

**DRAFT**

# ***Hunters Point Shipyard (Parcel F)***

## ***Human Health Evaluation***

### ***Work Plan***

**San Francisco Bay, California**



*Prepared for*



**U.S. NAVY  
SOUTHWEST DIVISION  
NAVFAC  
1220 Pacific Highway  
San Diego, CA 92132-5190**

**CONTRACT NO.: N62474-94-D-7609  
DELIVERY ORDER NO.: 0127**

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**January 12, 2001**

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**HUMAN HEALTH EVALUATION WORK PLAN**  
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## ACRONYMS AND ABBREVIATIONS

BRAC – Base Realignment and Closure Act

COPC – Chemical of Potential Concern

DQO – Data Quality Objective

DTSC – (California) Department of Toxic Substances Control

FS – Feasibility Study

HPS – Hunters Point Shipyard

NAVFAC – Naval Facilities Engineering Command

OEHHA – Office of Environmental Health and Hazard Assessment

PCB – Polychlorinated biphenyl

RBSC – Risk-based Screening Concentration

RMP – Regional Monitoring Program

RWQCB – (San Francisco Bay) Regional Water Quality Control Board

SFEI – San Francisco Estuary Institute

SWDIV – Southwest Division

UCL – Upper Confidence Limit

U.S. EPA – United States Environmental Protection Agency

VS – Validation Study

## 1.0 INTRODUCTION

Hunters Point Shipyard (HPS) is a former US Navy installation located on a peninsula in the southeast corner of San Francisco, CA. The HPS facility consists of approximately 955 acres, with approximately 400 acres of offshore sediment. During the period from 1945 to 1974, the Navy maintained and repaired ships at the facility. The Navy deactivated HPS in 1974 and leased portions of the property to Triple A Machine Shop, a private ship repair company. In 1986, the Navy resumed occupancy of HPS until its closure in 1991 under the Defense Base Realignment and Closure Act (BRAC) of 1990.

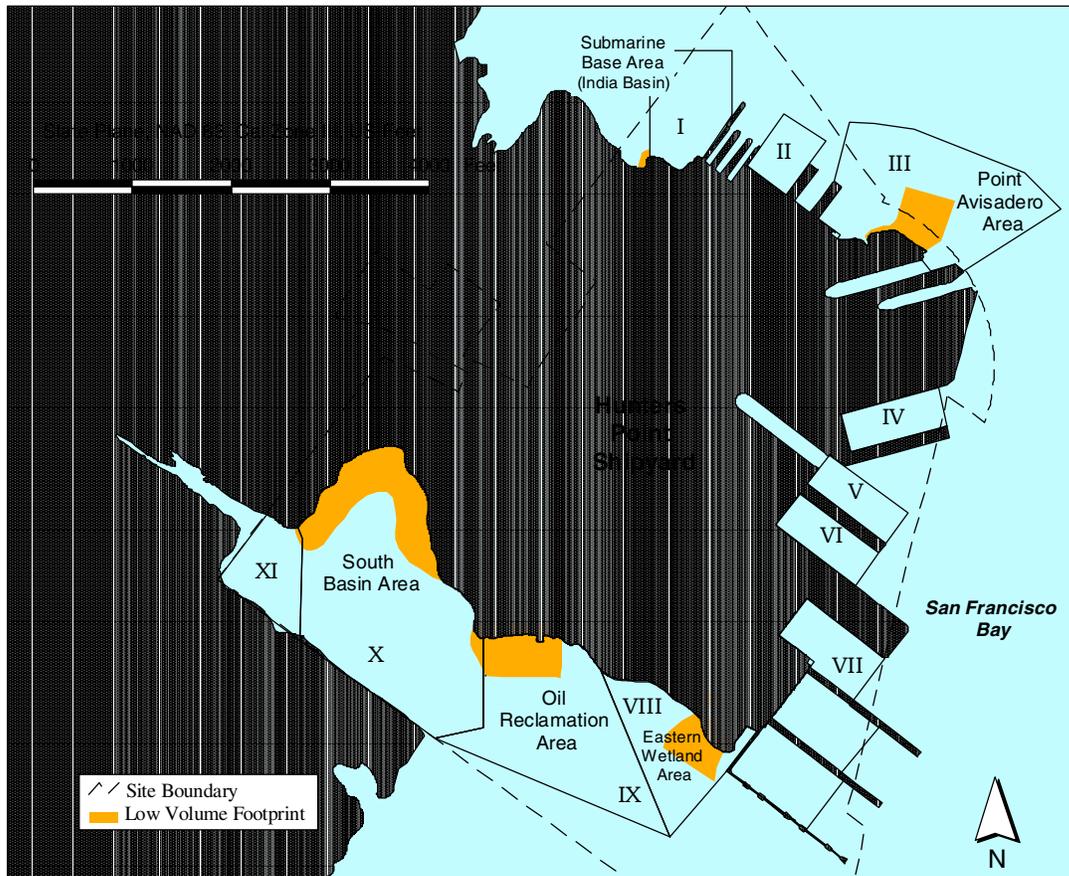
To facilitate the transfer and reuse of the offshore property (Parcel F), this Work Plan was prepared for the Southwest Division (SWDIV) Naval Facilities Engineering Command (NAVFAC) to describe work to be completed for the human health evaluation. The evaluation described will be conducted in conjunction with the HPS Validation Study (VS) (Battelle *et al.*, 2000). The method developed to address human health issues was based on discussions with the Navy and technical representatives of the U.S. Environmental Protection Agency (U.S. EPA) Region 9 and California Department of Toxic Substances Control (DTSC). Summaries of these technical conference calls are provided in Appendix A of this Work Plan. Position papers prepared by the Navy to support technical components of the human health approach have also been provided in Appendix B.

### 1.1 Human Health Evaluation Study Objectives

The primary goal of the human health evaluation of Parcel F is to define the extent of sediments that pose an unacceptable risk to human health and that require evaluation in the Feasibility Study (FS) of remedial options. As with the VS, this investigation will focus on the areas referred to as the low-volume footprint (Figure 1-1) as identified in the draft Parcel F FS report (Tetra Tech EM, Inc. and Levine-Friche-Recon, Inc. [TtEMI and LFR], 1998). The results of this investigation will be integrated with the ecological evaluation described in the VS work plan (Battelle *et al.*, 2000) to determine the sediment area that requires evaluation in the FS. In addition, at the request of the U.S. EPA Region 9 and DTSC, the difference in the risk posed by consuming fish from the HPS area relative to consuming fish from other locations within San Francisco Bay will be evaluated for the purposes of risk communication. Therefore, the specific objectives of the Human Health Work Plan are as follows:

1. Compare measured levels of chemicals in tissues from the *Macoma nasuta* bioaccumulation study being implemented as part of the HPS VS (Battelle *et al.*, 2000) to risk-based screening concentrations (RBSCs) in support of validating the FS footprint.
2. Collect and analyze fish tissue from the vicinity of HPS and at other Regional Monitoring Program (RMP) (SFEI, 1999) sample sites throughout San Francisco Bay for statistical comparison in support of risk communication.

A brief overview of the site history and a summary of previous investigations at Parcel F is presented in the HPS VS (Battelle *et al.*, 2000) and the HPS Data Summary Memorandum (Battelle *et al.*, 1999).



**Figure 1-1. Hunters Point Shipyard Low-Volume Footprint.**

## 1.2 Work Plan Organization

The Hunters Point Human Health Evaluation Work Plan is organized as follows:

**Section 1.0: Introduction**

**Section 2.0: Human Health Evaluation Approach.** This section summarizes the two key components of the human health evaluation which include an evaluation of risks associated with shellfish consumption, as well as additional risk communication activities.

**Section 3.0: Data Collection and Analysis.** The data quality objectives (DQOs) for the human health evaluation are described and the sampling design for the collection of new data is presented.

**Section 4.0: References**

- Appendix A: Summaries of Technical Conference Calls and Meetings on Human Health Evaluation.** Summaries of two technical conference calls between the Navy, U.S. EPA Region 9, and DTSC are provided in this appendix.
- Appendix B: Position Papers to Support Human Health Evaluation.** This appendix includes two position papers prepared in support of the human health evaluation approach.
- Appendix C: Development of Risk-Based Screening Concentrations (RBSCs).** This appendix includes detailed information regarding the development of RBSCs to be used in the evaluation of risks associated with the consumption of shellfish.
- Appendix D: Hunters Point Shipyard Parcel F Human Health Evaluation Field Sampling Plan (FSP).**
- Appendix E: Hunters Point Shipyard Parcel F Human Health Evaluation Quality Assurance Project Plan (QAPP).**

## 2.0 HUMAN HEALTH EVALUATION APPROACH

The human health study focuses on the potential exposures to offshore sediment in areas at HPS referred to as the low-volume footprint. The specific areas included (Figure 1-1) are identified in the draft Parcel F FS report (TtEMI and LFR, 1998). Based on available information regarding the likely future land uses at HPS, it was determined that potential exposures to humans would occur as the result of consumption of aquatic species such as fish and shellfish. As discussed in Appendix B, due to the relative mobility of most recreationally preferred fish species, it is difficult to attribute measured tissue concentrations in fish to one specific source. Therefore, to more clearly define the distribution of site sediments that pose an unacceptable risk to human health, this evaluation will focus on measured chemical concentrations in shellfish tissue (*i.e.*, *Macoma nasuta*) generated from the HPS VS 28-day bioaccumulation tests (Battelle *et al.*, 2000).

Although concentrations of chemicals measured in fish tissue cannot be directly related to site-specific remedial goals, concerns have been raised by the U.S. EPA Region 9 and DTSC regarding the relative risks of consuming fish caught from the vicinity of HPS compared to other locations within San Francisco Bay. Preliminary evaluations based on existing data (RWQCB *et al.* 1995; SFEI 1999; Appendix B) indicate that levels of chemicals in fish from the vicinity of HPS are similar to those collected elsewhere in the Bay; however, additional data are required for an accurate statistical comparison. To address this issue, fish tissue will be collected and analyzed from HPS as well as from designated locations throughout San Francisco Bay. These data will be collected to support a risk communication program only. The study design and objectives of the fish collection effort are not designed to evaluate the boundaries of the FS footprint.

### 2.1 Validation of Feasibility Study Footprint

The primary objective of the HPS VS is to more clearly define the extent of sediments that pose unacceptable risk to the environment and require evaluation in an FS. The work plan previously developed for the HPS VS (Battelle *et al.*, 2000) focused on ecological concerns, relying on three lines of evidence to evaluate risks to identified ecological receptors. The output of the ecological portion of the VS will be a preliminary FS footprint.

To ensure that potential risks to humans are also addressed, the human health evaluation will focus on exposures to humans associated with sediments within the low-volume footprint. For the purpose of this evaluation, one exposure scenario, the consumption of shellfish exposed to site-specific sediments will be considered. All bioaccumulative chemicals identified by Region 9 will be evaluated as COPC (Table 2-1). To evaluate the potential risks to human health, body burden data analyzed for the HPS VS 28-day *Macoma nasuta* bioaccumulation test will be compared to human health risk-based screening concentrations (RBSCs), developed as described in Appendix C. The RBSCs represent media concentrations that are considered 'safe' based on the assumed site-specific exposure parameters. In contrast to risk estimate calculations, for which media concentration is one of the input terms, RBSC calculations solve for the media concentration.

