baseline collections. The bioaccumulation of toxics in blue mussels will be assessed by comparing the concentrations of chemicals in blue mussel tissues prior to deployment and following the caged bioaccumulation studies. Results of the histopathological study of the flounder liver tissue will also be included.

The report will evaluate the power of the study designs to discern whether the outfall is contributing to spatial differences and will address whether statistical differences are ecologically meaningful. The 2006 report will include the following analyses:

- Statistical evaluations of pre- and six years' post-discharge fish and shellfish using Student's two sample t-tests on the flounder, lobster and mussel tissue data, the flounder, lobster and blue mussel morphology data, and the flounder histopathology data using individual data, rather than means, for each tissue contaminant found in flounder fillet and liver, edible lobster meat and hepatopancreas and blue mussel tissue. Two-way ANOVA will be used to evaluate station vs. year differences. Non-parametric analogues can be used if the data are not normally distributed.
- Temporal and spatial trends in the 2006/2007 data, graphically or using ANOVA as appropriate.
- Comparison of indicators of animal health and contaminant levels in tissues using linear regressions between contaminant concentrations in tissues and indicators of animal health (histopathological lesions in flounder, external lesions on lobsters, and biological condition of blue mussels).
- Comparison of mean and maximum contaminant levels in edible tissues to FDA action levels, EPA Region III risk-based concentrations for fish tissues, and MWRA threshold levels.
- Comparison of contaminant levels in edible tissues to other relevant monitoring data such as Mussel Watch as part of NOAA's National Status and Trends program.

These analyses will be used to synthesize the spatial and temporal trends in fish and shellfish data, relationships between contaminant concentrations in tissues and animal health, and comparisons to FDA levels and other relevant monitoring data to assess whether and to what extent tissue levels or pathology may be attributable to MWRA discharges or other sources and what the likely environmental impact the tissue levels may have on the health of natural resources in Boston Harbor. The report will also discuss the merits of various monitoring approaches, e.g., wild versus caged studies.

The 2007 report will be limited to reporting the results and analyzing spatial and temporal trends of the flounder liver histology and external characteristics survey.

6.2.2 Toxic Issues Report

The toxics issues report will update previous reports on "likely" effects of the outfall, including the Toxics Review report that is currently under preparation in 2006 (Hunt et al. 2006). This report will draw on data from all aspects of MWRA's monitoring programs and place these results within the context of the Massachusetts Bay environment. An understanding of all natural and anthropogenic influences on the ecosystem is critical to putting the effects of the outfall in perspective. The two main goals for this report are:

1. interpretation of the results of baseline contaminant monitoring and
2. comparison of actual impacts to expected impacts.

This report will also provide a key opportunity to guide regulatory reviewers towards future monitoring program modifications.

Though the specific content of this report has not yet been decided between the Normandeau Team and MWRA, the following may be provided/addressed in this 2007 report.

- Provide an overall synthesis and discussion of the effluent characterization studies, including the following:
  - Compare maximum and average concentrations of contaminants in effluent to marine receiving water criteria and water quality criteria, before and after dilution;
  - Analyze and discuss potential relationships between toxicity of effluent and concentrations of contaminants. Prepare graphs and analyze statistically for potential relationships; and
  - Prepare graphs that illustrate temporal trends in contaminant concentrations.
- Provide an overall synthesis and discussion of the contaminant data with an emphasis on an assessment of the potential impact of contaminants that exceed benchmarks. Specific subtasks include:
  - Compare data on concentrations of contaminants in tissue to FDA action levels and other relevant benchmarks for the protection of human health and the environment.
  - Examine temporal and spatial trends in graphical presentations of the tissue and sediment data, focusing on contaminants that exceed benchmarks.
  - Evaluate contaminant loads in body tissues relative to histopathology data (flounder) and gross external conditions (flounder and lobster).
  - Evaluate contaminant loads from MWRA sources in relation to other sources to the Harbor and Bays.
- Provide an overall synthesis of the information on sources of contaminants and provide a comparison of loads from various sources, including:
  - Prepare a conceptual model that graphically presents sources of contaminants to the Harbor and Bays;
  - Provide quantitative estimates of the loadings from various sources; and
  - Discuss and compare loads from MWRA sources in relation to other sources.
- Evaluate the efficacy of using chemical fingerprinting or some sewage tracer to determine the effects of the effluent outfall on the distribution of contaminants, using the following:
  - Examine available data from the effluent characterization and the benthic monitoring program to develop a list of candidate tracers that have been measured in both programs;
  - Examine whether potential tracers can be used to effectively identify effects from the effluent outfall in contrast to effects from other sources; and
  - Research, discuss, and evaluate the potential use of chemical fingerprinting to identify effects of the effluent outfall on the distribution of contaminants.
- Provide an overall analysis and synthesis of loading data and current levels of contaminants to assess the contribution of sources other than the outfall to current levels of contaminants in sediments, water, or tissue. Sub-tasks may include:
  - Summarize available pre-discharge data on concentrations of contaminants in water, sediment and tissue from the area of the outfall and compare to post-discharge data.
  - Summarize available information on loading of contaminants from other sources and compare to estimates of loadings from the outfall.

  - Discuss spatial and temporal trends in contaminant concentrations in relation to trends in loadings from various sources.
- Use the information provided in the 2006 report and more recent data to provide an overall evaluation of the findings of the baseline monitoring plan and a discussion of observed impacts. Sub-tasks may include:
  - Summarize available estimates of outfall impact that were prepared prior to the onset of the discharge, including a summary of results and predictions from various models and a discussion of the validity of assumptions that were used to develop the models prior to the onset of the discharge;
  - Graphically compare pre-discharge estimates of impacts to concentrations of contaminants in water, sediments, and tissue to data collected for these parameters after the onset of the discharge;
  - Compare pre-discharge estimates to post-discharge data using appropriate statistical techniques for each contaminant; and
  - Discuss factors that may be responsible for differences between predicted and observed impacts.

Deliverables

- Fish and Shellfish Report outline (due January 2007 and 2008)
- Draft Fish and Shellfish Report (due February 2007 and 2008)
- Final Fish and Shellfish Report (due April 2007 and 2008)
- 2007 Toxics Issues Review Report outline (due April 2007)
- 2007 draft Toxics Issues Review Report (due May 2007)
- 2007 final Toxics Issues Review Report (due July 2007)

6.3 PROJECT SCHEDULE

Project schedule requirements for various deliverables have been listed above for each task performed in support of the fish and shellfish monitoring efforts in 2006 and 2007. The entire project schedule timeline is depicted graphically in Figure 6.

Figure 6. Project Timeline.

7.0 PROJECT QUALITY OBJECTIVES AND MEASUREMENT PERFORMANCE CRITERIA

To ensure that all data generated during the conduct of surveys, analyses, and reporting will be of sufficient quality to meet the project objectives detailed in Section 6 of this QAPP, measurement performance criteria (MPCs), in terms of data quality objectives (DQOs), have been defined against which all data will be evaluated. Project DQOs have been defined in terms of the standard data quality measures of precision, accuracy, completeness, comparability, representativeness, and sensitivity. A critical project quality objective is to compare chemical measurements in flounder, lobster, and mussel to MWRA thresholds, FDA Action limits (see Tables 9 and 10), and historical data. This goal was incorporated into the development of project-specific sensitivity MPCs.

The definitions of the measures of data quality are below.

Accuracy - the extent of agreement between the measured value and the true value, "bias"

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

Sensitivity – the quantitation limit of individual measurements in comparison to the project-required quantitation limits (PQLs) needed to meet regulatory-based levels of concern and allow comparability with historical data

Qualitative measures for comparability and representativeness and quantitative measures for accuracy, precision, completeness, and sensitivity are summarized in this section. Equations for the quantitative statistical measures are presented in Section 15.2.2.

7.1 NAVIGATIONAL DATA

7.1.1 Accuracy and Precision

All dGPS units have a design positional accuracy of 15 m. Based on manufacturer specifications and project experience, precision and accuracy objectives for navigation and station depth are presented in Table 11.

7.1.2 Completeness

For all navigation data, 100% completeness has been defined as the QAPP requirement. Normandeau's differential GPS (dGPS) navigation system will be used to acquire navigation data for mussel surveys. The shipboard navigation system on the fishing vessel *Odessa* will be used for flounder surveys. For lobster surveys, the commercial vessel's navigation system will be used, and coordinates will be verified with a handheld GPS unit operated by the Normandeau field technician. The initial and final coordinates of each flounder trawl and the actual coordinates of each lobster pot will be hand recorded on field

logsheets. The location of the mussel collections and array deployments will be hand recorded onto the Station Log. Depth measurements will be recorded at each station.

Table 11. Accuracy and Precision of Navigation Data.

Sensor	Units	Range	Accuracy	Precision
Fathometer (depth)	m	0 to 200	2	0.1
dGPS Navigation	degree	Coastal	$9x10^{-5}$ deg (10 m)	$1.8x10^{-5}$ deg (2 m)
Loran-C Navigation	nautical mile	Coastal	0.1-0.25 nm (185-463 m)	18 – 90 m

7.1.3 Comparability

Latitude/longitude positions will be comparable to positions obtained by previous MWRA monitoring activities as well as by other researchers that have used or are using dGPS at these stations. The station locations are targets and sampling for flounder and lobster will be conducted within 300 m of the targets but will ultimately be based on the availability of individual organisms. The deployment of mussels will be conducted within 15 m of the targets as determined by Normandeau's dGPS.

7.1.4 Representativeness

The representativeness of the sampling program design is detailed in the Outfall Monitoring Plan (MWRA 1997) and defined by the results collected since 1992.

7.1.5 Sensitivity

Traditional measures of sensitivity are not applicable to navigational data.

7.2 FLOUNDER SURVEY

7.2.1 Accuracy

Traditional measures of accuracy do not directly apply to fish collection procedures. However, accuracy measures do apply to the identification of fish and the chemical analyses.

To ensure that specimens are accurately identified, taxonomic keys, in references such as Fishes of the Gulf of Maine (Collette B. and G. Klein-MacPhee, 2002) and various field guides will be used. The guaranteed accuracy of the "O'Haus" fish scale is 20 g. The accuracy of the fish measuring board is 0.1 cm.

7.2.2 Precision

The precision of fish length and weight measurements will be monitored through the re-measurement of at least 10% of the specimens collected at each sampling site. DQOs for precision of physical measurements are defined in Table 12.

Table 12. DQOs for Physical Measurements of Flounder and Lobster

QC Type and Frequency	Acceptance Criteria	Corrective Action
FLOUNDER/LOBSTER MEASUREMENTS		
Precision Duplicate Measurements 10%	Flounder Weight: ± 20 grams Flounder Total and Standard Length: ± 1 cm Lobster total weight: ± 1% Lobster carapace lengths: ± 1 mm	Check calibration of balance, if applicable.

7.2.3 Completeness

For flounder sampling, the project objective is to obtain 50 sexually mature specimens from each sampling site and the completeness goal is 100%. 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, Dr. Moore will determine the need for appropriate corrective action (e.g., re-sampling using a different otter trawl). The corrective action taken 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.

7.2.4 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 to 60 minutes at a speed of 1.5 to 2 kt. The sampling design of this survey is comparable to the design of previous surveys.

7.2.5 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. Representativeness will also be ensured by proper handling, storage, and analysis of samples, as defined in this QAPP, so that the flounder tissues collected and analyzed reflect the conditions at the site locations.

7.2.6 Sensitivity

Traditional measures of sensitivity are not applicable to flounder collection.

7.3 LOBSTER SURVEY

7.3.1 Accuracy

Traditional measures of accuracy do not directly apply to lobster collection procedures. However, accuracy measures do apply to the physical measurements and the chemical analyses.

The accuracy of the Ohaus balance (Model C-11) used for weight determination is 1 g. The accuracy of the calipers is 0.02 mm.

7.3.2 Precision

The precision of lobster carapace length and lobster weight measurements will be monitored through the re-measurement of at least 10% of the specimens collected at each sampling site. DQOs for precision of physical measurements are defined in Table 6. If agreement between the length or weight measurements meets the DQOs, measurements will continue. If measurements or weights differ by more than the QAPP criteria, the cause will be identified and all specimens measured since the last acceptable precision measurement will be re-measured or re-weighed.

7.3.3 Completeness

The sampling objective is to obtain 15 commercially harvestable specimens representative of their location. The completeness goal for lobster sampling is 100%. However, if every reasonable effort to acquire the required number of lobsters has been made, and lobsters were not available for collection, the 100% completeness goal may be waived.

7.3.4 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.

7.3.5 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 Offshore. Representativeness will also be ensured by proper handling, storage, and analysis of samples, as defined in this QAPP, so that the lobster tissues collected and analyzed reflect the conditions at the site locations.

7.3.6 Sensitivity

Traditional measures of sensitivity are not applicable to lobster collection.

7.4 MUSSEL SURVEY

7.4.1 Accuracy

Traditional measures of accuracy do not apply to mussel collection procedures. Calipers will be used to ensure that the mussels used in the survey are approximately six centimeters.

7.4.2 Precision

There are no DQOs for the precision of mussel physical measurements.

7.4.3 Completeness

Completeness goal for mussel collection is 100% (after the 60-day deployment), which should be achievable with the 15% additional contingency deployments (planning for potential loss of some mussel arrays). Large numbers of mussels are deployed in arrays, which should provide sufficient mussels for chemical analyses. An early 40-day retrieval is conducted to ensure sufficient tissue is available for each site (see Section 8 for further details on mussel deployment and collection plans).

7.4.4 Comparability

The deployment and retrieval of caged mussels for short-term bioaccumulation is identical to the design of previous surveys. Mussels from the established reference site, Stover's Point, ME, will be relocated to different environments (station locations).

7.4.5 Representativeness

The sampling sites represent previously sampled locations and are representative of the expected short-term bioaccumulation conditions for mussels. Representativeness will also be ensured by proper handling, storage, and analysis of samples, as defined in this QAPP, so that the mussel tissues collected and analyzed reflect the conditions at the site locations.

7.4.6 Sensitivity

Traditional measures of sensitivity are not applicable to mussel collection or deployment.

7.5 TISSUE CHEMICAL ANALYSIS

Attachment A-1 provides the Measurement Performance Criteria (MPCs) to meet the project DQOs for accuracy, precision, completeness, comparability, representativeness, and sensitivity for all chemical analyses (metals, SVOCs including PAHs, pesticides, and PCBs) for flounder, lobster, and mussel tissues. MPCs have been developed for each of the field and laboratory data quality indicators, as detailed in an EPA-compliant format in Attachment A-1. In this attachment, the frequency requirement of each QC element, the acceptance criteria, and the required corrective actions for QC that do not meet DQOs to maximize the usable data generated for this program, are defined. This replaces the need for extensive text in this QAPP section and allows for ease of reference for laboratory chemists during preparation and analysis of samples. Required project quantitation limits (PQLs) for all chemicals of concern, in support of sensitivity goals, are defined in Attachment A-2.

7.5.1 Accuracy

See Attachment A-1.

7.5.2 Precision

See Attachment A-1.

7.5.3 Completeness

Though the goal is 100% for analysis of all tissue samples collected and submitted to the laboratory, the goal for amount of usable data generated from chemical analysis is 95%. This allows for achievement of critical data points while also allowing for the potential loss of a small portion of the chemical data due to severe matrix effects during analysis and/or human error.

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 Attachment A-2, and for lipids and percent dry weight.