Due to the absence of site-specific information regarding the consumption behavior of individuals harvesting shellfish from HPS, there is considerable uncertainty associated with the value used to represent the shellfish consumption rate. To address this uncertainty, multiple RBSCs were developed based on varying consumption rates selected to represent the possible range of consumption rates among different subsets of the exposed population. Specifically, four RBSC values were developed, two based on the average (*i.e.*, central tendency exposure or CTE) and maximum (*i.e.*, reasonable maximum exposure or RME) consumption rates among the general population, as well as two based on the average

**Table 2-1. COPCs for Hunters Point Shipyard Human Health Evaluation.**

| TRACE METALS<br>(mg/kg wet weight) | ORGANIC COMPOUNDS<br>(µg/kg wet weight) |                              |
|------------------------------------|---|------------------------------|
| Ag                                 | Naphthalene                             | 4,4'-DDD                     |
| Sb                                 | 2-Methyl naphthalene                    | 2,4'-DDD                     |
| As                                 | Acenaphthylene                          | 4,4'-DDE                     |
| Cd                                 | Acenaphthene                            | 2,4'-DDE                     |
| Cr                                 | Fluorene                                | 4,4'-DDT                     |
| Cu                                 | Phenanthrene                            | 2,4'-DDT                     |
| Pb                                 | Anthracene                              | a-Chlordane                  |
| Hg                                 | Fluoranthene                            | g-Chlordane                  |
| Ni                                 | Pyrene                                  | Dieldrin                     |
| Se                                 | Benzo(a)anthracene                      | Endrin                       |
| Zn                                 | Chrysene                                | Endosulfan II                |
|                                    | Benzo(b)fluoranthene                    | Heptachlor                   |
|                                    | Benzo(k)fluoranthene                    | Total PCBs <sup>1</sup>      |
|                                    | Benzo(a)pyrene                          | TBT                          |
|                                    | Indeno(1,2,3-c,d)pyrene                 | DBT                          |
|                                    | Dibenz(a,h)anthracene                   | Total Butyltins <sup>2</sup> |
|                                    | Benzo(g,h,i)perylene                    |                              |

<sup>1</sup>Total PCB will be based on the sum of the 19 PCB congeners defined for the NOAA Status and Trends Program.

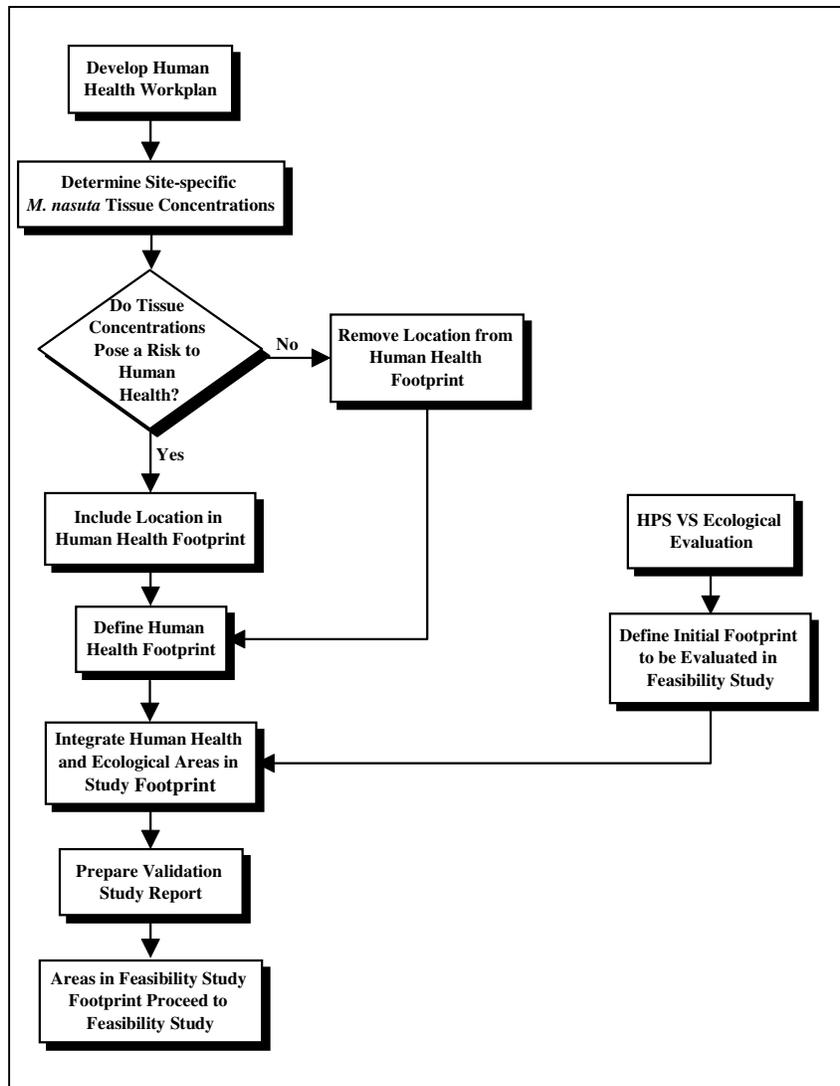
<sup>2</sup>Total butyltins is the sum of TTBT, TBT, DBT, and MBT. All four compounds will be measured but only TBT and DBT are COPCs.

and maximum values for individuals identified as “shellfish consumers” (*i.e.*, individuals who typically consume more shellfish than the general population). Of these four RBSCs developed, the minimum or most conservative (*i.e.*, based on the shellfish consumer RME) and the maximum or least conservative (*i.e.*, based on the general population CTE) values were considered for the purpose of identifying locations to be included in the FS footprint.

To determine whether sediments required further evaluation in the feasibility study, representative tissue concentrations of COPCs at each sampling location will be compared to the RBSC values. The following guidelines will be followed for the purpose of this comparison:

- Tissue concentrations that are below the minimum, most conservative RBSC will be considered ‘safe’, and the associated sampling locations excluded from the human health FS footprint.
- Tissue concentrations above the maximum RBSC will be determined to be associated with an adverse risk, therefore, those sampling locations will be included in the human health FS footprint.
- Tissue concentrations falling between the minimum and the maximum value will be identified as potentially causing a risk, and will also be evaluated with respect to data associated with reference locations.

Locations where tissue concentrations exceed both the minimum RBSC and reference locations will be included in the FS footprint, while locations with tissue concentrations below reference will be excluded. The FS footprints identified based on the ecological and human health evaluations, will be integrated to define the FS footprint (Figure 2-1).



**Figure 2-1. Integration of HPS VS Ecological and Human Health Evaluations.**

The laboratory-derived method detection limits (MDLs), and all but one reporting limit (RL), are lower than the minimum RBSCs for all COPCs (see QAPP Table E-5). However, the current reporting limit for Arsenic (As) is greater than the minimum RBSC (0.19 vs. 0.06 mg/Kg, respectively). Attempts will be made to lower the effective RL for As. If the RL for As remains higher than the minimum RBSC then any As values that are detected at less than the maximum RBSC will be treated as option 3 above, falling between the minimum and maximum RBSCs.

## 2.2 Risk Communication Approach

As a result of multiple chemical sources in San Francisco Bay, health concerns associated with fish consumption have been identified as a regional issue during the last decade. Currently available data from the Regional Monitoring Program (RMP; RWQCB *et al.* 1995; SFEI 1999) indicate that concentrations of six chemicals or groups of chemicals (*i.e.*, PCBs, dioxins, mercury, dieldrin, DDT, chlordane) in fish collected from throughout the San Francisco Bay are high enough to pose a potential risk to recreational anglers (OEHHA, 1994). Based on these data, sport fish health advisories have been

implemented for the Bay, along with an ongoing RMP. Although this is a regional issue, concerns have been raised regarding the relative risks of consuming fish caught from the vicinity of HPS compared to fish caught from other locations within San Francisco Bay. Preliminary evaluations based on existing data (Appendix B) indicate that levels of chemicals in fish from the vicinity of HPS are similar to those collected elsewhere in the Bay; however, additional data are required to achieve statistical confidence.

The objective of the risk communication portion of the HPS human health evaluation is to collect additional fish tissue data for the purpose of determining whether or not risks associated with consuming fish from the vicinity of HPS are significantly higher than those associated with consuming fish from other (*i.e.*, ambient) locations throughout San Francisco Bay. Previous discussions with representatives from the U.S. EPA and DTSC have acknowledged that fish are a mobile species and that it is difficult to directly link fish caught in an area to chemicals in sediments in that localized area (Appendix B). Therefore, these data will be collected to support a risk communication program only, and will not be considered when evaluating the boundaries of the FS footprint.

For the purpose of this evaluation, it will be assumed that all exposure parameters relevant to the calculation of risk associated with fish consumption (*e.g.*, ingestion rate, exposure duration, etc.) are the same for anglers at both HPS and ambient locations. The only parameter that will be assumed to vary between locations will be the concentrations of chemicals in fish tissue. Therefore, the focus of this investigation will be to determine if the concentrations of chemicals in fish near HPS are the same or different from the “ambient” conditions in the rest of the Bay. Any similarity or difference noted in the chemical concentrations indicates a parallel similarity or difference in risk associated with consumption of fish. This evaluation will focus on fillet tissues from the selected species, because that is the portion of fish most commonly consumed by recreational anglers and for consistency with the methods used by the RMP (RWQCB *et al.* 1995; SFEI 1999). In keeping with the methods used by the RMP, the skin will not be removed from the fillets prior to analysis.

As described in Section 3.2 and in the Field Sampling Plan (Appendix D) the methods used to collect the fish for this evaluation will be based on those used in the previous RMP studies (RWQCB *et al.* 1995; SFEI 1999) to ensure comparability of the data. The specific sample design was developed to ensure that an appropriate level of statistical confidence in the data is achieved. The fish tissue data generated during this evaluation will be statistically evaluated using non-parametric tests which are not sensitive to violations of assumptions of equal variance. The methods used will be similar to those described in Appendix B (see Attachment A to the document entitled “A Proposed Approach for Evaluating Sediment Impacts at Navy Facilities on Fish Consumption Health Risks in San Francisco Bay”). The purpose of the statistical testing will be to discern if the mean concentration of chemicals in fish fillets from HPS is significantly greater than the mean concentration of chemicals in fish collected from ambient locations in San Francisco Bay.

### 3.0 DATA COLLECTION AND ANALYSIS

This section describes the data to be collected and evaluated for both components of the human health evaluation, *i.e.*, the definition of the FS footprint and the risk communication evaluation. DQOs for both components are presented in Section 3.1 and the sampling design is presented in Section 3.2.

#### 3.1 Data Quality Objectives

DQOs were developed in accordance with the guidelines provided in the U.S. EPA's seven-step DQO process (U.S. EPA, 1994). Information to support Step 1 "State the Problem" is provided in Section 1.0 of this Work Plan. The problems to be addressed are summarized as follows:

- **Human Health Evaluation:** Previous data collected in Parcel F at HPS indicated areas of elevated chemical concentrations relative to ecological effect-based threshold values and screening ecological risk assessments (ATT, 1991; PRC, 1994 and 1996). However, the uncertainty associated with the previous data prevented clear definition of the extent of the Parcel F sediments that pose an unacceptable risk to human health and the environment. Therefore, additional data will be collected, in conjunction with the HPS VS (Battelle *et al.*, 2000), to evaluate human health in order to better define the FS footprint.
- **Risk Communication:** Fish tissue monitoring programs conducted in San Francisco Bay (RWQCB *et al.*, 1995; and SFEI, 1999) indicate that contaminant levels in sport fish tissue exceed health based criteria and have resulted in a fish consumption advisory for the Bay. To support risk communication efforts and community awareness, additional data are required to compare contaminant levels in sport fish collected from around HPS to fish collected from other areas within the Bay.

DQOs for each type of data to be collected in the human health evaluation are provided in table format (Tables 3-1 and 3-2). The DQO tables summarize Steps 2 through 6 of the DQO process. Step 7 "Optimize the Design for Obtaining Data" is presented in Section 3.2. Each DQO table includes an identification of the study questions (Step 2), a list of the measurements required (Step 3), a discussion of the study boundaries (Step 4), and a description of the decision rules for data evaluation (Step 5). Finally the DQO tables include a qualitative discussion of decision error types, and the specific consequences that must be considered in the study design (Step 6).

#### 3.2 Sampling Design

As previously described, there are two proposed components of the human health evaluation at HPS. The first focuses on evaluating the protectiveness of the proposed FS footprint that will be defined through the ecological portion of the VS. This component of the evaluation will be based on measured tissue levels from the *M. nasuta* bioaccumulation study being implemented as part of the ecological portion of the HPS VS. Specifically, *M. nasuta* will be exposed for 28 days to sediments collected from 59 locations within the low volume footprint (Figure 1-1). Details regarding the sampling design and bioaccumulation methodologies for those data are described in detail in the *Draft Final HPS Validation Study Work Plan* (Battelle *et al.*, 2000). The chemicals of potential concern (COPC) for human health were defined as those compounds identified by Region 9 as bioaccumulators (Table 2-1). The COPCs will be evaluated relative to the calculated RBSC as described in Section 2.1.

The second component of the evaluation is the collection of fish tissue for statistical comparisons to support a risk communication program. Specifically, the statistical sampling design and the selection of

locations evaluated is discussed in Section 3.2. Details of the specific sampling methodology are discussed in the Field Sampling Plan (Appendix D).

For the purpose of evaluating whether concentrations of COPCs in fish collected at HPS are different from concentrations in fish collected from ambient locations in San Francisco Bay, a statistically based sampling design was developed. The null and alternative hypotheses are as follows:

Null Hypothesis ( $H_0$ ): The mean COPC residue in filets from HPS ( $\mu_{HP}$ ) is less than or equal to the mean ambient residue ( $\mu_A$ ).

Alternative Hypothesis ( $H_A$ ): The mean COPC residue in filets from HPS is greater than the mean ambient residue.

**Table 3-1. Data Quality Objective for Determination of Feasibility Study Footprint.**

|   |
|---|
| <b>Step 1: State the Problem (See Section 3.1)</b>  |
| <b>Step 2: Identify the Decision</b>  |
| <ul style="list-style-type: none"> <li>Do COPCs in <i>Macoma nasuta</i> tissues exposed to sediments from HPS in 28 day bioaccumulation studies exceed risk-based screening levels?</li> </ul>  |
| <b>Step 3: Identify Inputs to the Decision</b>  |
| <ol style="list-style-type: none"> <li>Results of analyses of 28-day <i>Macoma nasuta</i> bioaccumulation studies for each sampling location within the low volume footprint at HPS</li> <li>Results of the ecological VS, identifying which portions of the low volume footprint pose an unacceptable ecological risk (and will be included in the proposed FS footprint).</li> <li>Human health risk-based screening criteria (RBSCs) for shellfish tissue ingestion.</li> </ol>  |
| <b>Step 4: Define the Study Boundaries</b>  |
| <ul style="list-style-type: none"> <li>Analytical chemistry data from <i>Macoma nasuta</i> bioaccumulation study results from the areas described in Table 3-4 (DQOs for the Bioaccumulation Test), in the September, 2000, HPS VS Work Plan. <i>M. nasuta</i> will be exposed to the top 5 cm of sediment from stations in each of the five areas included in the low-volume footprint represented by the numbers I, III, VIII, IX and X. Samples will not be collected in shoreline or intertidal areas covered with riprap or disposal debris. Surface sediment from each sample station will be represented by a localized composite sample to allow collection of sufficient sediment volume to support all required evaluations.</li> </ul> |
| <b>Step 5: Develop a Decision Rule</b>  |
| <ul style="list-style-type: none"> <li>If the concentration of any chemical in <i>M. nasuta</i> tissues exposed to sediments from a defined area of the low-volume footprint exceeds RBSCs, and the uncertainty in the exposure parameters is acceptable, then conclude that the area must be included in the human health FS footprint.</li> </ul>   |
| <b>Step 6: Evaluate Decision Errors</b>   |
| <ul style="list-style-type: none"> <li>Risk decision errors are controlled according to RAGs (EPA, 1989)</li> </ul>   |
| <b>Step 7: Optimize the Design for Obtaining Data (See Section 3.2)</b>   |
| <ul style="list-style-type: none"> <li>The <i>M. nasuta</i> bioaccumulation study design developed for the ecological portion of the HPS VS is adequate to support the evaluation of human health risk. Each portion of the low-volume footprint is sampled utilizing a stratified systematic approach, with more samples taken in areas of higher sediment chemistry variability and concentrations.</li> </ul>  |

**Table 3-2. Data Quality Objectives for Risk Communication Evaluation.**

|  |
|--|
| <p><b>Step 1: State the Problem (See Section 3.1)</b></p>  |
| <p><b>Step 2: Identify the Decision</b></p> <ul style="list-style-type: none"> <li>Do concentrations of chemicals in fish from the vicinity of HPS exceed those in fish from other (ambient) locations in San Francisco Bay?</li> </ul>  |
| <p><b>Step 3: Identify Inputs to the Decision</b></p> <ul style="list-style-type: none"> <li>Results of analysis of fillet tissues following the RMP protocol for fish collected at HPS and at ambient locations. This includes compositing equal weight, skin-on fillets to produce composite samples of at least 100 grams.</li> </ul>   |
| <p><b>Step 4: Define the Study Boundaries</b></p> <ul style="list-style-type: none"> <li>Fish will be collected at the offshore areas of HPS, and at the following RMP locations (SFEI 1999): San Francisco Waterfront, Berkeley, and South Bay Bridges. If sufficient fish tissue can not be sampled at any one of these selected RMP stations, then the San Pablo Bay station will be evaluated as a substitute.</li> </ul>  |
| <p><b>Step 5: Develop a Decision Rule</b></p> <ul style="list-style-type: none"> <li>If the mean concentration of chemicals in fish filets from HPS is significantly greater than the mean concentration of chemicals in fish collected from ambient locations, then determine what type of risk communication should take place to inform potential receptors.</li> </ul>   |
| <p><b>Step 6: Evaluate Decision Errors</b></p> <ul style="list-style-type: none"> <li>Probability of failing to determine that fish fillets in HPS are greater than ambient, when in "truth" they are elevated by 90% will be limited to 5%, and the probability of incorrectly determining they are the same to 5%. Failure to properly determine HPS fish are more contaminated would result in a failure to communicate increased risk due to fishing at this site. Improperly determining HPS fish are elevated over ambient fish would result in falsely alarming the public and the associated costs for risk communication. Both error types are of concern to the Navy.</li> </ul> |
| <p><b>Step 7: Optimize the Design for Obtaining Data (See Section 3.2)</b></p> <ul style="list-style-type: none"> <li>A minimum of 6 composite samples will be collected at HPS and from the three ambient locations (<i>i.e.</i>, 2 composites from each ambient location). The development of this sample size estimate is based on the procedures discussed in Section 3.2.</li> </ul>  |

Failure to reject  $H_0$  would lead to the conclusion that sport fish caught from HPS pose the same or lower risk to human health than those caught from ambient locations. Alternatively, rejecting  $H_0$  would lead to the conclusion that fish caught from HPS may pose a greater risk to human health than do those caught from ambient locations.

To develop a statistically based sampling design, three inputs are necessary: (1) selection of species, (2) selection of sampling locations, and (3) determination of sample size. These inputs are discussed in more detail in the following sections.

### 3.2.1 Selection of Species

Target fish species were selected based on the following three criteria:

- species previously evaluated by the RMP;
- species known to be caught and consumed by anglers in San Francisco Bay; and,
- species for which measured tissue concentrations exceed health-based guidelines based on the previous RMP data (RWQCB *et al.* 1995; SFEI 1999).

The three species previously evaluated by the RMP that best fit these criteria are: white croaker (*Genyonemus lineatus*); shiner surfperch (*Cymatogaster aggregata*); and jacksmelt (*Atherinopsis californiensis*) (SFEI 1999). Therefore, the proposed sampling for the HPS human health risk communication evaluation will target these three species. Tissue from only one of these species will be analyzed for this evaluation. Final selection of the species evaluated will be based primarily on the number of individuals caught at each of the specified sampling locations.

### 3.2.2 Selection of Sampling Locations

Fish from HPS will be collected in the areas offshore of the facility, including areas in South Basin, the north side near Point Avisadero and the northwest side of the facility toward India basin (Figure 1-1). Fish from ambient locations in San Francisco Bay will be collected from at least three areas that have already been sampled by the RMP (SFEI, 1999). These three areas include San Francisco Waterfront, Berkeley, and South Bay Bridges (Figure 3-1). A fourth location, San Pablo Bay, will be sampled only if sufficient tissue is not collected at the other locations.

San Francisco Waterfront, Berkeley, and South Bay Bridges were selected as ambient locations because sport fish have been sampled multiple times by the RMP at these locations (Figure 3-2). Additionally, these areas represent locations fished regularly by recreational fishermen and provide broad geographic coverage of the Bay (SFEI 1999). RMP sampling stations in the North Bay (e.g., Davis Point and Suisun Bay) were not selected as ambient locations because they are located in very different hydrologic regimes from HPS.

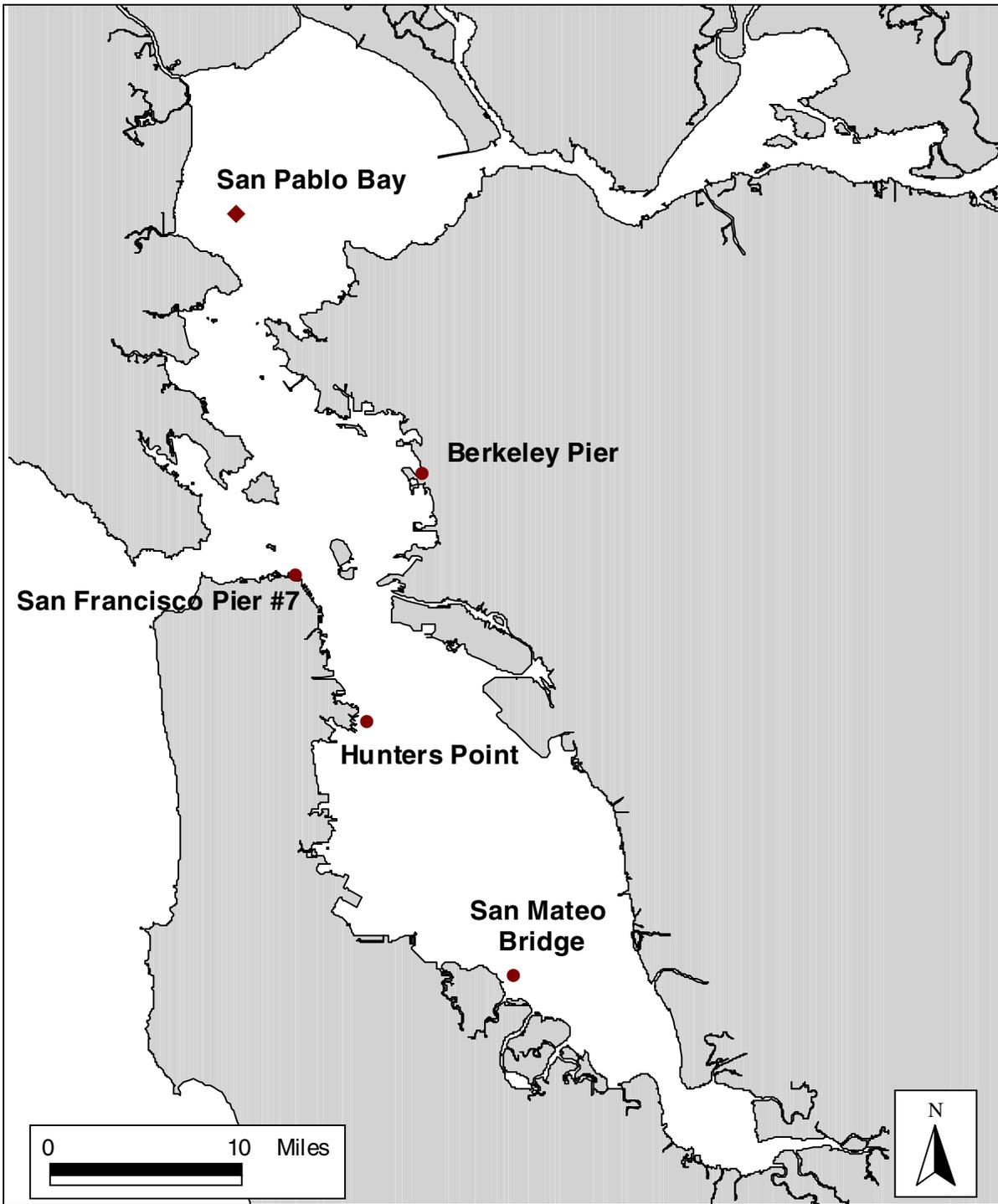
### 3.2.3 Sample Size Determination

A sample size equation for a one-tailed test (Walpole and Myers, 1989) was used to estimate the sample size required to achieve the desired statistical confidence in the evaluation (see Appendix B for more details) as follows:

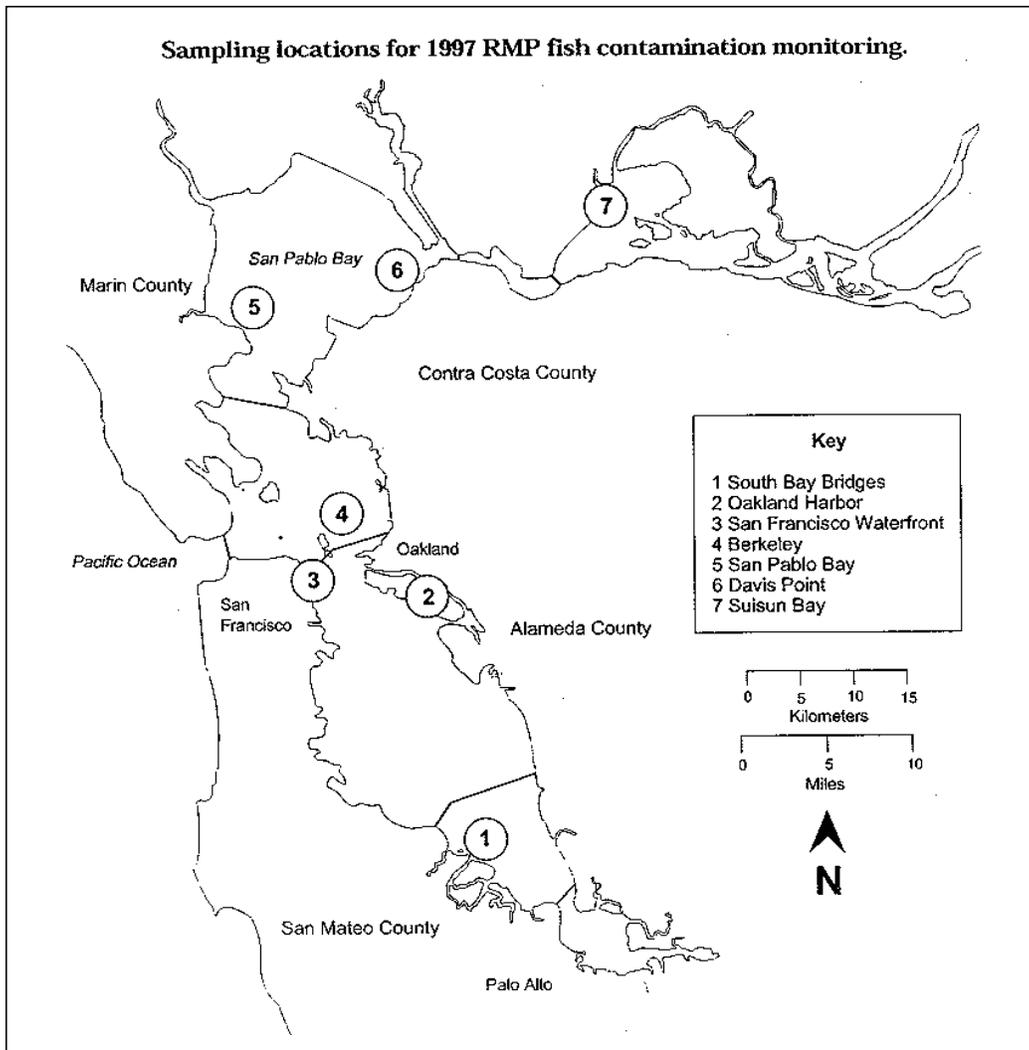
Where:

$$n \approx \frac{(z_{\alpha} + z_{\beta})^2 2s_x^2}{[\bar{X}(a - 1)]^2}$$

- $z_{\alpha}, z_{\beta}$  = The standard normal deviates associated with  $\alpha$  and  $\beta$ , respectively
- $s$  = The standard deviation of the data
- $\bar{X}$  = The mean of the data
- $a$  = Multiple of ambient residue reflecting difference from HPS
- $\alpha$  = The probability of making a Type I error resulting in a false-positive claim
- $\beta$  = The probability of making a Type II error resulting in a false-negative claim



**Figure 3-1. Ambient Locations for HPS Human Health Risk Communication Evaluation.**



**Figure 3-2. Regional Monitoring Program Sampling Locations (from SFEI 1999).**

For the purpose of this analysis, the following assumptions were made:

- A critical alpha value of five percent (*i.e.*,  $\alpha=0.05$ ) was used in testing the hypothesis  $H_0$ .
- A critical beta value of five percent (*i.e.*,  $\beta=0.05$ ) was used.
- For the purpose of estimating the variance in the concentration of COPCs in sport fish fillets from both ambient and HPS areas, tissue concentrations collected for the RMP (RWQCB 1995) evaluation were considered. Data from eight locations in San Francisco Bay were evaluated, excluding samples that were collected from Double Rock (this station was considered too close to HPS to be a valid sample) to determine the variation. To simplify the evaluation, PCBs in white croaker fillets were used to estimate the mean and standard deviation of the data. Evaluating PCB data from white croaker fillets was considered appropriate because white they have been identified as a species of concern by the regulatory agencies and because they have the highest median wet weight concentration of PCBs of all the species measured in the Bay (SFEI 1999). By using PCB data from croakers, it is assumed that other species and contaminants would follow a similar pattern. This evaluation is summarized in Appendix B.

One of the key considerations in determining sample size is the choice of how much greater than the ambient residue ( $\mu_A$ ) the HPS residue ( $\mu_{HP}$ ) must be before the hypothesis  $H_0$  is rejected in favor of  $H_A$ ; that is, the choice of an effect size ( $\Delta$ ). The larger the difference between the mean concentrations in the two areas, the more easily it can be detected. Conversely, the smaller the difference, the more difficult it will be to detect. There is no conventional standard for setting effect size, however, it should have toxicological relevance. For the purpose of this evaluation, sample sizes were estimated for various effect sizes.

Table 3-3 presents sample size estimates for different effect sizes ( $\Delta$ ) based on the assumptions described. For example, if one wished to detect a 50 percent increase in mean PCB residue compared to mean ambient residue (assuming  $\alpha=\beta=0.05$ ) a sample size of 19 would be required. In Table 3-3 a 50 percent difference equates to an  $a$  of 1.5 (e.g., 1.5 times ambient). If the mean ambient residue is 304 ng PCB/g wet weight then the HPS residue would have to be at least 456 ng/g to be 1.5 times greater. This equals an effect size of 152 ng/g (456 ng/g – 304 ng/g = 152 ng/g).

**Table 3-3. Estimated Sample Sizes Required to Achieve Specified Statistical Confidence.<sup>1</sup>**

| $a^2$ | Effect Size<br>$\Delta = \mu_{HP} - \mu_A$ | HPS Residue ( $\mu_{HP}$ ), ng<br>PCB/g<br>(Under $H_A$ ) <sup>3</sup> | Sample Size, $n$        |                               |
|-------|--|--|-------------------------|-------------------------------|
|       |  |  | $\alpha = \beta = 0.05$ | $\alpha = 0.10, \beta = 0.20$ |
| 1.1   | 30   | 334  | 486                     | 204                           |
| 1.2   | 61   | 365  | 118                     | 50                            |
| 1.3   | 91   | 395  | 53                      | 23                            |
| 1.4   | 122  | 426  | 30                      | 13                            |
| 1.5   | 152  | 456  | 19                      | 8                             |
| 1.6   | 182  | 486  | 14                      | 6                             |
| 1.7   | 213  | 517  | 10                      | 5                             |
| 1.8   | 243  | 547  | 8                       | 4                             |
| 1.9   | 274  | 578  | 6                       | 3                             |
| 2.0   | 304  | 608  | 5                       | 2                             |
| 2.1   | 334  | 638  | 4                       | 2                             |
| 2.2   | 365  | 669  | 4                       | 2                             |
| 2.3   | 395  | 699  | 3                       | 2                             |
| 2.4   | 426  | 730  | 3                       | 2                             |
| 2.5   | 456  | 760  | 3                       | 1                             |
| 2.6   | 486  | 790  | 2                       | 1                             |

<sup>1</sup>It is assumed that  $\mu_A = 304$  ng PCB/g wet weight.

<sup>2</sup>Multiple of ambient residue reflecting difference from HPS.

<sup>3</sup> $H_A$  is the alternative hypothesis that the mean COPC residue at HPS is greater than the mean ambient residue.

It is important to note that each sample will be comprised of a composite of several fish, as described in Appendix D. For example, each croaker and jacksmelt sample will be a composite of five fish, while each surfperch sample will be a composite of 20 fish. Thus, a sample size of 19 would require the collection of at least 95 white croaker and jacksmelt or 380 surfperch from both HPS and from the rest of the Bay (Table 3-4).

**Table 3-4. Number of Fish Required to Develop Composite Samples.**

| <b>Discrete Sample Size</b>                                    | <b>Composite Sample Size</b> |                  |                  |
|--|------------------------------|------------------|------------------|
| <b>Sample Size, n<br/>(<math>\alpha = \beta = 0.05</math>)</b> | <b>White<br/>Croaker</b>     | <b>Surfperch</b> | <b>Jacksmelt</b> |
| 486  | 2430                         | 9720             | 2430             |
| 118  | 590                          | 2360             | 590              |
| 53   | 265                          | 1060             | 265              |
| 30   | 150                          | 600              | 150              |
| 19   | 95                           | 380              | 95               |
| 14   | 70                           | 280              | 70               |
| 10   | 50                           | 200              | 50               |
| 8  | 40                           | 160              | 40               |
| 6  | 30                           | 120              | 30               |
| 5  | 25                           | 100              | 25               |
| 4  | 20                           | 80               | 20               |
| 4  | 20                           | 80               | 20               |
| 3  | 15                           | 60               | 15               |
| 3  | 15                           | 60               | 15               |
| 3  | 15                           | 60               | 15               |
| 2  | 10                           | 40               | 10               |

Based on both policy and practical concerns, the Navy proposes to collect at least six (6) discrete composite samples at HPS and at least two (2) discrete composite samples from each of three ambient locations in the Bay for a total of six ambient composite samples. Under the alternative hypothesis ( $H_A$ ), a sample size of five would allow a 100 percent (two-fold) increase in the mean PCB residue at HPS to be detected at the specified Type I and Type II error rates of 5 percent (*i.e.*,  $\alpha=\beta=0.05$ ). However, dependent on the dataset, one might be able to see smaller differences in mean residues with similar or less (but still acceptable) power. A sample size of six would achieve similar results.

A sample size of at least 6 composite samples from HPS is considered sound for the following reasons. First, from a toxicological perspective, a 100 percent difference in tissue residues equates to a fairly sensitive indicator of change. This magnitude of difference between HPS and ambient locations in the Bay translates to a doubling of HPS tissue concentrations and, therefore, approximately twice the risk. Screening values developed for PCBs in fish by the RWQCB (1995) have been calculated at 23 ng/g using a target risk level of  $10^{-5}$ . The median concentration of PCBs in croaker tissue collected in 1997 by the RMP was 306 ng/g wet (SFEI 1999), which is approximately equal to a risk level of  $10^{-4}$ . A doubling of this risk would equal a  $2 \times 10^{-4}$  probability of an adverse effect occurring. Therefore, tissue residues that vary between 300 and 600 ng/g would result in a risk that is not quantifiably different from either  $1 \times 10^{-4}$  and  $2 \times 10^{-4}$ . Second, from a practical perspective, a sample size of six would require a total of 30 croaker or jacksmelt or 120 surfperch that will need to be collected from both HPS and ambient locations. This is about twice the number of fish collected by SFEI (1999) for the 1997 RMP sampling effort. Additional samples may be difficult to obtain based on the size of the areas. However, if it is possible to collect more fish at all the locations, then additional composite samples may be analyzed.

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## **APPENDIX A**

### **Summaries of Technical Conference Calls on Human Health Evaluation**

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The following two memoranda are summaries of two conference calls that were held on March 30, 2000 and July 11, 2000 with Sediment Work Group members and agency representatives. The purpose of these calls was to discuss human health exposure pathways and the approach for evaluating fish consumption. Although every attempt was made to ensure that the discussions were accurately reflected, it is important to note that these summaries have not been reviewed and approved by all participants and are, therefore, considered draft.