Completeness of chemical analyses will also depend directly upon the amount of sample available. If inadequate tissue biomass is available for preparation and analysis, then the MWRA Project 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 QLs).

7.5.4 Comparability

The Standard Reference Material (SRM), when processed and analyzed with samples, will quantify the comparability characteristic for laboratory measurements.

The analytical methods defined for chemical analyses of flounder, lobster, and mussel tissue in Table 13 are comparable to the methods of analysis previously used for tissue analysis for this project in prior MWRA surveys. Either the same EPA methods of analysis are being employed during 2006, or, the methods of analysis used have been independently reviewed by MWRA (reference email of comparability of Battelle PAH method and CAS PAH method, January 2006) and Normandeau QA personnel to determine comparability prior to their use for this project.

7.5.5 Representativeness

The monitoring program was designed to ensure that results will be representative (MWRA 1997). Representativeness will also be ensured by proper handling, storage, preparation (homogenization and compositing), and analysis of samples, as defined in this QAPP, so that the tissues collected and analyzed reflect the conditions at the site locations.

7.5.6 Sensitivity

Sensitivity is the ability of the method or instrument to detect the contaminant of concern at the level of interest. Sensitivity requirements for the chemicals of concern, in terms of quantiation limits (QLs), are defined in Attachment A-2. Sensitivity requirements (project specific QLs, or PQLs) were developed in consideration of project data uses including comparison to threshold limits, FDA limits, the lowest detected results from the MWRA 2003 fish and shellfish monitoring database and consideration of method capabilities and limitations for the chemicals being analyzed. Several QC samples and procedures have also been defined to ensure that sensitivity of chemical data is consistent with project data uses. These QC steps include the analysis of method and instrument blanks to assess

Table 13. Analytical SOP Reference Table.

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Lab	Modified for Project Work? (Y/N)
D-1	CAS EXT-3540.8; Soxhlet Extraction (based on EPA SW846 Method 3540C)	Definitive	SVOC including PAHs	NA	CAS	N
D-2	CAS EXT-3541.3; Automated Soxhlet Extraction (based on EPA SW846 Method 3541)	Definitive	SVOC including PAHs	NA	CAS	N
D-3	CAS GEN-TISP.3; Tissue Sample Preparation	Definitive	All chemical analyses & Percent Solids in tissues	NA	CAS	N
D-4	CAS SOC-8270P.4; Polycyclic Aromatic Hydrocarbons by GC/MS Selective Ion Monitoring (EPA Method 8270C SIM)	Definitive	SVOC including PAHs	GC/MS - SIM	CAS	N
D-5	CAS SOC-8081.8; Organochlorine Pesticides by Gas Chromatography (based on EPA SW846 Method 8081A)	Definitive	Pesticides	GC/ECD	CAS	N
D-6	CAS SOC-8082C.6; Congener-Specific Determination of Polychlorinated Biphenyls (PCBs) by Gas Chromatography / Electron Capture Detection (GC/ECD) (based on EPA SW846 Method 8082)	Definitive	PCB Congeners	GC/ECD	CAS	N
D-7	CAS MET-7471.10; Mercury in Solid or Semisolid Waste (based on EPA SW846 Method 7471)	Definitive	Mercury	CVAA	CAS	N
D-8	CAS MET-ICP.17; Determination of Metals and Trace Elements by Inductively Coupled Plasma Atomic Emission Spectrometry (based on EPA SW846 Method 6010B EPA Method 200.7, and CLP methods)	Definitive	Metals (except mercury)	ICP-AES	CAS	N
D-9	CAS MET-ICPMS.9; Determination of Metals and Trace Elements by Inductively Coupled- Mass Spectrometry (ICP-MS) – EPA Method 200.8	Definitive	Metals (except mercury)	ICP-MS	CAS	N
D-10	CAS MET-6020.8; Determination of Metals and Trace Elements by Inductively Coupled- Mass Spectrometry (ICP-MS) – EPA Method 6020	Definitive	Metals (except mercury)	ICP-MS	CAS	N
D-11	CAS MET-3050B.8; Metals Digestion (based on EPA SW846 Method 3050B)	Definitive	Metals (except mercury)	NA	CAS	N
D-12	CAS SOC-LIPID – Percent Lipids in Tissue	Definitive	Percent Lipids	gravimetric	CAS	N

contamination, instrument initial and continuing calibration criteria, and the requirement that the low-level standard in the calibration curve must support the analyte quantitation limit (QL).

The type, frequency, and criteria for these QC samples associated with sensitivity (including calibration and blank frequency and criteria) are defined in Attachment A-1. Adherence to laboratory method SOPs (see Attachment D) will also assist in providing the appropriate level of sensitivity.

Sensitivity may be affected by contamination, method errors, and matrix interferences sometimes observed in tissue analysis. In a case in which project-specified PQLs are not achieved due to matrix effects, sample or extract cleanups will be performed, if appropriate. If the quantitation limits are still not achievable, the applicability and usability of the data, with respect to meeting the DQOs, will be evaluated during data validation and usability review.

7.6 FLOUNDER HISTOLOGICAL ANALYSIS

7.6.1 Accuracy and Precision

Traditional measures of accuracy and precision do not apply to flounder histology. However, flounder scales will be read by National Marine Fisheries Service (NMFS) scientists who are experienced in aging winter flounder.

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. Nonetheless, an intercomparability exercise carried out in 1993 documented that two 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.

7.6.2 Completeness

The completeness goal for histology analysis is 100%. Lesion scores will be calculated using three slides of liver tissue from each of 50 flounder collected at each site. This will provide sufficient data to perform the statistical analyses needed to assess the health of flounder populations, and to make inter-site comparisons of lesion prevalence.

7.6.3 Comparability

Inclusion of Dr. Michael Moore on the Normandeau Team ensures that the flounder histology analysis will be conducted in a manner consistent with previous surveys; thereby providing comparability of data for the 2006 and 2007 surveys with historical data. 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 who have aged winter flounder during the previous studies. Comparability of flounder liver histology data has been confirmed in a number of studies, as referenced above in Section 7.6.1.

7.6.4 Representativeness

The monitoring program was designed to ensure that results will be representative (MWRA 1997, 2004). Representativeness will also be ensured by proper handling and preparation of the liver samples for histology analysis, as defined in this QAPP, so that the flounder tissues collected and evaluated reflect the conditions at the site locations.

7.6.4 Sensitivity

Traditional measures of sensitivity are not applicable to flounder histology analysis.

8.0 SAMPLING DESIGN, LOCATIONS, AND PROCEDURES

A summary of the parameters to be collected is included in Table 14.

8.1 FLOUNDER SURVEY

Four sites will be sampled during each annual survey to collect winter flounder for histological and chemical analyses:

- Deer Island Flats (Boston Harbor),
- Off Nantasket Beach,
- Outfall Site (offshore effluent outfall), and
- East Cape Cod Bay.

Table 5 provides the sampling sites and locations. Figure 3 illustrates the sampling locations in Boston Harbor and Offshore. Attachment C-1 is the winter flounder survey plan for 2006. This plan includes detailed procedures for collection, handling, and processing of flounder prior to shipment to the fixed laboratory for chemical analysis. Sections 8.1.1 through 8.1.3 include brief summaries of these procedures. This Survey Plan will be updated prior to collection of winter flounder for the April 2007 sampling event.

At each of the five designated sampling sites, otter-trawl tows will be conducted to collect 50 sexually mature, 30 – 50 cm (usually 4-5 year old) winter flounder (*Pseudopleuronectes americanus*). Each fish will be assigned a unique identification number to indicate the event, year, survey, and site of collection.

8.1.1 Flounder Collection Procedures

1. A commercial otter trawl will be towed by a commercial dragger beginning at the site center of each sampling site listed in Table 5. The tows will be conducted for 30-60 minutes at a speed of 1.5 to 2 kt in a direction parallel to lobster-pot sets 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 differential GPS and/or 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 greater than 30-50 cm total length (50) is not collected during the first tow. If the required number of flounder is not collected after one 30-minute tow and three 1 hour tows at an appropriate adjacent site, collections at that site will be terminated for the survey period. 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. Physical measurements and observations will be recorded for flounder specimens on the Flounder Log (Attachment C).

Table 14. Monitoring Parameters, Collection Frequency, Sample Containers, Preservation, and Holding Time 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; Organics: Glass Inorganics: pre-cleaned polystyrene	Laboratory: Freeze, if not processed immediately	One year maintained frozen for all chemistry parameters (Thawed: all metals except Hg: 180-d; Hg: 28-d; SVOCs, PCBs, & Pesticides: 14-d to extraction & 40-d to analysis)
	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; Organics: Glass Inorganics: pre-cleaned polystyrene	Laboratory: Freeze, if not processed immediately	One year maintained frozen for all chemistry parameters (Thawed: all metals except Hg: 180-d; Hg: 28-d; SVOCs, PCBs, & Pesticides: 14-d to extraction & 40-d to analysis)
	Visual	15/15	N/A	Shipboard: Describe qualitatively	NA
	- Biometrics weight carapace length sex	15/15	N/A	Shipboard: Process immediately	NA
Mussel	Chemistry - soft tissue	DIL: 100/5[c] OS: 160/8 IH: 100/5 CCB: 80/4 LNB: 80/4 SP: 100/5	Clean, labeled jar; Organics: Glass Inorganics: pre-cleaned polystyrene	Laboratory: Freeze if not processed immediately	One year maintained frozen for all chemistry parameters (Thawed: all metals except Hg: 180-d; Hg: 28-d; SVOCs, PCBs, & Pesticides: 14-d to extraction & 40-d to analysis)

a = total individual specimens collected per station.
b = total pooled (composite) samples to be analyzed per station.
c = number for each site to be collected 40 and 60 days after deployment, accept for those collected initially at reference site, SP.

5. Fish held for histological and chemical analysis will be kept on ice and hand-delivered on-shore to EnviroSystems.
6. Field datasheets will be reviewed after all the fish are processed for a given station to ensure completeness, accuracy and legibility.

8.2 LOBSTER SURVEY

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

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

Table 5 provides the sampling sites and locations. Figure 4 illustrates the sampling locations in Boston Harbor and Offshore.

8.2.1 Lobster Collection

Fifteen lobsters will be collected per site. Historically it has not been possible to obtain the required lobsters at all the sites during July because of the seasonal onshore-offshore movements of this species. Therefore, several sampling events may be necessary at the outfall to obtain sufficient lobsters for analysis. Decisions about when to resample will be based on the survey reports provided under the water column monitoring program that include observations of lobstering activities. The following lobster collection procedures will be followed.

1. Commercial lobstermen will procure the lobsters for chemical analysis. The lobstermen will be provided with coordinates for deployment of the traps and guidelines for the maximum distance from these coordinates that traps may be placed. Traps will be left in place for several days.
2. When it is time to retrieve the traps, a fisheries technician from Normandeau will accompany the lobstermen. The fisheries technician will use a portable d-GPS unit to confirm the locations where the traps are retrieved (within 2 km of target site) and document the location on the lobster sample collection log (Figure 7).
3. Upon retrieval, lobster pots will be brought alongside the vessel to the gunnel (side railing). Specimens will be removed and measured on the gunnel (Figure 8). 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.
4. The fisheries technician will process the lobsters for physical characteristics (carapace length, weight, gender, and gross external abnormalities, such as black gill disease, shell erosion, parasites, and external tumors (see Attachment C-2); to be recorded on the lobster sample collection log. These measurements and inspections will be made immediately upon capture to improve chances of survival.
5. Fifteen specimens retained for processing will be banded with one band per claw. Each lobster will be given a unique sample control number to indicate event, year, survey, and site of collection.

Figure 7. Sample Collection Log – Lobster.

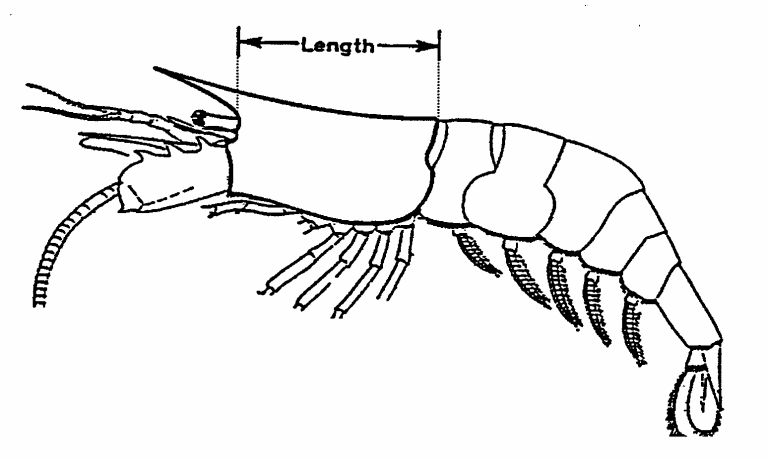

Figure 8. Carapace Measurement of Lobster

6. During the survey, lobster specimens will be stored away from commercial lobsters in a separate container with site water.
7. Whole lobsters will be shipped on-ice (transport from the dock to commercial air freight) to CAS for processing, compositing, and homogenization.

8.3 MUSSEL SURVEY

Live blue mussels (*Mytilus edulis*) approximately 6 cm in length will be collected from the baseline (pre-survey) reference site in Stover's Point, ME. Normandeau Associates possesses a scientific collecting permit from Maine for the procurement of these mussels. One hundred mussels will be randomly selected for chemical contaminant analysis. The remaining mussels will be deployed and retrieved at five sites:

Five locations will be used for mussel deployment for subsequent chemical analyses:

- Deer Island Light (~2 m above bottom),
- Outfall Site – approximately 60 ±15 m from the offshore outfall (depth of 10-15 m above bottom, water depth ~30 m (MLW)),
- Boston Inner Harbor (1.5 – 4.5 m above bottom – Rise and fall with tide, so that it is at a constant depth below the water surface),
- Cape Cod Bay (10-15 m above bottom),
- B Buoy (Boston Approach Buoy, 1 km south of offshore outfall; 10-15 m above bottom).

Table 5 provides the sampling sites and locations. Figure 5 illustrates the sampling locations in Boston Harbor and Offshore.

8.3.1 Mussel Deployment and Collection

Table 7 provides minimum number of mussels required for each location. In addition to the minimum number of mussels required for analysis, 15% more at each location will be deployed to account for loss due to mortality during the deployment. The most recent bioaccumulation survey recorded survival rates of 92-99% (Wisneski et al. 2004), so a 15% contingency should be ample to ensure there are sufficient

mussels for chemical analysis. Mussels collected for the bioaccumulation survey will measure approximately 6 cm (55-65mm) (see Figure 9).

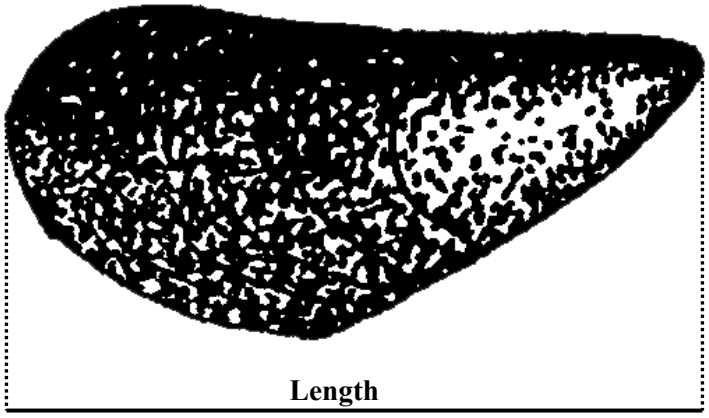

Figure 9. Length Measurement of Mussels.

Stover's Point, ME was chosen as a reference site since water quality in this region is affected by fewer discharges than in Massachusetts Bay. Nonetheless, many contaminants can be transported from great distances atmospherically, and knowledge of baseline levels of contaminants in mussels deployed for this survey is critical to assessing MWRA outfall effects. Normandeau will randomly select (i.e., choose without bias) 160 mussels (eight replicates of 20 individuals) from Stover's Point, assign unique sample control numbers to the replicates, and pack the samples in ice prior to shipment to the laboratory for chemical analysis.

Sufficient mussels at each of the locations identified in Table 5 will be deployed to allow for collection of 20 mussels per replicate at 40-day and 60-day deployments for chemical analysis. Table 7 provides minimum numbers of mussels required for each location. Preferred deployment period is 60 days but past surveys have occasionally encountered problems (vandalism or entanglement with fishing gear or vessels) that resulted in the loss of mussels. The following steps will be taken to minimize the possibility of missing data. First, mussel arrays will be constructed using heavy-duty materials. Second, one extra array will be deployed at each critical location (Deer Island and Outfall). Third, sufficient mussels for chemical analysis will be retrieved from each site after 40 days of exposure and shipped to the analytical laboratory on ice. These mussels will be shucked and frozen to be held as contingencies until the Fish and Shellfish Monitoring Report for 2006 has been accepted by MWRA. Thus, approximately 1600 mussels of the appropriate size will be collected during this survey. These redundancies in mussel collection should maximize the generation of usable data and minimize potential data gaps due to mussel losses.

At each location a minimum of three arrays will be deployed except for the offshore locations (Outfall Site and Cape Cod Bay) where four arrays will be deployed. Each array will be deployed on a separate mooring with enough mussels to provide sufficient tissue to complete the study. The locations of the arrays will be recorded using dGPS.

Normandeau will retrieve mussels from each location after 40 days (early August) to be held in contingency in the event that arrays are lost or mortality is unusually high between 40 and 60 days. A

sample control number will be assigned to each replicate and the mussels will be shipped to the analytical laboratory on ice to be archived (frozen) until it is determined whether processing is required. The condition of the cages (degree of fouling) and mussels (percent survival) will be recorded. If fouling is excessive such that it compromises the flow of water through the cages or weighs the array down sinking it in the water column, the field crew will retrieve the remaining arrays from that location and clean the fouling organisms from the cages prior to replacing them in the water.

In late August 2006, 60 days after deployment, Normandeau will retrieve mussels from the remaining arrays. As in the 40-day retrieval, condition of the cages and mussels will be determined. Live mussels will be selected to make up the requisite number of replicate samples from each location. A sample control number will be assigned to each replicate and samples will be shipped on ice, by commercial air carrier, to the CAS laboratory.

8.4 FLOUNDER HISTOLOGICAL ANALYSIS

Collection of flounder specimens for histological analysis will follow the protocols described above in Section 8.1 for the Flounder Survey. Flounder histological analysis will follow the procedures described in Section 11.

8.5 NAVIGATION

Information on navigation for the three surveys is presented in Section 7.1.

8.6 WHALE OBSERVATIONS

During the Flounder Surveys in April of 2006 and 2007, whale observations will be conducted using trained dedicated observers. Whale observations will be documented in the flounder survey summary and the results detailed in the Flounder Survey Report.

Field operations for the flounder survey will adhere to the Right Whale Guidance Protocol for Vessels Operated/Contracted by the Commonwealth of Massachusetts. Historical data indicate that there is a relatively high likelihood that right whales will be in Cape Cod Bay while the flounder collections are being made. Dr. Moore is a right whale biologist with field experience since 1979. During transit between stations the captain and Dr. Moore will maintain a careful lookout for vessels and marine mammals.

9.0 SAMPLE HANDLING, TRACKING, AND CUSTODY PROCEDURES

9.1 SAMPLE CUSTODY

Samples collected in the field will each be assigned a unique *Sample ID*. The *Sample ID* will identify the sample collected (i.e., a single flounder, a single lobster, or a mussel composite). The *Sample ID* will consist of the *Event ID*, the Station # (see Table 5), and a sequential number (001-050 for individual flounder, 001-015 for individual lobster, and 01-08 for mussel composites), concatenated. The five character *Event ID* will be unique to each survey, such as "FF061", with "FF" indicating that it is a flounder survey ("FL" for lobster survey and "FM" for mussel survey), "06" indicating the survey year, and "1" signifying the first survey of the year. Unique *Bottle ID*s will be assigned to identify sub-samples such as body tissue types for fish or lobster chemistry data, or liver slices for the flounder histology data.

9.2 CUSTODY OF ELECTRONIC DATA

9.2.1 Navigation Data

Custody of electronic navigation data will be the responsibility of the Chief Scientist during the field activity. For the flounder surveys, navigation data, including survey ID, date, time, trawl number, and vessel position at start and completion of each sampling event, will be hand-recorded on the flounder field log. For lobster surveys, navigation data, including survey ID, date, time, and position of each lobster pot, will be hand-recorded on the survey log sheet. For mussel surveys, navigation data, including survey ID, date, time, and location and condition of arrays, will be hand-recorded on the survey log sheet. The Normandeau Field Manager must receive a complete copy of the survey log for each survey.

9.2.2 Laboratory Data

Normandeau, WHOI, and CAS will produce electronic data under this task. At CAS and WHOI, 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 appropriate QA/QC checks, as defined by the individual SOPs. The electronic histology data will be transferred to Normandeau for inclusion into the team's project database. The chemistry data from CAS will undergo data validation assessment at NEH and then be transferred electronically to Normandeau for inclusion into the team's project database. After QA/QC checks of this database, Normandeau will transfer it to the MWRA Database Manager for entry into the EM&MS database.

9.3 FLOUNDER, LOBSTER, AND MUSSEL SAMPLE CUSTODY

An overview of sample handling is presented in Table 15. During field collection, custody 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. Examples of Chain-of-custody forms can be found in Attachment C.

The samples will remain in the custody of the Chief Scientist (designated for each survey) while in the field. Custody 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

Table 15. Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Erick Fel'dotto/Normandeau
Sample Packaging (Personnel/Organization): Erick Fel'dotto/Normandeau; /Environsystems, Inc.
Coordination of Shipment (Personnel/Organization): Erick Fel'dotto/Normandeau; /Envirosystems, Inc.
Type of Shipment/Carrier: Commercial Carrier (e.g. FedEx) or project personnel
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): TBD/Envirosystems, Inc.; Michael Moore/WHOI; Greg Salata/CAS
Sample Custody and Storage (Personnel/Organization): TBD/Envirosystems, Inc.; Michael Moore/WHOI; Greg Salata/CAS
Sample Preparation (Personnel/Organization): TBD/Envirosystems, Inc.; Michael Moore/WHOI; Greg Salata/CAS
Sample Determinative Analysis (Personnel/Organization): Michael Moore/WHOI; Greg Salata/CAS
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Less than 24 hours
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 40 days (organics); 6 months (metals)
Biological Sample Storage (No. of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Approval for disposal will be coordinated between MWRA and the Project Management.
Number of Days from Analysis: See above.

samples arrive at the laboratory, custody will be relinquished to the Laboratory Custodian. Upon receipt of the samples, the laboratory Sample Custodian will examine the samples, verify that sample-specific information recorded on the custody forms is accurate and that the sample integrity is uncompromised, log the samples into the laboratory tracking system, complete the custody forms, and sign the custody form so that transfer of custody of the samples is complete. Completed custody forms must be faxed to the Normandeau Project Manager within 24 hours of sample receipt. Any discrepancies between sample labels and transmittal forms, and unusual events or deviations from the project QAPP will be documented in detail on the custody form and the Normandeau Project Manager and Laboratory Project Manager notified. The original Chain-of-custody (COC) forms will be submitted to CAS with the samples. These originals will then travel with the chemistry data package to NEH for data validation assessment. Following NEH's assessment, the original laboratory data package, including the original COCs, will be submitted to the Normandeau Project 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.

9.4 HISTOLOGY SAMPLE CUSTODY

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. 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.

9.5 TISSUE CHEMISTRY SAMPLE CUSTODY

The CAS laboratory custodian of samples for chemical analyses will be responsible for receiving samples (by signing the chain-of-custody) for tissue chemical analysis. The procedures described in Section 9.3 apply for sample receipt and log-in. Unique laboratory sample identification numbers will be used to track samples through the chemistry laboratory. When samples are composited, a new sample identification number will be assigned to the composite sample (see Attachment G).

10.0 SAMPLE PROCESSING AND ANALYSIS FOR CHEMISTRY AND HISTOLOGY

10.1 FLOUNDER SAMPLE PROCESSING

Flounder specimens will be collected according to procedures documented in Section 8 and processed according to the procedures described in the sections below. All 50 flounder targeted for collection at each site will be processed for histology and gross external and internal health conditions, while 15 of these will also be used for Chemical analyses to determine contaminant concentrations in liver and edible tissue.

10.1.1 Flounder Processing for Histology

The flounder processing for histology analysis will be performed as follows. Steps 2 through 5 will be performed at sea for all specimens. Those flounder that will be used for chemical analyses will be processed for histology and internal conditions (steps 6-8) at EnviroSystems in a contaminant-free clean room. All other flounder will be processed on board the vessel, at sea. All observations and measurements will be recorded on the Field Fish Log sheets, an example of which is provided in Attachment C-4. Histology processing steps 9 and 10 will be done by Experimental Pathology Laboratories in Herndon, VA.

1. The fish from each site will be processed immediately, and processing may continue while proceeding to the next sampling site. The fish processed for histology analyses at sea will be killed by cervical section prior to processing.
2. The weight, standard length, and total length will be determined (see Attachment C-1).
3. Each fish will be examined externally and their external condition will be noted prior to histological processing. Each flounder will be examined for external evidence of disease (fin rot and external lesions) and notes will be recorded on the Field Fish Log sheets.
4. Scales will be collected from each specimen for age determination (by NMFS scientists, through the analysis of growth rings, annuli, on the scales). 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.
5. The gross external condition of the flounder (skin ulcers, lymphocystis, fin rot, bent fin ray, net damage) will be subjectively scored on a scale of 0 to 4.
6. The gonads of each flounder will be examined to determine sexual maturity.
7. The livers will be aseptically removed and examined for visible gross abnormalities (gross liver lesion). 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”.
8. The livers will be preserved in 10% neutral buffered formalin for histological analysis. Liver samples from each fish will be placed in a separate, clearly labeled histology cassette. The cassette will then be placed in a closed bucket of formalin.
9. Transverse sections of flounder livers fixed as part of Tissue Sample Processing 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, with three replicate liver slices per slide, and a total of 250 slides per year. The sections will be stained in hematoxylin and eosin.

10. Liver samples from each fish will be placed in a separate clearly labeled sample container.

10.1.2 Flounder Processing for Chemical Analyses

For stations where chemistry analyses are to be conducted, fifteen of the fifty fish will be randomly selected for joint histological and chemical analysis. These fish will be examined on board the collection vessel for external condition, including length (SL and TL), weight, and scales removed for aging. Because contaminant-free conditions cannot be found on board the vessel used for flounder collection, these fish will be placed alive on ice and transported to EnvironSystems, Hampton, NH, for on-shore processing for histological and chemical analysis. Fifteen unique sample identification numbers will be assigned to these fish during shipboard processing.

The flounder tissues will be removed at EnviroSystems under contaminant-free conditions (ISO level 8 clean room) (see Attachment I). Processing for histology and internal conditions are described in section 10.1.1. A small portion of the liver will be removed (using a titanium or ceramic knife) and preserved for histology, such that most of the liver tissue can be maintained for chemical analysis. In addition, for chemical analysis, fillets (muscle) will be removed from the flounder, and the skin will be removed from the fillet using a pre-cleaned (i.e., rinsed with 10% HCL, Milli-Q (18 megohm) water, acetone, DCM, and hexane) stainless steel knife. Liver and fillet samples for chemical analysis will be maintained and identified as individual fish, frozen, and shipped to CAS Kelso where they will be composited and homogenized.

10.1.3 Flounder Compositing and Homogenization for Chemical Analysis

Fillet composites will be made from equal aliquots (±10% by wet-weight) of the homogenate of 5 individual fish fillets using approximately equal masses of top and bottom tissue. The liver composite samples will contain approximately equal masses (5 grams) from each of the livers and will correspond to the composites made for the fillets. For fish with extremely small livers (< 5g wet weight), all available liver tissue will be used from such fish. Upon compositing, a new sample ID number will be generated to track the composite. There will be a total of three composities of each tissue for each station (Figure 7). When the composites are prepared for analysis, sufficient tissue will be archived in the event that an anomalous result indicates the need for reanalysis. CAS SOP GEN-TISP.3, included as Attachment D-3, includes further details on tissue sample processing for chemical analysis.

All fish tissue will be maintained frozen at CAS prior to analysis. Archived tissue will also be maintained frozen at CAS.

Homogenization of fillet composite samples will be performed using a stainless steel TEKMAR® tissuemizer. 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. 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 of ≤ 20 tissue samples to assess for sample contamination during the homogenization process. For the blank sample, a known quantity of (about 100 ml) laboratory analyte-free water will be transferred to a clear glass jar, “tissuemized” for two minutes, and analyzed for both PCBs, pesticides, and mercury (fillet measurements only).

Flounder composite samples (edible meat/fillet composites and liver composites) will be analyzed for the project-specific list of chemicals of concern listed in Attachment A-1.

10.2 LOBSTER SAMPLE PROCESSING

Lobster specimens will be collected according to procedures documented in Section 8 and processed according to the procedures described in the sections below.

10.2.1 Lobster Processing for Chemical Analysis

Whole lobsters will be shipped on-ice to CAS where the hepatopancreas and meat (claws and tail) will be removed. From the 15 lobsters collected for each site, three composites of five lobsters each will be made for each site. Two tissue types are to be analyzed per site (claw and tail meat, hepatopancreas), resulting in 18 composite samples (3 composites x 3 sites x 2 tissue types).

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. Homogenized samples of hepatopancreas or edible meat from each lobster in a pool will be quantitatively combined (±10% by wet- weight) to provide two composite samples per pool, one each of hepatopancreas and edible meat. Upon compositing, a new sample ID number will be generated to track the composite. Each composite will be placed in a sample container clearly identified with the unique sample identifier and maintained frozen prior to analysis. Material not required for analysis will be archived frozen.

CAS SOP GEN-TISP.3, included as Attachment D-3, includes further details on tissue sample processing for chemical analysis. Lobster composite samples (edible meat composites and hepatopancreas composites) will be analyzed for the project-specific list of chemicals of concern listed in Attachment A-1.

10.3 MUSSEL SAMPLE PROCESSING

Mussel specimens will be deployed and retrieved according to the procedures described in Section 8 and processed as described in the section below.

10.3.1 Mussel Processing for Chemical Analysis

CAS will shuck the mussels and homogenize the tissue to generate composite samples for each location. Each 20-mussel composite sample will be treated as an individual replicate. Composites for chemical analysis will be created as 4-8 composites (see Table 7) of 20 mussels each at each of the five site locations plus the baseline location.

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). Mussel composite samples will be prepared for chemical analyses by homogenization using a titanium TEKMAR® "tissuemizer", that has been rinsed with methanol and deionized water prior to use. Sample homogenates will then be split into appropriate containers for metals and organic analyses.