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*Project Number: G337395-22*

## Memorandum

**Date:** April 3, 2000  
**To:** Sediment Work Group  
**From:** Nancy Bonnevie  
**Subject:** Conference call with Agencies re: human health exposure pathways on 3/30/00

Participants: Agencies: Jim Polisini, Dan Stralka  
Sediment Work Group: Jim Leather and Stacey Curtis (Navy); Nancy Bonnevie and Donald Gunster (Battelle); Jennifer Holder and Wini Curely (Entrix)

### Summary

The purpose of the call was to discuss with the Agencies the Navy's proposed approach for addressing human health exposure pathways at the Navy facilities in San Francisco Bay (*i.e.*, fish tissue). Prior to the call, the draft document entitled "A Proposed Approach for Evaluating Sediment Impacts on Fish Consumption Health Risks at Navy Facilities in San Francisco Bay" was forwarded to the Agency representatives for their review and consideration.

The SWG initiated the discussion by stating the Navy's objective was to develop an approach that would allow the assessment of fish tissue to be linked to site-specific sediments because that is the media identified for remediation. Following that introduction, we reviewed the proposed approach by stepping through the decision matrix flowchart.

A summary of the points discussed is provided below.

- The Agencies stressed that evaluation of fish consumption needs to serve a dual purpose: 1) evaluating potential risk at the sites; and 2) risk communication with the surrounding communities. Jim Polisini indicated that this position has been previously communicated to the Navy, citing letters contained within the administrative record for Hunters Point Shipyard. The issue of public perception and risk communication appear to be the primary factors for their position regarding the collection of fish.
- The Agencies indicated that they are comfortable with much of the overall technical approach proposed by the Navy. However, while they agree with many of the technical arguments (*e.g.*, that fish are mobile and do not provide a direct link to site-specific sediments and that risk from contaminated fish is a Bay-wide problem) they have concerns with the stipulation that only resident fish are appropriate for evaluation. The Agencies noted that 28-day tests are considered sufficient to evaluate bioaccumulation in the laboratory, therefore, a relatively minimum amount of time at a site could be sufficient to result in elevated tissue concentrations.

- The Agencies acknowledged that there is a Bay-wide problem associated with the consumption of fish that will not be addressed through remediation at any one site.
- The Agencies agree that linking fish tissue back to sediment remediation goals will be difficult (if not impossible) due to the mobility of sport fish. However, they feel that it is possible to evaluate the potential contribution of the Navy facilities to chemical concentrations observed in fish tissue by determining the relative difference between tissue concentrations in fish collected from the vicinity of the site and the Bay-wide average.
- The Agencies acknowledge the evaluation presented in the technical memorandum that demonstrates the lack of a statistically significant spatial variation in the data presented by the RMP. However, they feel that this argument is limited due to existing data gaps. It is their opinion that the currently available data (*i.e.*, the RMP data from 1995 and 1997) do not include enough samples collected from the vicinity of the Navy sites (*e.g.*, Hunters Point Shipyard [HPS] and Alameda NAS) to support the argument that risks from consuming fish in those areas are no greater than the risks posed by consuming fish from the Bay in general. Therefore, they feel that additional fish tissue data are required to supplement the existing datasets and reduce the variability.
- Based on the existing RMP data, the public has a perception that risks associated with consuming fish from particular areas in the Bay (*i.e.*, Hunters Point and Alameda) are potentially greater than those associated with the Bay as a whole. There are currently too few samples from any one area to reliably say that there is no statistical difference. The Agencies acknowledge that the number of samples required to provide a statistically-based evaluation may be unrealistically large, but stated that additional data would be beneficial even if it did not improve the statistical confidence in the data.
- The Agencies acknowledged that it may not be possible or realistic to modify the remedial footprint based on measured fish tissue concentrations. However, the Agencies feel that collecting additional fish tissue samples demonstrate to the public a ‘good faith’ effort on the part of the Navy and, therefore, would improve public perception.
- The Agencies feel that additional work must also be done to identify/clarify the angler population at the individual facilities. They believe that the focus should be more on identifying who is fishing, what they are catching and what they are doing with it than on trying to link fish tissue concentrations back to sediment. They have anecdotal information that there are individuals that fish frequently from these areas, however, this has not been confirmed.
- The Agencies indicated that they would be willing to discuss alternative exposure parameters (*e.g.*, site-specific fish consumption rates, etc.) in the human health risk evaluations.
- The Agencies also suggested that shellfish (*e.g.*, mussels, clams, and crabs) be evaluated. Due to their limited mobility, these species could be used to identify the remedial footprint for the human health evaluations. For example, they have anecdotal information that individuals collect mussels off the pilings at HPS. This should be verified, and if true the pathway should be considered in the risk assessment. When questioned about the fact that the pilings were not within the remedial footprint currently identified (*i.e.*, the low volume footprint), Jim Polisini indicated that he does not feel that the boundaries of the ecological and human health footprints need to be exactly the same.



**Project Number:** G337384

## Memorandum

### *Distribution:*

|                 |   |                          |                                     |
|-----------------|---|--------------------------|-------------------------------------|
| <b>Date:</b>    | July 11, 2000   | <b>Battelle:</b>         | D. Gunster, P. White                |
| <b>To:</b>      | Michael Pound   | <b>Entrix:</b>           | J. Holder, W.<br>Curley, J. Slocomb |
| <b>From:</b>    | Nancy L. Bonnevie   | <b>Neptune<br/>Navy:</b> | D. Michael<br>J. Leather            |
| <b>Subject:</b> | Summary of Call with Agency<br>Representatives Regarding the Approach<br>for Fish Consumption |                          |                                     |

A conference call was held on Wednesday July 11 to discuss the approach for addressing potential risks at Navy facilities in San Francisco Bay associated with fish consumption. Call attendees included the following individuals:

Battelle: Don Gunster and Nancy Bonnevie  
Neptune and Co.: Dan Michael  
Entrix: Wini Curley and John Slocomb  
EPA: Dan Stralka and Sophia Serda  
DTSC: Jim Polisini

Based on previous discussions with the Agencies, a memorandum had been prepared that summarized the sample sizes required to statistically detect differences in tissue concentration between a specific facility and the remainder of the Bay. The purpose of this call was to review this memorandum and discuss the associated implications for the overall approach. The following is a summary of the discussion and the implications for the evaluation of human health.

### Summary

Jim Polisini reiterated his opinion that there are two components that must be considered in evaluating risks associated with the consumption of fish by individuals fishing at the Navy facilities: 1) determining a need for remedial activities at the site to protect individuals exposed via this pathway and selecting the appropriate alternative; and 2) risk communication to the public.

Regarding the first component, Jim Polisini stated that this issue is best addressed through the evaluation of shellfish data, because those species are relatively immobile and therefore best represent actual site conditions. Further, he indicated that he would be willing to accept laboratory bioaccumulation data in lieu of field-collected shellfish assuming that the results of the data collected in support of the ecological risk assessment at Hunters Point do not show a significant difference between the *Macoma* bioassay and the field-collected tissue data. This is based on the assumption that there will be sufficient shellfish collected during the sampling to warrant analyzing the full suite of chemical constituents in the field-collected samples.

Regarding the second component, the Agencies are concerned with public perceptions regarding the potential risks from consuming fish from the specific facilities and believe that fish tissue data needs to be collected in

order to better inform the public. Therefore, evaluations based on fish tissue would not be used to determine the areas requiring remedial activity, but rather to educate the public regarding their relative risks when consuming fish from the vicinity of a Navy facility. The Agencies specified that both whole body and filet data should be collected, so that the relative risks of consuming different portions of the fish could also be evaluated. The Agencies stated that the sample size estimate analysis performed was very informative and that it was a good first step toward determining the number of samples that would be required. They indicated that the analysis did not need to be as robust as assumed in the memorandum, therefore, sample sizes required are likely to be much lower. Jim Polisini indicated that he would not approve any site-specific action plan that did not include an analysis of fish consumption for the purpose of risk communication. John Slocomb stated that he could not definitively estimate the number of whole body samples that would be required to achieve a specified level of statistical confidence without historical data from which to determine the variability. However, it is likely that the results would be similar to those obtained based on the filet data. It was determined that the Agencies (*i.e.*, Jim Polisini, Dan Stralka, and Sophia Serda) would meet to determine the level of statistical confidence that would be acceptable to them for this type of analysis.

**APPENDIX B**

**Position Papers to Support Human Health Evaluation**

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- Attachment B: Abundance and Distribution of Species in the Recreational Fisheries of San  
Francisco Bay
- Attachment C: Sensitivity Analysis for Fish Consumption Risk Evaluation

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**DRAFT**  
**ESTIMATING SAMPLE SIZES**  
**FOR COMPARING**  
**CHEMICAL RESIDUES IN FISH TISSUE**  
**AMONG SAMPLING LOCATIONS**

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**Deliver Order No. 0084**

**June 7, 2000**

## 1.0 INTRODUCTION

In 1994, the San Francisco Regional Water Quality Control Board (SFRWQCB), the State Water Resources Control Board (SWRCB), and the California Department of Fish and Game (CDFG) conducted a pilot study that was aimed, in part, at providing data on concentrations of chemical contaminants in fish tissue (SFRWQCB et al, 1995). Based on results of this study, the Office of Environmental Health Hazard Assessment (OEHHA) issued an interim health advisory for human consumption of fish caught in San Francisco Bay. In part, this advisory was based on levels of total polychlorinated biphenyls (PCBs) and total mercury (Hg) found in edible portions of fish.

Currently, the Navy is evaluating the potential risks to human health associated with consumption of fish collected in the vicinity of the Hunters Point Shipyard (HPS). Based on the previously collected data (SFRWQCB et al, 1995), it is evident that concentrations of several chemicals measured in fish tissue from throughout San Francisco Bay exceed acceptable levels for human consumption as the result of a variety of sources. Therefore, the focus of the Navy's evaluation is to determine whether or not concentrations of chemicals in fish from the vicinity of HPS are greater than those in fish from other (ambient) locations in San Francisco Bay and, therefore, associated with a greater risk to human health. Specifically, this evaluation focuses on whether PCBs and Hg found in the filets of white croaker (*Genyonemus lineatus*) are greater in fish caught at Hunter's Point Shipyard (HPS) than in fish caught from ambient locations. The first step in conducting this investigation is to estimate the number of filet samples that would be needed to perform a statistical hypothesis test.

## 2.0 METHODOLOGY AND RESULTS

For the purpose of determining required sample sizes, only the PCB data collected in 1994 (SFRWQCB et al., 1995) were used. There are two reasons for not considering the Hg data in sample size calculations. First, variation in Hg content of white croaker filets has been shown to be positively correlated with fish length, resulting in a bias in the among-location comparisons using the 1994 data. Hence, pooling of the uncorrected Hg data from the 1994 investigation may not be justified. Second, the magnitude of variation in Hg content (ignoring bias due to length) was less than the variation observed for PCB and, therefore, sample size estimates required to evaluate PCB would be more conservative. Means and standard deviations of PCB residues in white croaker filets obtained in 1994 are shown in Table 1.

**Table 1. Total PCB Residues Found in Skin-on Filets of White Croaker Collected from Different San Francisco Bay Stations in 1994**

| Station Name                           | No. Samples | PCB, µg/kg wet weight |                    |
|--|-------------|-----------------------|--------------------|
|  |             | Mean                  | Standard Deviation |
| Double Rock (Candlestick) <sup>1</sup> | 3           | 371                   | 231                |
| Dumbarton Bridge                       | 3           | 298                   | 117                |
| Islais Island                          | 3           | 228                   | 88                 |
| Oakland Middle Harbor                  | 3           | 341                   | 15                 |
| Point Molate                           | 3           | 260                   | 43                 |
| Rodeo                                  | 3           | 310                   | 97                 |
| San Francisco Pier #7                  | 4           | 222                   | 262                |
| San Mateo Bridges                      | 3           | 348                   | 124                |
| Vallejo Mare Island                    | 3           | 452                   | 168                |

<sup>1</sup> Station located nearest to Hunter's Point

Estimating Sample Sizes for Comparing Chemical Residues

June 7, 2000

The residues summarized in Table 1 were found to be normally distributed, based on the probability plot correlation test (Filliben, 1974; Looney and Gullledge, 1985). An analysis of variance of these data indicated that there were no statistically significant differences in mean PCB residues in filets among the nine stations sampled in 1994 ( $P=0.685$ ). This finding supports the conclusion that PCBs in white croaker filets were similar throughout the bay at the time samples were collected. Specifically, PCB residues in white croaker filets obtained from the station closest to HPS (i.e., Double Rock station, which is also referred to as Candlestick) were statistically indistinguishable from residues measured at all other stations, including Rodeo and Valejo Mare Island, which are the stations farthest from HPS. Considering that white croakers of edible size would not be expected to exhibit fidelity to any station in the bay, this conclusion is plausible. A box plot of these data is presented in Figure 1 (see end of text).