The portion of the composites not required for analysis will be frozen and archived in the event that results indicate the need to reanalyze any samples.

CAS SOP GEN-TISP.3, included as Attachment D-3, includes further details on tissue sample processing for chemical analysis. Mussel composite samples will be analyzed for the project-specific list of chemicals of concern listed in Attachment A-1.

11.0 FIELD MEASUREMENT METHOD REQUIREMENTS

11.1 FIELD SAMPLING AND MEASUREMENT SOPS

Table 16 summarizes the field measurement methods and SOPs for flounder, lobster, and mussel samples. Limited DQOs have been defined for these measurements, in terms of precision. These are listed in Tables 11 and 12. The SOPs that include field measurements are included in Attachment C.

11.2 FIELD EQUIPMENT CALIBRATION AND MAINTENANCE REQUIREMENTS

Equipment will be monitored and/or calibrated according to the following methods:

- Measuring boards used to measure flounder will be wiped dry after measuring every 10th specimen or as needed and will be rinsed after sampling has been completed at each sampling site.
- The OHAUS® dial scale, Model No.8014 MA, will be dried after weighing every 10th fish or as soon as water starts to accumulate 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.

Table 16. Project Sampling SOP Reference Table

Attachment Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
C-1	Survey Plan Winter Flounder FF061	WHOI	Trawl	Y	
C-2	Survey Plan Lobster FL06	NAI	Lobster trap	Y	
C-3	Survey Plan Mussel FM06	NAI	Array/cage	Y	

***Note**: All Field SOPs are included in Attachment C of this QAPP.*

12.0 TISSUE ANALYSIS METHOD REQUIREMENTS

12.1 CHEMICAL ANALYSIS METHOD REQUIREMENTS

Table 13 summarizes the chemistry analysis methods and SOPs. Chemistry SOPs are included in Attachment D. Project-specific chemicals for analysis for each tissue type (flounder fillet, flounder liver, lobster meat, lobster hepatopancreas, and mussel), risk-based levels of concern, MWRA thresholds, FDA Action Limits, project quantitation limits (PQLs), and laboratory QLs and MDLs are listed in in Attachment A-2. DQOs for measures of data quality in terms of accuracy, precision, completeness, comparability, representativeness, and sensitivity have been developed to meet the project data uses (e.g., comparison to risk-based levels of concern and thresholds). These project-specific DQOs are detailed in Section 6 and in Attachment A-1.

This section includes a summary of the analytical method and any modifications to these methods that will be employed for this project. Details on the preparation (digestion for metals and extraction for organics) and analysis methods are not re-iterated herein as they are clearly presented in the SOPs included in Attachment D.

12.1.1 Modifications to Previous QAPP Procedures

Blank Correction

Blank correction of tissue results will not be performed by the laboratory for the 2006 tissue data. Specific DQOs for blank contamination have been defined such that data cannot be reported associated witha grossly contaminated laboratory blank. Corrective actions for blanks have also been defined and are required to be performed prior to reported tissue results. These acceptance criteria for blanks are detailed in Attachment A-1. Furthermore, the USEPA SW846 methods do not allow for blank correction of data. CAS will follow the QC requirements of this QAPP, which include strict requirements for blank levels. In addition, NEH will review all laboratory blanks in association with tissue data and make appropriate qualifications, as necessary, to the data, if it is determined that a sample result was influenced by a blank contaminant. Thus, it is not necessary to perform blank corrections to obtain quality data that meet the needs of this project.

12.1.2 Organic and Inorganic Analyses

Sample preparation, extraction, cleanups, and analysis will follow the specific procedures in the USEPA method references given in Table 13 and the CAS SOPs included in Attachment D for SVOCs (including PAHs), pesticides, PCB congeners, metals, percent lipids, and percent solids.

All organic extracts will be spiked with internal standards (IS) and surrogates, as listed in Attachment A-1 and the individual method SOPs. The project-specific lists of chemicals to be analyzed within each parameter type (SVOCs, pesticides, PCBs, and metals) are included in Attachment A-2. Analytical QC sample requirements, criteria for acceptance, and required corrective actions are listed in Attachment A-1. Quantitation limit (QL) requirements for sensitivity project objectives are listed in Attachment A-2.

Organic contaminants will be reported in units of ng/g dry weight, metals in μg/g dry weight, lipids as percent dry weight, surrogate recoveries as percent dry weight, and dry weight as percent.

12.1.3 Analytical Instrument Calibration and Maintenance Requirements

All laboratory equipment will be calibrated and maintained according to CAS Standard Operating Procedures (SOPs) included in Table 13. 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 laboratory and field SOPs. Only exceptions or modifications to the laboratory's SOPs are described below. Attachment A-1 details the required calibration criteria and corrective actions for acceptance of results in support of this project in terms of initial calibrations and continuing calibrations.

12.2 FLOUNDER HISTOLOGY ANALYSIS REQUIREMENTS

Age determination will be performed by NMFS scientists through the analysis of growth rings (annuli) on the scales collected from each flounder specimen. The Age and Growth Unit has analyzed winter flounder scales for the MWRA project since 1988. Dr. Jay Burnett has committed his staff to provide this service for the 2006-2007 sampling program.

Histological analysis of flounder liver tissue from 50 fish at each of the four sites will be undertaken using the same methods that Dr. Moore has employed in previous years, thus insuring comparability of these data to previous survey data. One slide per fish, with three liver slices per slide, will be prepared for histological analysis of a total of 250 slides comprising 750 replicates.

Using the criteria that have been established previously for this project, each liver histology slide will be examined by Dr. Moore at WHOI 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. Prevalence or the presence of each lesion, to any degree will then be calculated.

13.0 DATA MANAGEMENT TASKS

13.1 PROJECT DOCUMENTATION AND RECORDS

Documents and records that will be generated for the project are listed in Table 17. Examples of records such as chain-of-custody and collection logs are included in Attachment C-4.

13.2 DATA ENTRY, DATA SET STRUCTURE, AND CODES

13.2.1 Project Data Entry and Processing

Flounder survey data collected on field logs will be entered by WHOI. Verification will be provided though a 100% quality check of the electronic data against the field logs.

Field collection logs for the lobster and mussel surveys will be delivered to the Normandeau Data Manager for data entry. The Normandeau data management team will enter data using the KeyesPunch™ software application, which employs automated controls and data verification. Formats designed to comply with rules of the EM&MS database will be used to constrain data entry, and data verification will be provided through double data entry. These features will ensure that any entry errors are caught and corrected as the operator keys the data.

Analytical laboratories with existing data processing capabilities (CAS and WHOI) will submit their quality checked, electronic data to the Normandeau data manager.

Normandeau's FTP site will be used for file transfers. CAS, WHOI, and NEH will upload Electronic Data Deliverables (EDDs) to the FTP site on or before internal project due dates. Recipients will be notified of the submittal by email. Files will be available on the FTP site for seven days, after which Normandeau may remove them from the site.

13.2.2 Data Set Structure

Electronic Data Deliverables will be submitted to Normandeau in a structure and format that complies as much as possible with the MWRA database. Specifications for data sets are listed in Attachment G. EDDs should be submitted as comma-delimited ASCII files using the latest database rules and code lists (see Tables 18-21). Any deviations from these specifications must be approved by the Normandeau data manager prior to submittal.

Final EDDs will be submitted to MWRA as comma-delimited ASCII files using the latest database rules and code lists, and following the specifications for data sets listed in Attachment G.

13.2.3 Project Database Codes

Because the studies included in the Fish and Shellfish Monitoring Program deal with individual species and sampling protocols, it is anticipated that there will be limited need to establish new codes for the database. Observation of previously unseen abnormalities on flounder or lobsters could require new codes. In addition, condensing of the numerous data quality codes to the four standard data validation qualifiers may necessitate the creation of additional codes (see further information on validation codes in Section 15.2.3, below). If these, or other unforeseen situations, arise during the course of the project, Normandeau's Data Manager will create a provisional code, if necessary so that data can continue to be

Table 17. Project Documents and Records

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field Notes	Sample Receipt Custody and Tracking Records	Sample Receipt Custody and Tracking Records	Corrective Action LOG	Project Personnel Sign-Off Sheet
Chain of Custody Records	Traceability Record	Traceability Record	Data Validation Reports	
Air Bills	Equipment Maintenance, Testing and Inspection Logs	Equipment Maintenance, Testing and Inspection Logs	Laboratory Quality Records	
Trawl Field Data Sheet	Equipment Calibration Logs	Equipment Calibration Logs		
Flounder Sample Field Data Sheet	Sample Disposal Records	Data Package Completeness		
Lobster Field Data Sheet		Sample Disposal Records		
Mussel Field Data Sheet		Raw Data Listing		

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

PARAM_CODE	DESCR	ABBREV	METH_CODE	INSTR_CODE
1022-22-6	4,4 DDD olefin (DDMU)		EPA 8081A	GCECD
1024-57-3	Heptachlor Epoxide		EPA 8081A	GCECD
118-74-1	Hexachlorobenzene		EPA 8081A	GCECD
120-12-7	Anthracene		EPA 8270C SIM	GCMS
127330-66-9	Dibenzothiophene		EPA 8270C SIM	GCMS
129-00-0	Pyrene		EPA 8270C SIM	GCMS
132-64-9	Dibenzofuran		EPA 8270C SIM	GCMS
191-24-2	Benzo(g,h,i)perylene		EPA 8270C SIM	GCMS
192-97-2	Benzo(e)pyrene		EPA 8270C SIM	GCMS
193-39-5	Indeno(1,2,3-c,d)pyrene		EPA 8270C SIM	GCMS
198-55-0	Perylene		EPA 8270C SIM	GCMS
205-99-2	Benzo(b)fluoranthene		EPA 8270C SIM	GCMS
2051-24-3	Decachlorobiphenyl	CL10(209)	EPA 8082	GCECD
206-44-0	Fluoranthene		EPA 8270C SIM	GCMS
207-08-9	Benzo(k)fluoranthene		EPA 8270C SIM	GCMS
208-96-8	Acenaphthylene		EPA 8270C SIM	GCMS
218-01-9	Chrysene		EPA 8270C SIM	GCMS
2245-38-7	2,3,5-Trimethylnaphthalene		EPA 8270C SIM	GCMS
2385-85-5	Mirex		EPA 8081A	GCECD
309-00-2	Aldrin		EPA 8081A	GCECD
31508-00-6	2,3',4,4',5-Pentachlorobiphenyl	CL5(118)	EPA 8082	GCECD
32598-10-0	2,3',4,4'-Tetrachlorobiphenyl	CL4(66)	EPA 8082	GCECD
32598-13-3	3,3',4,4'-Tetrachlorobiphenyl	CL4(77)	EPA 8082	GCECD
32598-14-4	2,3,3',4,4'-Pentachlorobiphenyl	CL5(105)	EPA 8082	GCECD
3424-82-6	o,p'-DDE	2,4'-DDE	EPA 8081A	GCECD
34883-43-7	2,4'-Dichlorobiphenyl	CL2(8)	EPA 8082	GCECD
35065-27-1	2,2',4,4',5,5'-Hexachlorobiphenyl	CL6(153)	EPA 8082	GCECD
35065-28-2	2,2',3,4,4',5'-Hexachlorobiphenyl	CL6(138)	EPA 8082	GCECD
35065-29-3	2,2',3,4,4',5,5'-Heptachlorobiphenyl	CL7(180)	EPA 8082	GCECD
35065-30-6	2,2',3,3',4,4',5-Heptachlorobiphenyl	CL7(170)	EPA 8082	GCECD
35693-99-3	2,2',5,5'-Tetrachlorobiphenyl	CL4(52)	EPA 8082	GCECD
37680-65-2	2,2',5-Trichlorobiphenyl	CL3(18)	EPA 8082	GCECD
37680-68-5	2',3,5-Trichlorobiphenyl*	CL3(34)	EPA 8081A, EPA 8082	GCECD
37680-73-2	2,2',4,5,5'-Pentachlorobiphenyl	CL5(101)	EPA 8082	GCECD
38380-07-3	2,2',3,3',4,4'-Hexachlorobiphenyl	CL6(128)	EPA 8082	GCECD

(continued)

Table 18. (Continued)

PARAM_CODE	DESCR	ABBREV	METH_CODE	INSTR_CODE
39765-80-5	trans-Nonachlor		EPA 8081A	GCECD
40186-72-9	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	CL9(206)	EPA 8082	GCECD
41464-39-5	2,2',3,5'-Tetrachlorobiphenyl	CL4(44)	EPA 8082	GCECD
50-29-3	p,p'-DDT	4,4'-DDT	EPA 8081A	GCECD
50-32-8	Benzo(a)pyrene		EPA 8270C SIM	GCMS
5103-71-9	cis-Chlordane		EPA 8081A	GCECD
52663-68-0	2,2',3,4',5,5',6-Heptachlorobiphenyl	CL7(187)	EPA 8082	GCECD
52663-78-2	2,2',3,3',4,4',5,6-Octachlorobiphenyl	CL8(195)	EPA 8082	GCECD
53-19-0	o,p'-DDD	2,4'-DDD	EPA 8081A	GCECD
53-70-3	Dibenzo(a,h)anthracene		EPA 8270C SIM	GCMS
56-55-3	Benz(a)anthracene		EPA 8270C SIM	GCMS
57465-28-8	3,3',4,4',5-Pentachlorobiphenyl	CL5(126)	EPA 8082	GCECD
58-89-9	Lindane		EPA 8081A	GCECD
581-42-0	2,6-Dimethylnaphthalene		EPA 8270C SIM	GCMS
60-57-1	Dieldrin		EPA 8081A	GCECD
7012-37-5	2,4,4'-Trichlorobiphenyl	CL3(28)	EPA 8082	GCECD
72-20-8	Endrin		EPA 8081A	GCECD
72-54-8	p,p'-DDD	4,4'-DDD	EPA 8081A	GCECD
72-55-9	p,p'-DDE	4,4'-DDE	EPA 8081A	GCECD
7439-92-1	Lead	Pb	EPA 6020/200.8	ICPMS
7439-97-6	Mercury	Hg	EPA 7471A	CVAA
7440-02-0	Nickel	Ni	EPA 6020/200.8	ICPMS
7440-22-4	Silver	Ag	EPA 6020/200.8	ICPMS
7440-43-9	Cadmium	Cd	EPA 6020/200.8	ICPMS
7440-47-3	Chromium	Cr	EPA 6020/200.8 or EPA 6010B/200.7	ICPMS or ICPAES
7440-50-8	Copper	Cu	EPA 6020/200.8	ICPMS
7440-66-6	Zinc	Zn	EPA 6020/200.8	ICPMS
74472-36-9	2,3,3',5,6-Pentachlorobiphenyl*	CL5(112)	EPA 8081A, EPA 8082	GCECD
76-44-8	Heptachlor		EPA 8081A	GCECD
789-02-6	o,p'-DDT	2,4'-DDT	EPA 8081A	GCECD
83-32-9	Acenaphthene		EPA 8270C SIM	GCMS
832-69-9	1-Methylphenanthrene		EPA 8270C SIM	GCMS
85-01-8	Phenanthrene		EPA 8270C SIM	GCMS
86-73-7	Fluorene		EPA 8270C SIM	GCMS
90-12-0	1-Methylnaphthalene		EPA 8270C SIM	GCMS
91-20-3	Naphthalene		EPA 8270C SIM	GCMS
91-57-6	2-Methylnaphthalene		EPA 8270C SIM	GCMS
92-52-4	Biphenyl		EPA 8270C SIM	GCMS

(continued)

Table 18. (Continued)

PARAM_CODE	DESCR	ABBREV	METH_CODE	INSTR_CODE
95-16-9	Benzothiazole		EPA 8270C SIM	GCMS
D10_86-73-7	Fluorene-D10 (surrogate)*		EPA 8270C SIM	GCMS
D10_206-44-0	Fluoranthene-D10 (surrogate)*		EPA 8270C SIM	GCMS
D14_26140-60-3	Terphenyl-D14 (surrogate)*		EPA 8270C SIM	GCMS
LIPID	Lipids		CAS SOP LIPID	BAL
MWRA10	C3-Naphthalenes		EPA 8270C SIM	GCMS
MWRA11	C4-Naphthalenes		EPA 8270C SIM	GCMS
MWRA4	C2-Chrysenes		EPA 8270C SIM	GCMS
MWRA5	C2-Dibenzothiophenes		EPA 8270C SIM	GCMS
MWRA52	C3-Phenanthrenes/Anthracenes		EPA 8270C SIM	GCMS
MWRA54	C4-Phenanthrenes/Anthracenes		EPA 8270C SIM	GCMS
MWRA57	C2-Phenanthrenes/Anthracenes		EPA 8270C SIM	GCMS
MWRA6	C2-Fluorenes		EPA 8270C SIM	GCMS
MWRA64	C1-Naphthalenes		EPA 8270C SIM	GCMS
MWRA65	C1-Fluorenes		EPA 8270C SIM	GCMS
MWRA66	C3-Fluorenes		EPA 8270C SIM	GCMS
MWRA67	C1-Phenanthrenes/Anthracenes		EPA 8270C SIM	GCMS
MWRA68	C1-Dibenzothiophenes		EPA 8270C SIM	GCMS
MWRA69	C1-Fluoranthrenes/Pyrenes		EPA 8270C SIM	GCMS
MWRA7	C2-Naphthalenes		EPA 8270C SIM	GCMS
MWRA70	C1-Chrysenes		EPA 8270C SIM	GCMS
MWRA71	C3-Chrysenes		EPA 8270C SIM	GCMS
MWRA72	C4-Chrysenes		EPA 8270C SIM	GCMS
MWRA83	C2-Fluoranthenes/Pyrenes		EPA 8270C SIM	GCMS
MWRA84	C3-Fluoranthenes/Pyrenes		EPA 8270C SIM	GCMS
MWRA9	C3-Dibenzothiophenes		EPA 8270C SIM	GCMS
PCTDRYWT	Percent weight of the sample which is dry		CAS GEN-TICP.3	BAL

* surrogate

Table 19. 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	BSOP5-175
Homarus americanus	SEX	Gender		VISUAL
Homarus americanus	WEIGHT	Wet Weight of Organism	g	LWEIGHT
Pseudopleuronectes americanus	AGE	Chronological age of specimen	y	SCALE
Pseudopleuronectes americanus	SEX	Gender		VISUAL
Pseudopleuronectes americanus	STAN_LEN	Standard length of a fish. From upper jaw tip to posterior end of the hypural bone.	mm	BSOP5-175
Pseudopleuronectes americanus	TOTAL_LEN	Total Length	mm	BSOP5-175
Pseudopleuronectes americanus	WEIGHT	Wet Weight of Organism	g	PWEIGHT

Table 20. Histopathological Parameters and Database Codes for Fish and Shellfish Monitoring

SPEC_CODE	DESCR	FRACTION_CODE	PARAM_CODE	DESCR
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	BALLOONS	Apoptopic lesion prevalence, rated on a scale from 0-4.
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	BIL_PROLIF	Biliary proliferation
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	CENTRO_HV	Centrotubular hydropic vacuolation
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	FOCAL_HV	Focal hydropic vacuolation
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	MACROPHAGE	Macrophage aggregation, rated on a scale from 0-4.
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	NEOPLASM	Neoplasia prevalence, rated on a scale from 0-4.
8857041504	*Pseudopleuronectes americanus*	LIVER_SECTION	TUBULAR_HV	Tubular hydropic vacuolation
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	FIN_ROT	Fin rot score
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	GROSS_LIV_LESIONS	Gross lesions visible on whole flounder liver
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	ULCER	Flounder skin ulcer
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	LYMPHO	Lymphocystis
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	BENT_FIN	Bent fin ray
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	NET_DAMAGE	Net damage
8857041504	*Pseudopleuronectes americanus*	WHOLE_BODY	LIVER_COL	Liver color
6181010201	*Homarus americanus*	WHOLE_BODY	BLACK_GILL	Black gill disease
6181010201	*Homarus americanus*	WHOLE_BODY	EXT_TUMORS	External tumors
6181010201	*Homarus americanus*	WHOLE_BODY	PARASITES	Parasite prevalence, rated on a scale from 0-4.
6181010201	*Homarus americanus*	WHOLE_BODY	SHELL_EROS	Shell erosion

Table 21. General Database Codes for Fish and Shellfish Monitoring

FIELD NAME	CODE	DESCRIPTION
ANAL_LAB_ID	CAS	Columbia Analytical Services, Inc. – Kelso *[new code for lab]*
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 and 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 spectrometer
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	EPA 8082	CAS Lab SOP No. SOC-8082C, PCBs by dual column GCECD
METH_CODE	EPA 8081A	CAS Lab SOP No. SOC-8081, Pesticides by dual column GCECD
METH_CODE	EPA 8270C SIM	CAS Lab SOP No. SOC-8270CPAH, Polyaromatic Hydrocarbons by GCMS-SIM
METH_CODE	CAS SOP LIPID	CAS Lab SOP No. SOC-Lipid, Percent Lipids in Tissue
METH_CODE	FSF98	Method for pathology parameters described in Fish and Shellfish CW/QAPP, 1998: ENQUAD MS-49
METH_CODE	LWEIGHT	Lobster weight to the nearest gram using conventional scale
METH_CODE	CAS SOP GEN-TISP.3	CAS Lab SOP No. GEN-TISP. 3, Tissue Sample Preparation including freeze-dried percent solids determination
METH_CODE	EPA 7471A	CAS Lab SOP No. MET-7471A, Mercury in Solid or Semisolid Waste, CVAA
METH_CODE	EPA 6010B/200.7	CAS Lab SOP No. MET-ICP, Determination of Metals and Trace Metals by Inductively Coupled Plasma Atomic Transmission Spectroscopy (ICP), ICPAES

(continued)

Table 21. (continued)

FIELD NAME	CODE	DESCRIPTION
METH_CODE	EPA 6020/200.8	CAS Lab SOP No. MET-6020 & MET-ICPMS, Determination of Metals and Trace Metals by Inductively Coupled-Mass Spectrometry (ICP-MS) – Method 200.8 and Determination of Metals and Trace Metals by Inductively Coupled-Mass Spectrometry (ICP-MS) – EPA Method 6020, ICPMS
METH_CODE	PWEIGHT	Flounder wt measurement mentioned in CW/QAPP for Fish and Shellfish Monitoring Sec 11.2.ENSR 1997
METH_CODE	SCALE	Aging by scales
METH_CODE	VISUAL	Visual inspection mentioned in CW/QAPP for Fish and Shellfish Monitoring Sec 11.2/11.3.ENSR 1997
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	PCTREC	Percent recovery
UNIT_CODE	ug/g	micrograms per gram
UNIT_CODE	y	years

recorded until the new code can be submitted to and approved by MWRA. The current codes are listed in Tables 18 through 21.

13.3 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. The data discussed in this section are those data that require some manipulation before being submitted to MWRA for entry into the project database. Data reduction will be performed by the Normandeau data management team using SAS software.

13.3.1 Flounder Survey Data

Bottom depth values will be recorded at the start and end of each trawl. Depth values for individual trawls and stations will be derived from these values as follows: DEPTH_TO_BOTTOM in the TRAWL table (see Attachment G) will be computed as the mean of start and end depths for each trawl. DEPTH_TO_BOTTOM in the STATION table will be computed as the mean of all DEPTH_TO_BOTTOM values for each station in the TRAWL table.

13.3.2 Tissue Chemistry Data

The CAS laboratory data for all analyses are collected and processed via laboratory data systems described in the Quality Assurance Manual (Attachment E) and the individual analytical SOPs (included in Attachment D). Data tables will be generated in electronic format from the CAS Laboratory Information Management System (LIMS) using the specifications required by the EM&MS database, listed in Attachment G.

Chemistry data from the CAS Laboratory will require data reduction prior to submittal to MWRA. Values for organic compounds will be surrogate-corrected so that current data are comparable to historical project data and to National Status and Trends program results. The three surrogates (fluorene-d_{10}, fluoranthene-d_{10}, and terphenyl-d_{14}) being used for SVOC (including PAH) analyses (see Attachment A-1) are different from those used to generate historical data; however, they are considered technically comparable for project objectives. Table 22 documents the mapping of these surrogates to the SVOC target compound list (i.e., shows which surrogate will be used to surrogate-correct data for each target compound). The computation for surrogate-correction will be performed as follows:

13.4 DATA TRACKING AND CONTROL

Data submissions will be logged in upon receipt at Normandeau by the Data Manager and a copy of the login will be maintained in the project files.

Data submissions for flounder histology and tissue chemistry will consist of electronic spreadsheets and laboratory data reports (in hard copy or pdf file formats). Data from the laboratories will receive a quality assurance review by Normandeau during which SAS software will be used for logical error checks and to check for violations of EM&MS database constraints and business rules. Any issues will be corrected in the data files prior to submittal to MWRA. Any irresolvable issues in the data files identified by quality

Table 22. Surrogate to Compound Mapping.

Group	Parameter Name	PARAM_CODE	Surrogate	PARAM_CODE
PCB	Decachlorobiphenyl	2051-24-3	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,4'-Dichlorobiphenyl	34883-43-7	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	2,2',5-Trichlorobiphenyl	37680-65-2	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	2,4,4'-Trichlorobiphenyl	7012-37-5	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	2,2',3,5'-Tetrachlorobiphenyl	41464-39-5	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	2,2',5,5'-Tetrachlorobiphenyl	35693-99-3	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	2,3',4,4'-Tetrachlorobiphenyl	32598-10-0	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	3,3',4,4'-Tetrachlorobiphenyl	32598-13-3	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',4,5,5'-Pentachlorobiphenyl	37680-73-2	2',3,5-Trichlorobiphenyl	37680-68-5
PCB	2,3,3',4,4'-Pentachlorobiphenyl	32598-14-4	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,3',4,4',5-Pentachlorobiphenyl	31508-00-6	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	3,3',4,4',5-Pentachlorobiphenyl	57465-28-8	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,3',4,4'-Hexachlorobiphenyl	38380-07-3	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,4,4',5'-Hexachlorobiphenyl	35065-28-2	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',4,4',5,5'-Hexachlorobiphenyl	35065-27-1	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,3',4,4',5-Heptachlorobiphenyl	35065-30-6	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
PCB	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	4,4 DDD olefin (DDMU)	1022-22-6	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	Aldrin	309-00-2	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	cis-Chlordane	5103-71-9	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	Dieldrin	60-57-1	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	Endrin	72-20-8	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	Heptachlor	76-44-8	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	Heptachlor Epoxide	1024-57-3	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	Hexachlorobenzene	118-74-1	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	Lindane	58-89-9	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	Mirex	2385-85-5	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	o,p'-DDD	53-19-0	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	o,p'-DDE	3424-82-6	2',3,5-Trichlorobiphenyl	37680-68-5
Pesticide	o,p'-DDT	789-02-6	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	p,p'-DDD	72-54-8	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	p,p'-DDE	72-55-9	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	p,p'-DDT	50-29-3	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9
Pesticide	trans-Nonachlor	39765-80-5	2',3,5-Trichlorobiphenyl	37680-68-5
PAH	1-Methylnaphthalene	90-12-0	Fluorene-d10	D8_91-20-3

(continued)

Table 22. (Continued)

Group	Parameter Name	PARAM_CODE	Surrogate	PARAM_CODE
PAH	1-Methylphenanthrene	832-69-9	Fluoranthene-d10	D10_85-0108
PAH	2,3,5-Trimethylnaphthalene	2245-38-7	Fluorene-d10	D10_85-0108
PAH	2,6-Dimethylnaphthalene	581-42-0	Fluorene-d10	D10_85-0108
PAH	2-Methylnaphthalene	91-57-6	Fluorene-d10	D8_91-20-3
PAH	Acenaphthene	83-32-9	Fluorene-d10	D10_85-0108
PAH	Acenaphthylene	208-96-8	Fluorene-d10	D10_85-0108
PAH	Anthracene	120-12-7	Fluoranthene-d10	D10_85-0108
PAH	Benz(a)anthracene	56-55-3	Terphenyl-d14	D12_218-01-9
PAH	Benzo(a)pyrene	50-32-8	Terphenyl-d14	D12_218-01-9
PAH	Benzo(b)fluoranthene	205-99-2	Terphenyl-d14	D12_218-01-9
PAH	Benzo(e)pyrene	192-97-2	Terphenyl-d14	D12_218-01-9
PAH	Benzo(g,h,i)perylene	191-24-2	Terphenyl-d14	D12_218-01-9
PAH	Benzo(k)fluoranthene	207-08-9	Terphenyl-d14	D12_218-01-9
PAH	Benzothiazole	95-16-9	Fluorene-d10	D8_91-20-3
PAH	Biphenyl	92-52-4	Fluorene-d10	D10_85-0108
PAH	C1-Chrysenes	MWRA70	Terphenyl-d14	D12_218-01-9
PAH	C1-Dibenzothiophenes	MWRA68	Fluorene-d10	D10_85-0108
PAH	C1-Fluoranthrenes/Pyrenes	MWRA69	Fluoranthene-d10	D10_85-0108
PAH	C1-Fluorenes	MWRA65	Fluorene-d10	D10_85-0108
PAH	C1-Phenanthrenes/Anthracenes	MWRA67	Fluoranthene-d10	D10_85-0108
PAH	C2-Chrysenes	MWRA4	Terphenyl-d14	D12_218-01-9
PAH	C2-Dibenzothiophenes	MWRA5	Fluorene-d10	D10_85-0108
PAH	C2-Fluoranthenes/Pyrenes	MWRA83	Fluoranthene-d10	D10_85-0108
PAH	C2-Fluorenes	MWRA6	Fluorene-d10	D10_85-0108
PAH	C2-Naphthalenes	MWRA7	Fluorene-d10	D10_85-0108
PAH	C2-Phenanthrenes/Anthracenes	MWRA57	Fluoranthene-d10	D10_85-0108
PAH	C3-Chrysenes	MWRA71	Terphenyl-d14	D12_218-01-9
PAH	C3-Dibenzothiophenes	MWRA9	Fluorene-d10	D10_85-0108
PAH	C3-Fluoranthenes/Pyrenes	MWRA84	Fluoranthene-d10	D10_85-0108
PAH	C3-Fluorenes	MWRA66	Fluorene-d10	D10_85-0108
PAH	C3-Naphthalenes	MWRA10	Fluorene-d10	D10_85-0108
PAH	C3-Phenanthrenes/Anthracenes	MWRA52	Fluoranthene-d10	D10_85-0108
PAH	C4-Chrysenes	MWRA72	Terphenyl-d14	D12_218-01-9
PAH	C4-Naphthalenes	MWRA11	Fluorene-d10	D10_85-0108
PAH	C4-Phenanthrenes/Anthracenes	MWRA54	Fluoranthene-d10	D10_85-0108
PAH	Chrysene	218-01-9	Terphenyl-d14	D12_218-01-9
PAH	Dibenzo(a,h)anthracene	53-70-3	Terphenyl-d14	D12_218-01-9
PAH	Dibenzofuran	132-64-9	Fluorene-d10	D10_85-0108
PAH	Dibenzothiophene	127330-66-9	Fluorene-d10	D10_85-0108

(continued)

Table 22. (Continued)

Group	Parameter Name	PARAM_CODE	Surrogate	PARAM_CODE
PAH	Fluoranthene	206-44-0	Fluoranthene-d10	D10_85-0108
PAH	Fluorene	86-73-7	Fluorene-d10	D10_85-0108
PAH	Indeno(1,2,3-c,d)pyrene	193-39-5	Terphenyl-d14	D12_218-01-9
PAH	Naphthalene	91-20-3	Fluorene-d10	D8_91-20-3
PAH	Perylene	198-55-0	Terphenyl-d14	D12_218-01-9
PAH	Phenanthrene	85-01-8	Fluoranthene-d10	D10_85-0108
PAH	Pyrene	129-00-0	Fluoranthene-d10	D10_85-0108

control checks (for example, stations more than specified distance from target) will also be submitted to MWRA with the data export.