This analysis also supports a claim that white croakers caught in the vicinity of HPS did not pose greater risks to human health than fish caught at other locations in the Bay. However, the 1994 study was not designed to compare filet residues from HPS *per se* to ambient residues. To make such a comparison, a sufficient number of white croaker samples would need to be collected from HPS and an equally sufficient number from ambient locations.

To determine the number of samples required, it is assumed that a comparison will be made between two population means: 1) the mean concentration of PCB in white croaker filets collected from HPS, and; 2) the mean concentration of PCBs from stations representative of ambient conditions. The immediate concern is to determine how many samples to collect to achieve specific statistical power in testing the null hypothesis using a fixed significance level  $\alpha$  (Type I Error) and a fixed specific alternative hypothesis. The null and alternative hypotheses are given as:

Null Hypothesis ( $H_0$ ):                    The mean PCB residue in filets from HPS ( $\mu_{HP}$ ) is less than or equal to the mean ambient residue ( $\mu_A$ ).

Alternative Hypothesis ( $H_A$ ):        The mean PCB residue in filets from HPS is greater than the mean ambient residue.

Failure to reject  $H_0$  would lead to the conclusion that white croaker caught from HPS pose the same or lower risk to human health than those caught from ambient locations. Alternatively, rejecting  $H_0$  would lead to the conclusion that white croaker caught from HPS may pose a greater risk to human health than do those caught from ambient locations. The different decision outcomes of testing the hypothesis are given in Table 2 (see end of text).

Three choices must be made to determine sample sizes for testing the null hypothesis. They are:

1. The choice of a critical test size  $\alpha$  (i.e., the probability of making a Type I Error that would result in a false-positive claim) for testing  $H_0$ . For planning purposes, two values will be used:  $\alpha=0.05$  and  $\alpha=0.10$ .
2. The choice of a critical  $\beta$ -value (i.e., the probability of making a Type II Error resulting in a false-negative claim). The emerging convention is that  $\beta$  should be equal to at least 0.2 (i.e., the power of the test is  $1-\beta=0.80$ ) or such that  $\alpha=\beta$ . For planning purposes, values for  $\beta$  will be set at 0.05 and 0.20.

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- The choice of how much greater than the ambient residue ( $\mu_A$ ) must the HPS residue ( $\mu_{HP}$ ) be before the hypothesis  $H_0$  is rejected in favor of  $H_A$ ; that is, the choice of an effect size ( $\Delta$ ). There is no conventional standard for setting this effect size and one could, for example, use a PCB concentration of at least 10% above ambient. The critical issue in selecting the effect size is that the value has ecological or toxicological relevance. The larger the difference between the mean residues in the two areas, the more easily it can be detected. Conversely, the smaller the difference, the more difficult it will be to detect. For planning purposes, a range of  $\Delta$ -values will be used.

In addition to these choices, variation in the concentration of PCBs in white croaker filets from both ambient and HPS areas must be known from historically relevant studies. A reasonable assumption is that the combined 1994 data, excluding Double Rock samples, provides a good estimate of the true ambient variation in PCB concentration in white croaker filets. For these data, the mean  $\bar{X}$  and standard deviation  $s_x$  of PCB residue in filets is

$$\bar{X} = 304 \mu\text{g tPCB/kg wet weight}$$

and

$$s_x = 142 \mu\text{g tPCB/kg wet weight.}$$

The 95% confidence interval for  $s_x$  is approximately ( $111 < s_x < 198$ ,  $\mu\text{g PCB/kg wet wt.}$ ). It will also be assumed that

$$s_x = \sigma_{HP} = \sigma_A = \sigma.$$

Given this assumed knowledge as well as specified values of  $\alpha$ ,  $\beta$ , and  $\Delta$ , the required number of samples,  $n = n_{HP} = n_A$ , for a one-tailed test is determined by (see Walpole and Myers, 1989):

$$n = \frac{(z_\alpha + z_\beta)^2 (\sigma_{HR}^2 + \sigma_A^2)}{\Delta^2} = \frac{(z_\alpha + z_\beta)^2 2\sigma^2}{\Delta^2}$$

where  $z_\alpha$  and  $z_\beta$  are the standard normal deviates associated with  $\alpha$  and  $\beta$ , respectively,  $\sigma$  is the variation in the tissue concentration of PCBs from both HPS and ambient locations, and  $\Delta$  is the chosen effect size.

It is not possible to exactly specify the fixed specific alternative since the value of  $\mu_{HP}$  is unknown. However, it seems reasonable under  $H_A$  that HPS would exhibit a mean PCB residue equal to some multiple of ambient residue. If it is assumed that  $\mu_{HP} = a(\mu_A)$ , for  $a > 1$ , then an approximate effect size and sample size can be determined accordingly:

$$\Delta = \mu_{HP} - \mu_A = a\mu_A - \mu_A \approx \bar{X}(a - 1)$$

and

$$n \approx \frac{(z_\alpha + z_\beta)^2 2s_x^2}{[\bar{X}(a - 1)]^2}$$

In Table 3 below, sample size estimates are provided for different values of  $a$ , which give rise to the  $\Delta$ -values. Additional sample size estimates are provided in Table 4 in which the upper 95% confidence limit for  $s_x$  is used.

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**Table 3. Estimated Sample Sizes Required for Comparing Mean Pcb Residues in White Croaker Filets from HPS to Residues from Ambient Locations in San Francisco Bay. It is assumed that the mean ambient PCB residue is  $\mu_A = 304$  mg PCB/kg wet weight.**

| <i>a</i> | $\Delta = \mu_{HP} - \mu_A$ | HPS Residue, mg PCB/kg | Sample Size, <i>n</i> |                           |
|----------|-----------------------------|------------------------|-----------------------|---------------------------|
|          |                             | (Under $H_A$ )         | $\alpha=\beta=0.05$   | $\alpha=0.10, \beta=0.20$ |
| 1.1      | 30                          | 334                    | 486                   | 204                       |
| 1.2      | 61                          | 365                    | 118                   | 50                        |
| 1.3      | 91                          | 395                    | 53                    | 23                        |
| 1.4      | 122                         | 426                    | 30                    | 13                        |
| 1.5      | 152                         | 456                    | 19                    | 8                         |
| 1.6      | 182                         | 486                    | 14                    | 6                         |
| 1.7      | 213                         | 517                    | 10                    | 5                         |
| 1.8      | 243                         | 547                    | 8                     | 4                         |
| 1.9      | 274                         | 578                    | 6                     | 3                         |
| 2.0      | 304                         | 608                    | 5                     | 2                         |
| 2.1      | 334                         | 638                    | 4                     | 2                         |
| 2.2      | 365                         | 669                    | 4                     | 2                         |
| 2.3      | 395                         | 699                    | 3                     | 2                         |
| 2.4      | 426                         | 730                    | 3                     | 2                         |
| 2.5      | 456                         | 760                    | 3                     | 1                         |
| 2.6      | 486                         | 790                    | 2                     | 1                         |

**Table 4. Assumed Upper Limits on the Estimated Sample Sizes Required for Comparing PCB Residues in White Croaker Filets from HPS to Ambient Residues in San Francisco Bay. It is assumed that the mean ambient PCB residue is  $\mu_A = 304$  mg PCB/kg wet weight. Sample sizes are based on using the upper 95% confidence limit for variation, which is  $s_x = 198$   $\mu$ g PCB/kg wet weight.**

| <i>a</i> | $\Delta = \mu_{HP} - \mu_A$ | HPS Residue, mg PCB/kg | Sample Size, <i>n</i> |                           |
|----------|-----------------------------|------------------------|-----------------------|---------------------------|
|          |                             | (Under $H_A$ )         | $\alpha=\beta=0.05$   | $\alpha=0.10, \beta=0.20$ |
| 1.1      | 30                          | 334                    | 943                   | 396                       |
| 1.2      | 61                          | 365                    | 229                   | 96                        |
| 1.3      | 91                          | 395                    | 103                   | 43                        |
| 1.4      | 122                         | 426                    | 58                    | 24                        |
| 1.5      | 152                         | 456                    | 37                    | 16                        |
| 1.6      | 182                         | 486                    | 26                    | 11                        |
| 1.7      | 213                         | 517                    | 19                    | 8                         |
| 1.8      | 243                         | 547                    | 15                    | 7                         |
| 1.9      | 274                         | 578                    | 12                    | 5                         |
| 2.0      | 304                         | 608                    | 10                    | 4                         |
| 2.1      | 334                         | 638                    | 8                     | 4                         |
| 2.2      | 365                         | 669                    | 7                     | 3                         |
| 2.3      | 395                         | 699                    | 6                     | 3                         |
| 2.4      | 426                         | 730                    | 5                     | 2                         |
| 2.5      | 456                         | 760                    | 5                     | 2                         |
| 2.6      | 486                         | 790                    | 4                     | 2                         |

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Interpreting sample sizes that are given in either table can best be illustrated by example using Table 3 and  $\alpha=\beta=0.05$ . If an effect size ( $\Delta$ ) of 213  $\mu\text{g}$  PCB/kg wet weight (equivalent to the mean HPS residue exhibiting a 70% increase from the mean ambient residue of 304  $\mu\text{g}$  PCB/kg wet weight) is considered to have toxicological relevance, a sample size of  $n=10$  is required. In this case, it is anticipated that there is a 5% (or 1-in-20) chance of committing a Type I or Type II error in testing the null hypothesis. The greatest concern in using either of the tables for planning purposes is making sure that the chosen effect size has relevance to the overall objectives of the investigation. A pertinent question might be at what magnitude difference between mean HPS residue and mean ambient residue (i.e., the effect size) would regulatory action be prompted.

### 3.0 CONCLUSIONS

The purpose of this memo was to estimate the number of samples that would need to be collected in an investigation comparing PCB residues in filets of fish caught at HPS to ambient residues. If this new investigation is pursued, the study will have to be properly designed, including a determination of how best to allocate the required sample numbers and how best to collect samples from an area representative of ambient conditions. For example, an optimum design may be to collect an equal number of HPS and ambient samples; that is, a balanced design. Hence, assuming  $\alpha=\beta=0.05$  and  $\Delta=91$  ppb, a total of 106 samples would need to be collected (i.e., 53 samples from HPS and another 53 ambient samples).