Flounder and lobster composites will be tracked in the COMPOSITE table. A conceptual procedure is outlined (Figure 10) to show the logic behind the treatment of composites in the MWRA database. In this example, lobsters are collected from the field and the chemical contaminants from their tissues are analyzed separately for the meat (claws and tail) composite and the hepatopancreas composite. Each composite consists of lobster tissue from 5 lobsters.

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 (Figure 10) 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).

The COMPOSITE table is submitted to MWRA. In the EM&MS database, 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 shallowest.

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 organisms will all have the same SAMPLE_ID. This

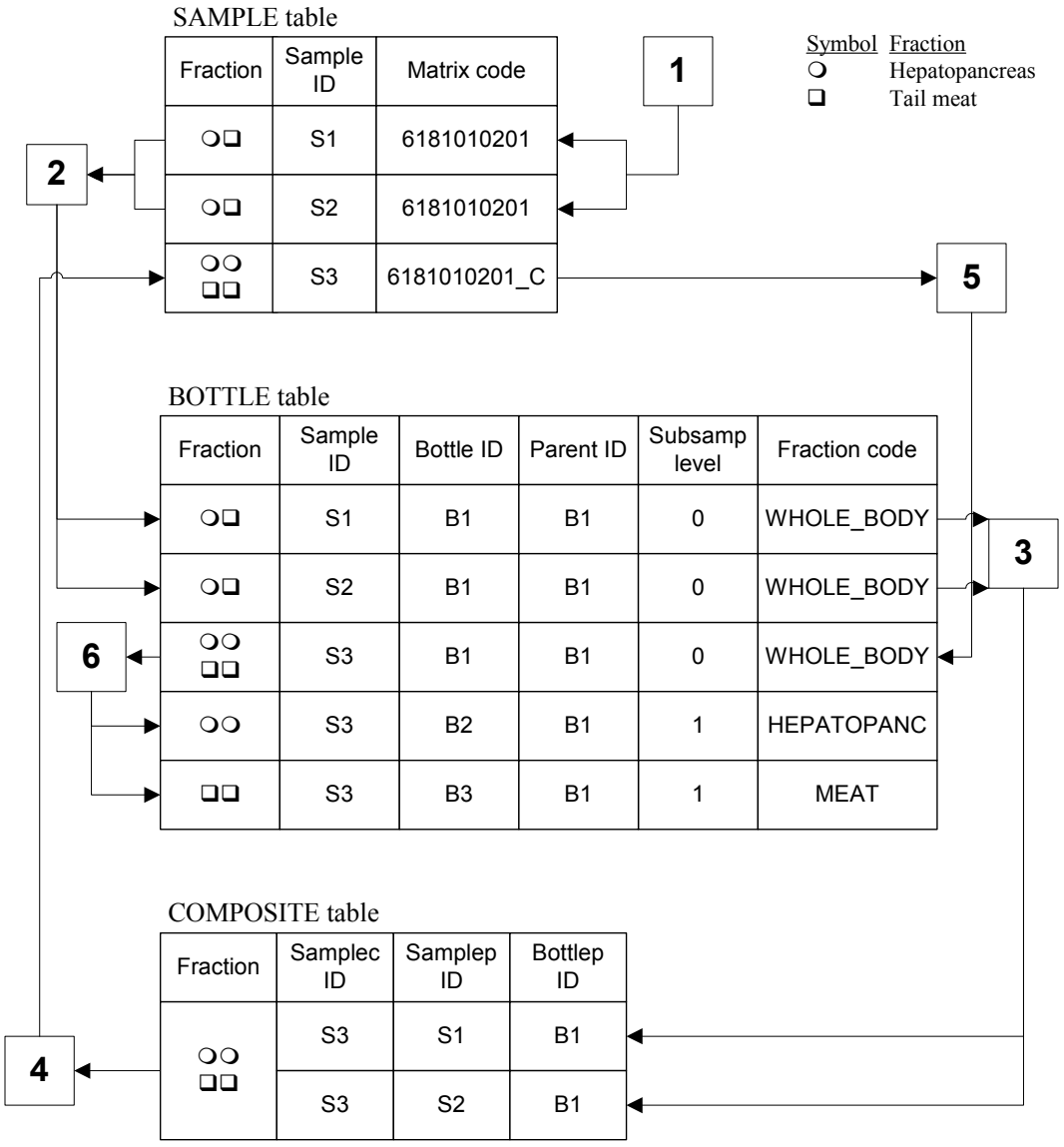

Figure 10. Conceptual Procedure for Reporting of Composite Samples

facilitates queries that bring together results from different fractions coming from the same pooled organisms.

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, because no morphology or pathology measurements are made on the individual mussels making up the chemistry composite. A SAMPLE_ID is assigned to the group of mussels composited for chemical analysis, but the information about which mussels made up the composite is not stored in the composite table. The MATRIX_CODE indicates that these are composite samples (5507010101_C). Bottles from composite mussel samples have a FRACTION_CODE of SOFT_TISSUE.

13.5 DATA SUBMITTAL AND DOCUMENTATION

Data will be submitted to MWRA as comma-delimited ASCII files using the latest database rules and code lists. Electronic Data Deliverables are listed in Table 23. Each data file submittal will be accompanied by a description of any qualifiers, missing data or other comments that will document deviations from the QAPP.

Each data set submitted to MWRA will include the documentation listed below.

- Documentation of in-house checks
- Cover letter describing any problems during loading
- Notes on all missing data and all data qualified as “suspect/invalid”
- List of problems encountered and corrective actions taken
- Explanation of any outstanding issues resulting from the checks
- List of samples planned vs. collected, or measurements planned vs. reported
- Quality Assurance Statement including a checklist of QA actions, and notes on deviations and corrective actions (electronic and signed hard copy)
- Summary statistics
- Exceptions report showing results of checks

Documentation will be maintained for six years at Normandeau following the completion of the Project.

Table 23. Listing of Electronic Data Deliverables

Project Component	Electronic Data Deliverable	Due Date	Data Sets Included in Deliverable
Flounder	Flounder Survey	May 2006, 2007	FF_EVENT, FF_STATION, FF_TRAWL, FF_SAMPLE
	Temporary Outfall Site Histology	June 2006, 2007	FF_OS_PHOTO, FF_OS_MORPH, FF_OS_LIVER, FF_OS_LIVHIST
	Flounder Chemistry	July 2006	FF_COMPOSITE, FF_CHEMISTRY
	Flounder Histology	August 2006, 2007	FF_PHOTO, FF_MORPH, FF_LIVER, FF_LIVHIST
Lobster	Lobster Survey	August 2006	FL_EVENT, FL_STATION, FL_SAMPLE, FL_LOB_MORPH
	Lobster Chemistry	October 2006	FL_COMPOSITE, FL_CHEMISTRY
Mussel	Mussel Survey	September 2006	FM_EVENT, FM_STATION, FM_DEPLOY, FM_SAMPLE
	Mussel Chemistry	November 2006	FM_CHEMISTRY

14.0 ASSESSMENT AND CORRECTIVE ACTION RESPONSE

14.1 PLANNED ASSESSMENTS

The planned project assessments are included in Table 24. These assessments will be documented on the quarterly Corrective Action Log.

14.2 ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

The assessment findings and recommended corrective actions for the planned assessment tasks listed in Table 24 will be documented in memoranda generated by the project team member responsible for performing the assessment. Additionally, the recommended corrective actions will be followed up by the project team member responsible for the assessment to ensure that procedures have come into compliance with this QAPP.

Although the quality control procedures defined in this QAPP, to be followed by all of the Normandeau Team members (field, laboratory, data validation, and data management), will significantly reduce the likelihood of errors in the data generated under the Fish and Shellfish Monitoring Program, it is possible that errors will be discovered after a dataset has been added to MWRA's EM&MS database. If errors are belatedly discovered, Normandeau's Team will correct the dataset and evaluate whether the errors have the potential to affect presentations, calculations, statistical analyses, or other data in the database. In the event that an error has consequences beyond the specific dataset, Normandeau will correct and resubmit any documents where the erroneous data had been used.

Corrective actions may include, in general, additional documentation, re-analysis of tissue samples for one or more chemicals of concern, or re-submittal of a report with corrections clearly identified (e.g., for sample identifications). These issues will be maintained in a Corrective Action Log. The Normandeau Project QA personnel (Robert Hasevlat, Normandeau and Susan D. Chapnick, NEH) will generate and/or review all corrective actions required during the project and monitor their effectiveness in meeting project quality objectives. The Normandeau Project Manager, Ann Pembroke, will review these issues on a monthly basis, but the Project QA personnel will bring serious issues to Ms. Pembroke's attention immediately. The Corrective Action Log will be submitted to MWRA on a quarterly basis.

14.3 QA MANAGEMENT REPORTING

QA management reports will include both formal reports (e.g., Data Validation Reports), logs (e.g., Corrective Action Log), and verbal communication at quarterly project meetings with MWRA. The planned QA management reporting requirements are included in Table 25.

Table 24. Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Flounder Survey	Annual	Internal	Normandeau	Robert Hasevlat QA Director	Michael Moore WHOI & Erick Fel'dotto/ Field Manager	Michael Moore	Robert Hasevlat
Lobster Survey	Annual	Internal	Normandeau	Robert Hasevlat QA Director	Michael Moore WHOI & Erick Fel'dotto/ Field Manager	Michael Moore	Robert Hasevlat
Mussel Survey	Annual	Internal	Normandeau	Robert Hasevlat QA Director	Erick Fel'dotto Field Manager	Erick Fel'dotto	Robert Hasevlat
Data Validation	Annual	Internal	NE	Susan Chapnick	Ann Pembroke Normandeau Project Manager	Susan Chapnick Data Validator	Robert Hasevlat

Table 25. QA Management Reports Table

Type of Report or Communication	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s)
QAPP	1 / for the 2006-2007 Fish & Shellfish Monitoring Program	March 2006 (draft) and April 2006 (final) with potential update in March 2007, if necessary	Ann Pembroke & Robert Hasevlat, Normandeau; Susan Chapnick & Nancy Rothman, NEH; Greg Salata, CAS Lab; Michael Moore, WHOI; Susan Kane-Driscoll, MCA	MWRA
Survey Plan	One per survey each for Flounder, Lobster, & Mussel 2006 - 2007	Two weeks prior to Survey date	Ann Pembroke & Robert Hasevlat, Normandeau; Susan Chapnick, NEH; Michael Moore, WHOI	MWRA
Corrective Action Log (will include any Field/Lab Audit findings)	Quarterly	March 2006 through June 2008	Susan Chapnick, NEH; Michael Moore, WHOI; & Robert Hasevlat, Normandeau	MWRA
Update on QAPP generation and implementation	Quarterly Project Meetings	March 2006 through Fall 2007	Susan Chapnick, NEH & Robert Hasevlat, Normandeau	MWRA
Data Validation Reports	1 for each laboratory data package deliverable for all tissue chemistry analyses	June 2006 through December 2007	Susan Chapnick & Nancy Rothman, NEH	Ann Pembroke & Robert Hasevlat, Normandeau & MWRA
Fish & Shellfish Report	1 / Draft 1 / Final After completion of all 2006 surveys, flounder histology, tissue chemistry analysis, & data validation	February 2007 Draft April 2007 Final	Ann Pembroke, Normandeau; Michael Moore, WHOI; & Susan Kane-Driscoll, MCA	MWRA
Toxic Issues Report	1 / Draft 1 / Final	May 2007 Draft July 2007 Final	Ann Pembroke, Normandeau & Susan Kane-Driscoll, MCA	MWRA
Fish & Shellfish Report	1 / Draft 1 / Final After completion of all 2007 surveys, flounder histology, tissue chemistry analysis, & data validation	February 2008 Draft April 2008 Final	Ann Pembroke, Normandeau & Michael Moore, WHOI	MWRA

15.0 DATA REVIEW, VALIDATION, AND USABILITY ASSESSMENT

Data generated in support of the fish and shellfish monitoring program will be reviewed following the procedures in this section, including verification, validation, and usability assessment of results.

15.1 DATA VERIFICATION

Data verification and validation criteria and procedures are documented in this section of the QAPP to establish that data will be evaluated properly, completely, and consistently, for use in meeting the project-specific DQOs established for the fish and shellfish monitoring program.

Verification of data begins with the field scientist or analyst generating the data (survey data, morphology and external abnormalities, flounder histology, and tissue chemistry) and follows through several steps of internal and external reviews, as described in Table 26.

At the analytical laboratory, internal verification of the results will occur through the analyst and peer review and senior-level review processes. Specific analytical laboratory protocols for data verification and review are described in the CAS-Kelso Quality Assurance Manual, included as Attachment E of this QAPP.

Once data have been generated and compiled in the laboratory, the laboratory project manager, Greg Salata, will review the data to identify and make professional judgments about results associated with QC that do not meet the measurement performance criteria listed in Attachment A-1 or the sensitivity requirements in Attachment A-2. CAS will apply laboratory qualifiers to such data and will include in the laboratory narrative an explanation of the laboratory-qualified results. Laboratory-qualified data will be formally reviewed during data validation (see Section 15.2, below, and Tables 26 and 27) to determine the validity and usability of these results. If samples are lost during shipment or analysis, CAS will document this in the narrative.

15.2 DATA VALIDATION

Data validation will be performed to evaluate whether the data obtained during the fish and shellfish monitoring covered in this QAPP meet the project-specific DQOs, and to identify and qualify data that do not meet the measurement performance criteria defined in Attachments A-1 and A-2.

In order to perform data validation, a complete laboratory data package deliverable (hard copy and electronic) are required from CAS. This full deliverable data package will include all sample results (units, sample-specific reporting limits, % lipids, etc.), QC summary forms for method QC and project-specific QC as defined as measurement performance criteria in Attachment A-1, all raw instrument data and preparation/extraction documentation, chain-of-custody forms, sample receipt information, and a laboratory narrative.

15.2.1 Validation Process for Sampling and Analysis Data

All of the tissue chemistry data (100%) will be validated prior to final reporting and incorporation into the project database. The validation process is outlined in Table 27 and summarized in this section. Details

Table 26. Data Verification Process.

Verification Task	Description	I/E	Responsible for Verification (Name, Organization)
Field Log / Notes	*Field logs will be generated each day of sample collection for the three surveys: flounder, lobster, and mussel. These logs and notes will be reviewed internally by the person responsible for the survey (e.g., Flounder Survey would be Michael Moore) or the Field Technician for completeness, accuracy and comparability compared to QAPP procedures and planned sample locations. Any corrections will be noted and initialed directly on the log. Any required corrective actions will be documented in a memorandum or included in the Corrective Action Log and brought to the attention of the Normandeau QA team (Robert Hasevlat, Normandeau and Susan Chapnick and Nancy Rothman, NEH) to be addressed with the field samplers prior to further survey work. The field logs / notes will be maintained by Normandeau in the project files. A copy of these logs / notes will be included in the final survey reports.*	*I*	*Survey-Specific Field Technician/Scientist, WHOI & Normandeau*
Chain-of-Custody and Shipping Forms	*Chain-of-Custody (COC) forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent by the field technician. The COC will be signed to verify accuracy and completeness. A copy of the COC will be maintained in the project files and a copy will be placed into the cooler for shipment to the laboratory. Upon laboratory receipt of the samples, the COC will be matched to the samples in the cooler and any discrepancies documented (see procedures in CAS Quality Assurance Manual, Attachment E) and brought to the attention of the Laboratory Project Manager, Greg Salata, who will contact the Normandeau Project Manager, Ann Pembroke, immediately for reconciliation and potential corrective action(s).*	*I*	*Survey-Specific Field Technician/Scientist, WHOI & Normandeau, CAS*
Field / Lab Audit Reports and Corrective Action Logs	*Any field / lab audit reports and corrective action logs will be verified by the Normandeau Project Manager, Ann Pembroke, and the Project QA Team, as necessary. Follow-up of corrective actions will be performed following procedures detailed in QAPP Section . All corrective action logs and field / lab audit reports will be maintained in the project files at Normandeau and forwarded to MWRA as part of the QA Management reports (see Table 25).*	*I* *E*	*Ann Pembroke Project Manager Normandeau Robert Hasevlat Project QA Normandeau Susan Chapnick Project QA, NEH*
Flounder Histology Data	*All flounder histology data will be verified internally by Michael Moore, WHOI, for accuracy, completeness, and comparability to methods described in this QAPP prior to submittal to Normandeau for inclusion into the project database and for retention of project reports.*	*I*	*Michael Moore, WHOI*

Table 26. (Continued)

Verification Task	Description	I/E	Responsible for Verification (Name, Organization)
Tissue Chemistry Laboratory Data	*All tissue chemistry laboratory data packages and the electronic data deliverables (EDDs) will be verified internally by the laboratory (CAS) performing the work for accuracy and completeness prior to submittal to NEH and Normandeau.* *All tissue chemistry data packages will be transmitted from the laboratory directly to the Data Validator (NEH). The EDDs generated by CAS will be sent directly to the Database Manager at Normandeau and NEH. The Data Validator will make an initial check for completeness against the COC documentation from the field and note any discrepancies or need for resubmittals or corrective actions for both the full laboratory data package submittal and the EDD. Normandeau will also perform a series of verification checks (see QAPP Section for further details) on the EDD and enter the preliminary data into the project database.*	*I* *E*	*Laboratory Project Manager, CAS* *Eric Nestler* *Database Manager* *Normandeau* *Susan Chapnick and Nancy Rothma* *Project QA and Data Validators* *NEH*
Data Validation Reports and Validated EDDs	*The Data Validator will further verify and validate the data according to the formal data validation procedures specified in Table 27. Following the validation, a Data Validation Report will be issued by NEH for each laboratory data report for tissue chemisty and a validated EDD will be submitted electronically to the Database Manager at Normandeau for upload to the project database. The Data Validation Report will be verified for completeness by Normandeau Project QA, Robert Hasevlat and the Normandeau Project Manager, Ann Pembroke. Data validation reports will then be forwarded for to MWRA and final databases will be transmitted to MWRA.*	*E*	*Susan Chapnick &* *Nancy Rothman* *Project QA and Data Validators* *NEH* *Eric Nestler* *Database Manager* *Normandeau* *Robert Hasevlat* *Project QA* *Normandeau* *Ann Pembroke* *Project Manager* *Normandeau*
Project Databases	*The Database Manager will set up and maintain the project database at Normandeau for eventual upload to the EM&MS database. The project database will be updated as data are received from the field (survey data) and from the histology and tissue chemistry analyses. Hand-entered data will be checked as it is entered and proofread after data entry. A series of database checks will routinely be performed after new data are uploaded to maintain accuracy and completeness of the project database. These verification checks are further detailed in QAPP Section*	*I*	*Eric Nestler,* *Database Manager* *Normandeau*

Table 27. Sampling and Analysis Validation Process Table

Validation Input	Description	Responsible for Validation (name, organization)
Field Information	Field information from field logs and notes, such as sampling locations, will be internally verified by the field technician/scientist as described in Table 26 and externally validated/checked by the Normandeau Project Manager and the Database Manager for compliance and completeness.	Ann Pembroke & Eric Nestler, Normandeau
SOPs	Ensure that all sampling and analytical SOPs were followed for flounder, lobster, and mussel surveys including flounder histology analysis and tissue chemistry analysis.	Ann Pembroke & Robert Hasevlat, Normandeau Susan Chapnick & Nancy Rothman, NEH Michael Moore, WHOI
Documentation of Method QC Results	Establish that all method required QC samples were run and met required limits. Document (in data validation report), qualify, and determine potential bias for results associated with QC that do not meet method criteria.	Susan Chapnick & Nancy Rothman, NEH
Documentation of QAPP QC Sample Results	Establish that all QAPP required QC samples were run and met required limits. Document (in data validation report), qualify, and determine potential bias for results associated with QC that do not meet QAPP measurement performance criteria. Further details on validation process for chemistry data included in NEH SOP, Attachment F.	Susan Chapnick & Nancy Rothman, NEH
Project Quantitation Limits	Evaluate if non-detected sample results met the sensitivity requirements in terms of the project quantitation limits defined in the QAPP. Document in data validation report results that do not meet sensitivity measurement performance criteria.	Susan Chapnick & Nancy Rothman, NEH
Raw Data	Validate laboratory calculations for one tissue sample of each type (flounder, lobster, mussel) and each chemical type of concern (metals, SVOCs, PCB congeners, and pesticides) from raw data. Document in data validation report. Discrepancies in sample calculations may require corrective actions (generated by NEH, performed by CAS laboratory, and monitored by NEH) to be documented in the corrective action log.	Susan Chapnick & Nancy Rothman, NEH
Flounder Morphology & Histology Data	Validate calculation of measures in flounder morphology and histology data such as prevalence by re-calculation from raw data.	Robert Hasevlat, Normandeau

concerning the validation process, to be performed by the third-party validator (NEH), can be found in the NEH SOP included in Attachment F.

The first laboratory data package for each analyte group (metals, SVOCs, PCBs, and Pesticides) will be validated using the USEPA Region I Tier III-type validation (EPA 1996). The Tier-III type data validation is a "full" data validation review that encompasses an in-depth check of the chemical data.

This full validation (Tier III-type) will be performed on the first laboratory data package of each analyte group so that deficiencies observed in the analytical procedures could be corrected relatively early in the analytical program, as needed. For these analytical results, the raw data will be examined in detail to check for calculation, compound identification, and transcription errors. The results of the QC checks and QA/QC samples will be assessed relative to the measurement performance criteria established in Attachments A-1 and A-2. The electronic data (EDD) will be checked for accuracy of results as compared to the hard copy laboratory data report. During the data validation review, the standard USEPA-NE Region I data validation qualifiers will be added, as necessary, to the electronic data to validate the project database results (see Section 15.2.3, below, for further details on qualification of data). Validation documentation, produced on a laboratory data package basis, will include a data validation narrative report, copies of completed data validation checklists, and the validated results transmitted to Normandeau in electronic format for incorporation into the project database.

During the validation process, any deficiencies, including critical deficiencies (those which would cause rejection of data as unusable for project decisions) in the data that could have been corrected by the laboratory (i.e., non-matrix related QC issues) will be brought to Normandeau's and the laboratory's attention for corrective action. Corrective actions will be documented as described in Section 14.

If the initial full validation indicates critical deficiencies (those which may cause rejection of data), this may trigger an additional full validation for the next laboratory data package for the analytical group affected to ascertain that corrective action(s) have been accomplished. This pro-active approach is intended to produce analytical data for the remainder of the monitoring effort that meet the project DQOs.

Following the initial full data validation, the remainder of the tissue chemical data for metals, SVOCs, PCBs, and Pesticides will undergo an USEPA Region I Tier II-type validation review. This level of data validation will encompass the assessment of: holding times, QC results including surrogate recoveries, matrix spike, matrix spike duplicate, and matrix duplicate results, laboratory blanks, trip blanks, field equipment blanks, laboratory control samples and standard reference material (SRM) results. This process of data validation is equivalent to a full data validation, with the exception that raw data are not reviewed (it is assumed that since the same procedures were used to generate the data as those used in the full data review). A data validation narrative report, copies of completed Tier II-type data validation/usability checklists, and the validated/qualified results transmitted electronically for incorporation into the project data, will be generated on a laboratory data package basis and transmitted to Normandeau.

15.2.2 Statistical Evaluation of Chemical Data

To evaluate the achievement of the project DQOs, in terms of measurement performance criteria defined in Attachment A-1, statistical evaluations will be performed on QC results during laboratory data review and reporting, data validation, and usability assessment. The following equations represent some of these statistical evaluations.

As a measure of accuracy, percent recoveries of the spiked analytes will be calculated for all matrix spike (MS) samples, matrix spike duplicate (MSD) samples (organics only), and surrogates (organics only) as follows:

As a measure of accuracy (external verification of accuracy in the tissue matrix), the percent difference (PD) of standard reference material (SRMs) from the certified value(s) will be calculated as follows:

As a measure of precision, the relative percent difference (RPD) between the MS and MSD for organic analyses and sample and matrix duplicate (MD) for inorganic laboratory duplicate analyses will be calculated as follows.

MS/MSD Precision for Organics:

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

Sample/MD Precision for Inorganics:

where C_1 = concentration of analyte detected in sample 1 (sample)
C_2 = concentration of analyte detected in sample 2 (matrix duplicate)

After data validation has been performed, the percent completeness will be calculated for each tissue type for each analytical group (metals, SVOCs, PCB congeners, and Pesticides), as follows:

The DQOs in terms of project-specific measurement performance criteria for these measures of accuracy, precision, and completeness are presented in Attachment A-1. Results of these statistical analyses and the affect on the data will be documented in the data validation reports and in the data usability section of the final project reports.

15.2.3 Data Validation Qualifier Codes

The Normandeau Team, in concurrence with MWRA, has condensed the numerous qualifiers that have been used to annotate the uncertainty in data (39 qualifiers are listed in the CW/QAPP of 2002) to the

following seven project-specific data validation qualifiers for chemical data generated during 2006: j, j+, j-, a, aj, aj-, and s. This approach will allow for a more universal understanding of the data qualifiers in the database and their interpretation for data users. Using these qualifier codes, the bias in all qualified results is identified as well (see definitions below). A comment field will be added to clearly state the reason for any qualification. The definitions of the project-specific qualifiers are listed below.

j	Result is considered estimated (uncertain) due to quality control (QC) criteria exceedance(s). The reason for the qualification is documented in the explanatory comment in the project database and in the Data Validation Report. The value is usable for project decisions as an estimated result with indeterminate bias.
j+	Result is considered estimated (uncertain) due to QC exceedance(s). The reason for the qualification is documented in the explanatory comment in the project database and in the Data Validation Report. The value is usable for project decisions as an estimated result with potential high bias.
j-	Result is considered estimated (uncertain) due to QC exceedance(s). The reason for the qualification is documented in the explanatory comment in the project database and in the Data Validation Report. The value is usable for project decisions as an estimated result with potential low bias.
a	The compound/analyte was analyzed for, but was not detected at or above the level of the sample-specific quantitation limit (QL). The associated numerical value is the sample-specific QL. The value is usable for project decisions as a non-detect result. Database result input is null.
aj	The compound/analyte was analyzed for, but was not detected at or above the level of the sample-specific QL. The associated numerical value is the sample-specific QL, which is considered estimated (uncertain) due to QC exceedance(s). The reason for the qualification is documented in the explanatory comment in the project database and in the Data Validation Report. The value is usable for project decisions as a non-detect result with indeterminate bias in the QL. Database result value input is null.
aj-	The compound/analyte was analyzed for, but was not detected at or above the level of the sample-specific QL. The associated numerical value is the sample-specific QL, which is considered estimated (uncertain) due to QC exceedance(s). The reason for the qualification is documented in the explanatory comment in the project database and in the Data Validation Report. The value is usable for project decisions as a non-detect result with potential low bias in the QL. Database result value input is null.
s	The compound/analyte was analyzed for, but the result is rejected due to severe or cumulative exceedance(s) of QC criteria. The reason for the qualification is documented in the explanatory comment in the project database and in the Data Validation Report. The value is suspect/invalid and unusable for project decisions.

Project-specific database codes for qualifying data are presented in Table 28.

Table 28. Database Qualifier Codes for Fish and Shellfish Monitoring – 2006

Field Name	2006 Project val_qual	EPA Standard DV Qualifier Equivalent	Requires Sample-Specific Quantitation Limit? [Yes / No]	Description
VAL_QUAL	j+	J	Yes	Usable detected result with a potential high bias due to QC exceedance(s). See explanatory comment.
VAL_QUAL	j-	J	Yes	Usable detected result with a potential low bias due to QC exceedance(s). See explanatory comment.
VAL_QUAL	j	J	Yes	Usable detected result with potential indeterminate bias due to QC exceedance(s). See explanatory comment.
VAL_QUAL	a	U	Yes	Usable non-detect result; not detected at or above the level of the sample-specific quantitation limit (QL). Database value input as null.
VAL_QUAL	aj	UJ	Yes	Usable non-detect result; not detected at or above the level of the sample-specific quantitation limit (QL). Database value input as null. Potential indeterminate bias in the level of the QL due to QC exceedance(s). See explanatory comment.
VAL_QUAL	aj-	UJ	Yes	Usable non-detect result; not detected at or above the level of the sample-specific quantitation limit (QL). Database value input as null. Potential low bias in the level of the QL due to QC exceedance(s). See explanatory comment.
VAL_QUAL	s	R	No	Suspect/Invalid. Not fit for use (unusable result). See explanatory comment.

Notes:

1. All CAS lab qualifiers (data flags) will be converted to one of these seven (7) project-specific qualifiers during data validation by NEH.
2. CAS lab data flags will not be accumulated with the project "val_qual" but, rather, will be maintained in a separate table in the project database for reference.
3. The project-specific "val_qual" are the final qualifiers for data users to indicate valid/usable (j+, j-, j, a, aj, aj-) or unusable (s) data for project decisions.
4. Sample-specific quantitation limits (detection limits supported by the low-level standard in the calibration curve for each analysis) will be reported for all valid/usable results.
5. No data will be reported as non-detected (null) to the level of the MDL.

Detected results reported below the level of the sample-specific QL, down to the level of the MDL, will be reported by NEH as "j" qualified data to indicate the uncertainty in the result (with indeterminate bias) at levels below the calibration range.