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Table 2. Possible decision outcomes in testing the statistical hypothesis ( $H_0$ ) that the mean PCB residue in filets of white croaker caught at HPS are less than or equal to ambient residues from the San Francisco Bay.

| TRUE STATE OF PCB RESIDUES IN WHITE CROAKER FILETS | DECISION OUTCOME  |   |
|--|---|---|
|  | ACCEPT $H_0$  | REJECT $H_0$  |
| $H_0: \mu_{HP} \leq \mu_A$                         | <p><b><u>CORRECT DECISION</u></b></p> <ul style="list-style-type: none"> <li>This decision would correctly claim that mean residue in HPS filets is less than or equal to mean residue levels associated with ambient conditions.</li> <li><math>Pr(\text{No Error}) = (1-\alpha)</math></li> </ul>   | <p><b><u>INCORRECT DECISION</u></b></p> <ul style="list-style-type: none"> <li>This decision is a Type I Error, resulting in a <u>false-positive</u> claim that mean residues in HPS filets are higher than ambient residues (when in truth they are not). The implications of this error are that higher risks to human health might be claimed when, in fact, risks would not be higher than ambient. This error could also trigger unnecessary regulatory actions.</li> <li><math>Pr(\text{Type I Error}) = \alpha</math></li> </ul> |
| $H_1: \mu_{HP} > \mu_A$                            | <p><b><u>INCORRECT DECISION</u></b></p> <ul style="list-style-type: none"> <li>This decision is a Type II Error, resulting in a <u>false-negative</u> claim that residues in HPS filets are lower than or equal to ambient residues (when in truth they are greater). The implications of this error are that potentially higher risks to human health would go unrecognized and that additional regulatory actions would not be implemented.</li> <li><math>Pr(\text{Type II Error}) = \beta</math></li> </ul> | <p><b><u>CORRECT DECISION</u></b></p> <ul style="list-style-type: none"> <li>This decision would result in a correct claim that residues in HPS filets are higher than ambient residues and may be associated with greater human health risks than fish collected at ambient locations in the Bay.</li> <li><math>Pr(\text{No Error}) = (1-\beta)</math></li> </ul>   |

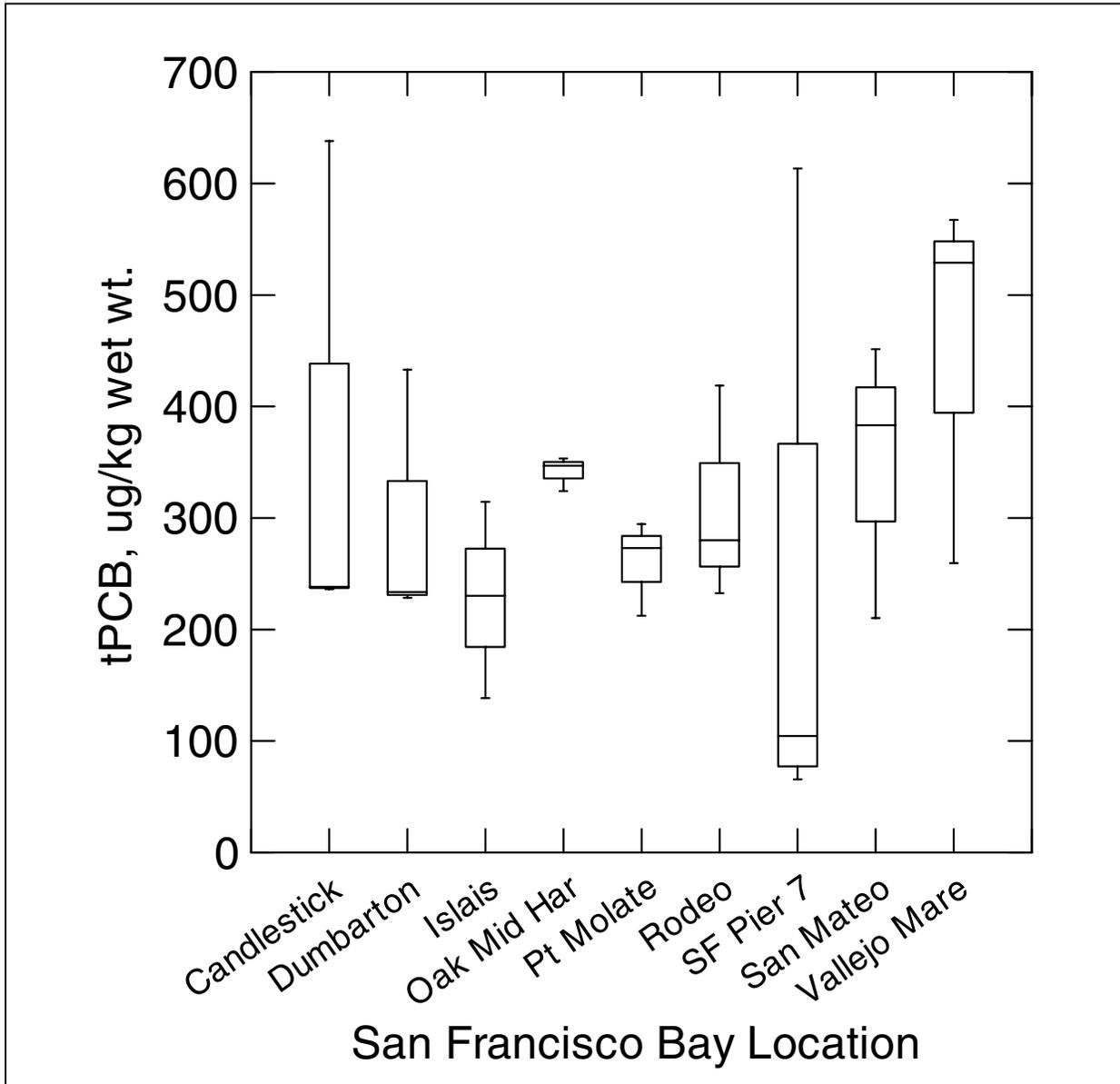


Figure 1. Total PCB Residue Measured in Skin-on Filets of White Croaker Collected from Different Locations in San Francisco Bay in 1994

**WORKING DRAFT**

**A PROPOSED APPROACH FOR EVALUATING SEDIMENT IMPACTS  
AT NAVY FACILITIES  
ON FISH CONSUMPTION HEALTH RISKS IN SAN FRANCISCO BAY**

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**March 17, 2000**

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## 1.0 INTRODUCTION

As a result of multiple chemical sources in San Francisco Bay, health concerns associated with fish consumption have been identified as a regional issue during the last decade. Currently available data (SFRWQCB *et al.* 1995; SFEI 1999) indicate that concentrations of six chemicals or groups of chemicals (*i.e.*, PCBs, dioxins, mercury, dieldrin, DDT, chlordane) in fish collected from throughout the San Francisco Bay are high enough to pose a potential risk to recreational anglers (OEHHA, 1994). Based on these data, sport fish health advisories have been implemented for the Bay, along with an on-going monitoring program.

Due to these concerns, the impact of contaminated sediments on the risks associated with consumption of fish and shellfish by recreational anglers has been identified as one of the technical issues requiring further evaluation by the Sediment Work Group (SWG). Although the SWG agrees that the potential contribution of Navy site sediments to risk associated with the consumption of fish and shellfish from the Bay is an important consideration, there are numerous issues associated with conducting these types of evaluations that need to be discussed prior to initiating any site-specific fish and shellfish collection surveys. The intent of this technical memorandum is to provide a forum for discussing these issues, with the goal of reaching consensus on how best to address the relationship between chemicals found in sediment at Navy sites and potential human health risk associated with consumption of those chemicals in fish and shellfish tissue taken from the Bay. It is anticipated that the final approach, and its application to identifying remediation goals for sediments at Navy facilities, will be identified by focused technical groups comprised of regulatory agencies and Navy participants. It is recognized that Agency involvement in this proposed method is vital to the success of this approach.

The memorandum is organized as follows. Section 2 presents and discusses a proposed decision matrix approach for integrating the human health risk evaluation with the ecological evaluations conducted at each facility for the purpose of developing realistic and effective sediment remedial goals. Section 3 summarizes the conclusions of this evaluation and Section 4 presents the references used in this discussion paper.

## 2.0 PROPOSED PROCESS FOR ADDRESSING SEDIMENTS BY EVALUATING FISH CONSUMPTION

Evaluating the potential impacts of site-specific sediments on risks associated with the consumption of fish and shellfish from San Francisco Bay is a very complex process with a high degree of uncertainty. For example, there are numerous sources of chemical contaminants to the Bay making it difficult to attribute measured tissue concentrations in relatively mobile species to one specific source. In addition, there is limited information regarding the site-specific factors potentially influencing sediment uptake into biota and fishing activities at the various Navy Facilities.

It has already been demonstrated based on the results of the Regional Monitoring Program (RMP) evaluations that consumption of certain species of fish from the Bay is a health concern, as evidenced by the current sport fish health advisory. Thus, the focus of the SWG is to evaluate the contribution of the individual Navy facilities to that overall potential risk. The regulatory agencies have suggested that the uncertainties associated with this exposure pathway be addressed through the collection of additional fish tissue data. However, because the remediation at the offshore sites will focus on sediment not tissue, data collected to reduce uncertainties need to make the link between tissue and sediment for remedial activities to be effective in reducing the potential risk. The results of a statistical analysis of the RMP data (SFRWQCB *et al.* 1995; SFEI 1999) indicates that there is only limited spatial variation in concentrations

of bioaccumulative chemicals (*e.g.*, mercury and PCBs) measured in fish tissue collected from throughout the Bay (see Attachment A). Therefore, it is unclear whether additional tissue data will provide information useful to reducing uncertainty associated with evaluating human health fish consumption at the Navy facilities. Since many sport fish are mobile species, collecting additional fish tissue data at the site will not necessarily reflect exposure due solely to site-specific sediments, but rather a variety of sediment locations possibly contacted by the fish. Therefore, the SWG has developed a proposed approach that incorporates the potential risks associated with this pathway into the remedial decision process while taking the factors described above into account.

## **2.1 Decision Matrix Flowchart for Fish Consumption**

A decision matrix flowchart for the evaluation of potential sediment impacts on adverse human health effects associated with consumption of contaminated fish and shellfish in the San Francisco Bay is presented in Figure 1. This flowchart provides a roadmap for decision-making and identifies the role that ecological and human health risk evaluations play in the evaluation of risk management alternatives. The decision matrix flowchart (Figure 1) is divided into four groups for discussion purposes: preliminary evaluation (A); site-specific human health risk evaluation (B); ecological evaluation (C); and remediation evaluation (D).

### **2.1.1 Preliminary Evaluation (A)**

The decision matrix flowchart begins with a preliminary evaluation (A) that identifies the presence of bioaccumulative COPCs in site sediments. Bioaccumulative and bioavailable COPCs present in sediment may accumulate in invertebrates, shellfish, and sport fish. Therefore, the bioaccumulation line of evidence provides the link between sediments and the evaluation of human health through the consumption of fish and shellfish. The presence of bioaccumulative COPCs will be determined based on a review of the detected analytes in site sediments. A review of available literature, site data, or key physical/chemical properties (*e.g.*, molecular weight and octanol-water partition coefficient [ $K_{ow}$ ]) of the constituent can each be used to define its bioaccumulation potential. If bioaccumulative COPCs are not present in site sediment, then No Further Action (NFA) from a human health perspective is warranted. If potential bioaccumulative COPCs are present in site sediments, then the bioavailability of COPCs in sediment will be assessed. Bioassays and literature reviews can be used to identify the relationship between site-specific conditions and bioavailability of site-specific COPCs. Bioavailability of bioaccumulative COPCs can also be determined by gathering information about the physical/chemical characteristics of the site sediment. For example, information on total organic carbon (TOC), acid volatile sulfide, and grain size of the sediment at the site can be used to provide qualitative evidence regarding bioavailability. If bioaccumulative COPCs are not bioavailable, then NFA for human health concerns is warranted because the pathway is not complete. If bioaccumulative COPCs are present at the site and are bioavailable, then both a human health risk (B) and ecological evaluation (C) are performed. These evaluations (B and C) will be conducted in parallel and results from both will be integrated in the remediation evaluation (D).

### **2.1.2 Human Health Risk Evaluation (B)**

The first step to the site-specific human health risk evaluation is to determine the presence of sport fish or shellfish that are resident at the site. Sport fish are defined as those fish species that are commonly targeted and consumed by recreational anglers. Attachment B provides a description of the most common sport fish species in the Bay, including general information on their distribution throughout the Bay. Since most sport fish are mobile species that spend time in areas greater in size than any one Naval facility, it becomes difficult to evaluate risk due to site-specific exposure unless resident sport fish can be

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identified at the site. For example, if the site comprises only a small percentage of the species' overall home/foraging range, it is impossible to determine the potential impact of the site sediments on the observed tissue concentrations in the fish with any degree of accuracy due to the mobility of the fish and the possibility that it will encounter contaminated sediments associated with other sources. Therefore, the evaluation should be focused only on those species likely to spend the majority of their time in the vicinity of the site. To identify those species, the SWG will employ a weight of evidence approach using site-specific information as well as available sport fish life-history information. The first step will be to determine the available habitats at the site. Sport fish species likely to frequent the site will then be identified based on preferences for those habitat types. Whenever possible, this information will be confirmed through site-specific observations or conversations with representatives of local agencies (*e.g.*, Fish and Wildlife, EPA, etc.). Once species likely to frequent the site are identified, information regarding their migratory patterns and home/foraging ranges will be obtained from literature searches as well as conversations with individuals from relevant agencies (*e.g.*, Fish and Wildlife, EPA, etc.). This information will be compared to the size of the site, and a determination made as to whether or not those sport fish species are likely to spend sufficient time at the site to warrant further evaluation.