15.3 DATA USABILITY ASSESSMENT

Data usability assessment will be performed by members of the Normandeau Project Team, including Ann Pembroke (Project Manager), Michael Moore (Scientist), Susan Kane Driscoll (Risk Assessor), Robert Hasevlat (Project QA), and Susan Chapnick (Project QA and Data Validator), with assistance from Eric Nestler (Data Manager) for statistical queries of the project database. Data usability assessment will be performed on validated data only (i.e., after all survey, histological, and chemical data have been validated for a sampling year). The data usability assessment will evaluate both field and laboratory activities in determining the usability of the data, as a whole, to achieve project objectives.

Two data usability assessments will be generated, associated with the 2006 and 2007 monitoring results. Results of the data usability assessments will be presented in a section of the final project reports (see Section 16.0 for description of project reports).

Specifically, the Data Usability Assessment process consists of two steps:

- Data Usability Assessment focused on the quality of the data generated as compared to the project-specific DQOs and measurement performance criteria of accuracy, precision, and sensitivity, defined in this QAPP and specifically in Attachments A-1 and A-2, and the use or limitations of such data for project decisions; and
- Data Usability in terms of the usefulness of the project data as a "whole" in making environmental project decisions and overall evaluation of representativeness, completeness, and comparability.

15.3.1 Data Usability Assessment Process – Step 1

The first step of the Data Usability Assessment, will be performed mainly by the Normandeau Project QA team, including Robert Hasevlat (Normandeau), Susan Chapnick (NEH), and Nancy Rothman (NEH). The project QA team will include an evaluation of the chemistry data in comparison to the project-specific DQOs in the validation reports. Specific restrictions on data, such as data that would be qualified "j" or "aj", will be determined and documented. For example, if the quality control exceedances that caused certain data to be qualified give an indication of a low bias in the result (e.g., low surrogate recoveries, low LCS recoveries, low MS recoveries), this will be documented as data validation code j- for the data users and will also be documented in the explanatory comment field in the project database and in the Data Validation Report. Furthermore, if cumulative QC exceedances are noted that cause severe uncertainty in a result, or results, these data may be considered unusable for project decisions during the data assessment. In addition, the limitations on use of qualified data for comparison to thresholds and for risk assessment purposes will be identified and described in the data validation reports and summarized in the data usability assessments.

The following items will be assessed and conclusions drawn on usability of the data based on their results as the first step of the data usability assessment process.

Accuracy/Bias Contamination

Results for all laboratory method blanks and instrument blanks will be evaluated during data validation. The results for each analyte will be checked against the measurement performance criteria presented in Section 7.0 and Attachment A-1. Results for analytes that exceed criteria will be identified in the data validation report and data validation actions taken to qualify associated results, as necessary, based on validation guidance presented in Table 29. Data usability assessment of these findings will summarize

the validation actions taken for the accuracy/bias contamination evaluation and present conclusions and any limitations on the use of the data.

Analytical/Matrix Accuracy/Bias

Results for the standard reference material (SRM), as an external verification of accuracy will be evaluated during the data validation. Other measures of accuracy, including initial and continuing calibration QC sample results, laboratory control sample results, matrix spike and matrix spike duplicate sample results, and surrogate recovery results will also be evaluated during data validation. For each accuracy measure, a percent recovery or a percent difference will be calculated, using the equations presented in Section 15.2.2, to quantitate the accuracy. These results will be checked against the measurement performance criteria presented in Section 7.0 and in Attachment A-1. Results for analytes that exceed criteria will be identified in the data validation report and data validation actions taken to qualify associated results, as necessary, based on validation guidance presented in Table 29. Data usability assessment of these findings will summarize the validation actions taken, indicate potential bias in qualified results (as high, low, or indeterminate), and present conclusions and any limitations on the use of the data.

Precision

Results of all laboratory duplicates (matrix duplicates for inorganics and matrix spike duplicates for organics) will be evaluated during data validation. For each duplicate pair, the relative percent difference (RPD) will be calculated, using the equations presented in Section 15.2.2. These results will be checked against the measurement performance criteria presented in Section 7.0 and on in Attachment A-1. Results for analytes that exceed criteria will be identified in the data validation report and data validation actions taken to qualify associated results, as necessary, based on validation guidance presented in Table 29. Data usability assessment of these findings will summarize the validation actions taken for the precision evaluation, indicate that the data may be imprecise, and present conclusions and any limitations on the use of the data.

Sensitivity

Results for low-level calibration checks (e.g., metals analysis) and calibration criteria (e.g., inclusion of the reporting limit equivalent as the low-level standard in the calibration curve for organics) will be evaluated during data validation. These results will be checked against the measurement performance criteria presented in Section 7.0 and in Attachment A-1. In addition, the achievement of sensitivity DQOs will be evaluated based on a comparison of the sample-specific quantitation limits reported for non-detect results for all analytes. These will be compared against the project quantitation limits based on MWRA thresholds, FDA action limits, and historical concentrations, as presented in Attachment A-2. Non-detected results that show elevated quantitation limits, above the project quantitation limits (PQLs) will be evaluated for usability for project objectives. Data usability assessment of these findings will summarize the review of the quantitation limits achieved for all analytes and present conclusions and any limitations on the use of the data.

Table 29. Tissue Chemistry Analysis Validation Criteria.

Tissue Type / Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
Flounder – Fillet Lobster – Meat Mussel	Mercury	Attachments A1 and A2; *Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses,* February 1989	Susan Chapnick & Nancy Rothman, Data Validators, NEH
Mussel	Lead	Attachments A1 and A2; *Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses,* February 1989	Susan Chapnick & Nancy Rothman, Data Validators, NEH
Flounder – Liver Lobster - Hepatopancreas	8 Metals	Attachments A1 and A2; *Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses,* February 1989	Susan Chapnick & Nancy Rothman, Data Validators, NEH
All Tissue Types	PCB Congeners	Attachments A1 and A2; *Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, Part III (Pesticide/PCB Data Validation Functional Guidelines),* Draft February 2004	Susan Chapnick & Nancy Rothman, Data Validators, NEH
All Tissue Types	Pesticides	Attachments A1 and A2; *Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, Part III (Pesticide/PCB Data Validation Functional Guidelines),* Draft February 2004	Susan Chapnick & Nancy Rothman, Data Validators, NEH
Flounder – Liver Lobster – Hepatopancreas Mussel	SVOCs including PAHs	Attachments A1 and A2; *Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses,* 1996	Susan Chapnick & Nancy Rothman, Data Validators, NEH
All Tissue Types	Lipids	CAS SOP (Attachment D-12)	Susan Chapnick & Nancy Rothman, Data Validators, NEH

15.3.2 Data Usability Assessment Process – Step 2

The second step of the Data Usability Assessment, concerning the achievement of overall project objectives in a holistic approach, will be performed by the Normandeau Project Manager, with input from the Risk Assessor, the Flounder Histology Scientist, and assistance from the Project QA team and Data Manager for queries and statistics from the project databases generated for the 2006 and 2007 fish and shellfish monitoring projects. This will involve a review of chemical and non-chemical information generated during the monitoring program to evaluate representativeness, completeness, and comparability of the data generated. The evaluation of overall achievement of the project objectives will be made and documented in the final reports. Details of some of the overall data assessment procedures are described in the following section and summarized in Table 30.

Table 30. Fish and Shellfish Overall Data Checks

General:

For each data report a table of:

- Planned analyses against actual number of analyses (measure of completeness)
- Count of samples with non-detectable results
- Number of null (empty cell/field) values
- List of missing samples

Type of Overall Data Check			
Parameter	**Flounder** **Each tissue type**	**Lobster** **Each tissue type**	**Mussels**
Length	Range check against longest and shortest flounder from previously acceptable data. Flag organisms outside of this range.	Range check against longest and shortest lobster from previously acceptable data. Flag organisms outside of this range.	NA
Weight	Range check against previously acceptable data. Flag organisms outside of this range	Range check against previously acceptable data. Flag organisms outside of this range	NA
Age	Plot Age vs. Length and Weight. Flag outliers and re-evaluate measurement.	NA	NA
External Abnormalities	0-4 range check for each external abnormalities measure. Flag organisms outside of this range.	0-4 range check for each external abnormalities measure. Flag organisms outside of this range.	NA
Liver Histopathology	0-4 range check for each histopathology parameter. Flag organisms outside of this range. Plot prevalence by station to ensure no obvious errors such as tumors at a station where none seen.	NA	NA
Individual metal concentrations ***Total PCB*** ***Individual pesticides*** ***Total DDT*** ***Total Chlordane*** ***HMW PAH*** ***LMW PAH*** ***Total PAH*** ***Lipid***	Range check against highest and lowest dry weight value (each composite sample, not individuals) from previously acceptable data. Flag samples outside of this range.	Range check against highest and lowest dry weight value (each composite sample, not individuals) from previously acceptable data. Flag samples outside of this range.	Range check against highest and lowest dry weight value (each composite sample, not individuals) from previously acceptable data. Flag samples outside of this range.

Representativeness

Although sample size may somewhat limit the statistical confidence for applying contaminant levels to the entire population, it does conform to currently accepted fish and shellfish monitoring methods of sampling and analysis (Lefkovitz et al. 2002). Composite sample data can be used to raise the confidence in the representativeness of the results from pooled samples. Additionally, achievement of representativeness is dependent upon achievement of completeness in sample collection and valid data generation. The representativeness of the sampling program is detailed in the Outfall Monitoring Plan (MWRA, 1997, 2004).

Comparability

Results will be reviewed in comparison to existing monitoring data in the MWRA project database as one evaluation of comparability (see Table 30). Additionally, adherence to the field sampling and analytical SOPs defined in this QAPP (Tables 13 and 16) will be evaluated as a measure of comparability of results generated during 2006 and 2007 with prior monitoring results.

MWRA split sample results from flounder fillet and mussel tissue chemical analyses will be compared to the sample results from CAS for analytical comparability. RPD will be calculated to determine acceptable comparability of results. Acceptance criterion for analytical comparability in split samples is RPD of less than or equal to 50%. RPD will be calculated using the formula presented in Section 15.2.2.

Completeness

Completeness for all sample collection surveys and for tissue chemistry analysis of all analyte groups in all tissue types will be calculated, using the equation presented in Section 15.2.2. The percent completeness achieved will be compared to the acceptable completeness criteria defined in Section 7.0 and Attachment A-1. Any sample collection activity or analyte group that does not achieve the completeness goal will be summarized in the data usability assessment and potential data gaps will be identified.

Overall Data Quality Control Checks

The Normandeau data management team will use SAS software programs to run the necessary quality control checks. These checks will be designed to flag any errors or outliers and to ensure that all data files submitted to MWRA will meet the specifications of the existing project database and database rules.

Normandeau's Team will implement two separate but complementary procedures for data validation of all chemistry data. Data will be reviewed by NEH for sensitivity, accuracy, precision, representativeness, comparability, and completeness, following procedures outlined in Section 15 and Attachment F. Any errors or questionable data will be reviewed with the generator of the data and corrected. Data will then be submitted to Normandeau's Data Manager, Mr. Eric Nestler, who will run a series of additional error checks that are designed to confirm that all reported variables fall within acceptable ranges. When these steps are completed, Mr. Nestler will confirm that the data set meets MWRA's database format specifications prior to submission.

15.4 FISH AND SHELLFISH THRESHOLD EVALUATION

Results from the chemical analysis of flounder, lobster, and mussel tissue composites will be compared on a wet weight basis to the FDA "action levels" and the MWRA Contingency Plan (MWRA 2001) threshold values immediately upon receipt of the data by Normandeau's Data Manager. Any exceedances

of "action levels," thresholds, or other anomalous results will be reported immediately to MWRA. See Summary of Threshold Testing in Attachment H.

16.0 PROJECT REPORTS

Reports that will be generated under Tasks 4 through 9 include survey plans, survey reports, histopathology and chemical analysis data, and synthesis reports for each of the three fish and shellfish surveys to be conducted in 2006 and and for the flounder survey in 2007, as described below.

Reporting Data to MWRA

The data contained in each hard copy data report will be submitted to MWRA as an ASCII file. The supporting documentation files will be included with the data submission. Data deliverables will be combined only with permission from MWRA.

16.1 SURVEY PLANS, SUMMARIES, AND REPORTS

One copy 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 summaries will be delivered by e-mail to MWRA's Task Manager within two (2) business days of survey completion.

Survey reports shall describe survey dates, vessel, personnel, methods which deviate from the QAPP, survey operations, results, problems encountered, corrective actions, and recommendations. They will tabulate the number of samples collected (versus planned), and provide maps of the survey track lines. They will describe observations of whales, whether noted by the whale observer or as incidental. Any unusual observations of environmental conditions, especially those with implications for the later testing of Contingency Plan thresholds will be emphasized.

All survey reports shall also include tables of information specific to an individual survey (including but not limited to date, time, survey id, sample types, etc), produced by MWRA from the EM&MS database.

16.2 TISSUE CHEMISTRY DATA REPORTS (TASK 4)

From data and documentation submitted by Normandeau, MWRA will produce tissue chemistry data reports from the EM&MS database, with tables of results of a given study (flounder, lobster, mussel) in a year, and a brief discussion of any deviations from this QAPP. Results of the quality control checks related to tissue chemistry for flounder, lobster, and mussels will be included. The chemical surrogate data is reported in a separate QC data table. Normandeau will review and comment on the data report and MWRA will incorporate necessary corrections.

Data from chemical analyses of tissues will also be used in reports to be prepared under Task 11, specifically the fish and shellfish monitoring annual synthesis report and the annual toxics review.

16.3 HISTOLOGY DATA REPORTS (TASK 9)

Histological data reports (Task 9) will include a table of results and a brief discussion of any deviations from this QAPP. In addition, data from Outfall Site are due 60 days after survey completion in a temporary data report that must be Quality Assured but which is not produced from the project database. The temporary data report will include a calculation of the trigger parameter (i.e. liver disease incidence). The temporary data report will be discarded after the complete data report is produced by MWRA and reviewed by Normandeau in September.. Normandeau will review and comment on the data report and MWRA will incorporate necessary corrections. Results of the QC checks related to flounder morphology and histopathology will be included in the final data reports. The histopathology will be discussed under the annual fish and shellfish monitoring synthesis report (Task 11).

16.4 FISH AND SHELLFISH MONITORING ANNUAL SYNTHESIS REPORTS (TASK 11)

There will be two (2) fish and shellfish synthesis reports delivered under the HOM5 contract, one for each field year (2006 and 2007). This annual report will include all data collected as part of the fish and shellfish program under Tasks 4–9). This report will contain an evaluation of the year's results against all relevant monitoring thresholds and will devote particular attention to thresholds that may have been exceeded. Such evaluation would include comparison to the baseline data, as well as whether and/or to what extent such exceedances might be attributable to MWRA discharges, and the likely environmental impact of the exceedance. The report will include an evaluation of the spatial and temporal trends in contaminants, morphology, and pathology in flounder, lobster, and mussel tissue. The conclusions from flounder, lobster, and mussel will be summarized and integrated in the report, and the merits of different approaches used will be discussed.

16.4.1 Histology Data Analysis

For each liver lesion type, the percent prevalence will be calculated by station 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. Analysis of variance will be used to compare lesions from site to site and annually from 2006 and 2007.

16.4.2 Tissue Chemistry Data Analysis Totals

Several chemistry data parameters are reported in the Fish and Shellfish Monitoring Annual Synthesis Report 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 31).

Table 31. Individual Chemistry Analytes Included in the Chemistry Data Totals.

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

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ATTACHMENTS

(Click on each attachment to view)

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