Similarly, the presence of resident shellfish will be determined based on the presence of appropriate habitat (*e.g.*, shellfish beds) of sufficient size at the site. These habitats will be identified based on a site reconnaissance or discussions with the site managers. If shellfish beds are identified, their potential utility as a food source for humans will be evaluated based on considerations such as accessibility, size of the area, species present, and proximity to other shellfish beds.

If resident sport fish are present at the site, it can be conservatively assumed that they are primarily exposed to site sediments and not sediments in other Bay locations. However, if no sport fish or shellfish are resident at the site, then NFA is warranted for the human health risk evaluation because the site-specific contribution of contaminants to fish tissue cannot be determined. For those sites, the proposed remedial footprint will be based solely on the results of the ecological weight-of-evidence (WOE) evaluation.

If sport fish or shellfish are resident at the site, it will be necessary to determine whether there is a site-specific angling population consuming those species. This could be determined based on limited on-site surveys or through interviews with site managers and contractors working at the site. If anglers do not frequent the site (*e.g.*, due to lack of access, preference for other areas, etc.) then NFA is warranted for the human health risk evaluation and the proposed remedial footprint will be based solely on the results of the ecological WOE evaluation.

If anglers are fishing for resident species at the site (including shellfish), then the identification of the site-specific angler population is warranted. Through site reconnaissance or surveys, site-specific data can be collected to identify the size and site-specific behaviors (*e.g.*, abundance and frequency of fishing at the site) of the angler population. Data collection should focus on gathering information to identify the amount of fish consumed by this population from the site (*e.g.*, waterbody access, fish productivity, abundance and distribution of preferential edible fish, mode of fishing, etc.). The data collection should focus on refining those key parameters (*e.g.*, fish tissue concentration [ $C_{\text{fish}}$ ], fraction of fish ingested from the site [FI], and fish ingestion rate [IR]) that were identified in the sensitivity analysis (see Attachment C) that reflect site-specific activity and behavior. Once site-specific information is collected concerning behavior activities, a risk-based concentration (RBC) for fish tissue can be calculated that incorporates the refined site-specific exposure parameter(s). Two RBCs will be calculated; one that represents a central tendency exposure (50<sup>TH</sup> percentile, or CTE) scenario and another that represents a reasonable maximum exposure (95<sup>th</sup> percentile, or RME). The CTE and RME RBCs will provide a range

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of safe concentrations in site-specific fish tissue. The purpose of conducting evaluations for both CTE and RME is for risk management decision-making perspective.

Once the RBCs are calculated, they will be compared to site-specific fish tissue concentrations. If the RBC is greater than the site-specific fish tissue concentration, then NFA is warranted for the human health risk evaluation and the proposed remedial footprint will be based solely on the results of the ecological WOE evaluation. If the RBC is less than the site-specific fish tissue concentration, then these data will be integrated with the ecological WOE evaluation to develop the final remedial footprint.

### **2.1.3 Ecological Evaluation (C)**

An ecological evaluation will be conducted in parallel with the human health evaluation for the purpose of defining a remedial footprint protective of ecological exposures. The intent of this memorandum is to focus on addressing human health concerns at the Navy facilities; therefore, details of the ecological evaluation will be presented in the site-specific ecological evaluation for the particular Navy Facility.

### **2.1.4 Remediation Evaluation (D)**

If sport fish are found to be resident at the site, results from the site-specific human health risk evaluation, (B in Figure 1), will be integrated with the ecological WOE evaluation, (C in Figure 1), to finalize the proposed remedial footprint. If sport fish are not found to be resident at the site, the proposed remedial footprint will be solely based on results from the ecological WOE evaluation. The finalized remedial footprint will be used to evaluate risk management alternatives.

## **3.0 CONCLUSIONS**

As indicated in this memorandum, there are a number of variables contributing to the uncertainty associated with estimating potential impacts from a Navy site on risks associated with consumption of fish from the Bay. This type of analysis is complicated by the difficulty inherent in linking measured concentrations in fish with site-specific sediment concentrations. The intent of this memorandum was to summarize these issues, focusing on the key parameters contributing to the uncertainty associated with evaluation of this exposure pathway.

The conceptual decision framework provided in this technical memorandum is intended to provide a vehicle for discussion of the technical and policy issues inherent in addressing this complex relationship. This approach is predicated on the assumption that risk management decisions must be based on exposure pathways providing the most direct link to site sediments. As a result, it relies on the ecological evaluation to derive a preliminary remedial footprint because the ecological evaluation addresses the potential food chain impacts of chemicals in sediments more directly. The final step in the process is an integration of the human health evaluation with the ecological assessment to ensure that the proposed remedial actions will result in a clean up goal that is protective of human health as well as ecological concerns.

It is anticipated that there will be differing points of view on some of the issues discussed and presented in this paper. By putting those issues in this proposed approach, it is expected that the discussions will highlight where efforts need to focus to resolve the differences, modify the approach, and develop consensus for a path forward. It is understood that focused technical groups comprised of Navy and Agency participants will be required to achieve resolution. Agency involvement in this discussion process and development of consensus is vital to the success of this approach.

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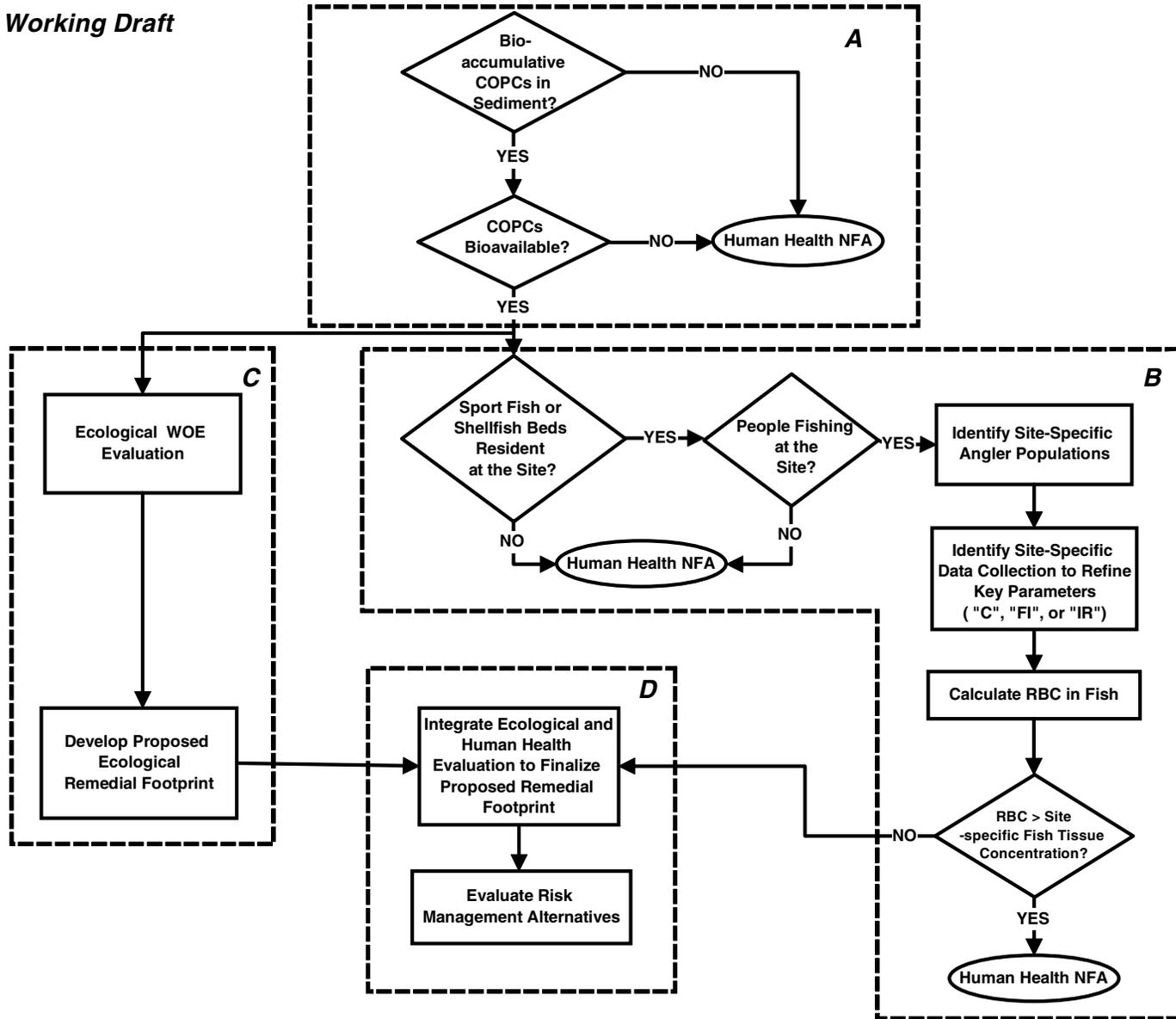


Figure 1. Decision Matrix Flowchart for Evaluation of Potential Human Health Risk Associated with Consumption of Fish

**ATTACHMENT A**

**San Francisco Bay Regional Fish Tissue Studies: Summary and Statistical Analysis**

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It is a well-known fact that there are multiple sources of chemical contaminants in San Francisco Bay which may contribute to elevated concentrations of bioaccumulative compounds in fish (SFRWQCB, *et al.* 1995). Human consumption of potentially contaminated fish has been identified as a regional issue during the last decade. To that end, it is the objective of this Attachment to present the following: 1) a summary of the studies conducted on fish tissue contamination in the Bay; and 2) present and discuss the results of a statistical analysis to ascertain if data from previous studies can be used to conclude if spatial differences exist in levels of contamination in fish tissue samples collected from geographically distinct locations around the Bay.

### **A.1 Summary of Regional Fish Monitoring Program Studies**

In 1994, the San Francisco Regional Water Quality Control Board (SFRWQCB), State Water Resources Control Board (SWRCB), and California Department of Fish and Game (CDFG) conducted a pilot study to provide information on the levels of chemical contaminants in several media, including fish tissue, and to identify chemicals of potential concern (COPCs) for this fish consumption pathway (SFRWQCB, *et al.* 1995). Based on the results of the pilot study, the Office of Environmental Health Hazard Assessment (OEHHA) issued an interim health advisory for people consuming fish from San Francisco Bay. In 1997, the Regional Monitoring Program for Trace Substances in the San Francisco Bay (RMP) began monitoring fish contamination (SFEI 1999). The data and results of the 1994 and 1997 studies are presented in technical reports released in 1995 (SFRWQCB, *et al.* 1995) and 1999 (SFEI 1999), respectively.

Target sport fish species were selected in the 1994 study based on three criteria: 1) relative abundance; 2) feeding behavior and habitat ranges, and; 3) frequency of consumption by anglers. The 1997 study was planned to be consistent with the 1994 study and targeted species based on the same rationale. The following species were targeted for collection during both studies:

- White croaker (*Genyonemus lineatus*)
- Walleye (*Hyperprosopob argenteum*) or White surfperch (*Phanerdon furcatus*)
- Shiner Surfperch (*Cymatogaster aggregata*)
- Jacksmelt (*Atherinopsis californiensis*)
- Leopard shark (*Triakis semifasciata*) or Brown smoothhound shark (*Mustelus henlei*)
- Striped bass (*Morone saxatilis*)
- White sturgeon (*Acipenser transmontanus*)
- Halibut (*Paralichthys californicus*)

Geographic sampling locations were selected based on a number of considerations, including representation of the major geographic areas of the Bay and proximity to commonly fished shorelines or piers. The 1994 study evaluated fish collected from thirteen discrete stations: San Mateo Bridge; Dumbarton Bridge; Fremont Forebay; Richmond Inner Harbor (Friendship Shamada Park); Berkeley Pier; Oakland Inner Harbor (Fruitvale); Oakland Middle Harbor; Double Rock (Candlestick); Islais Creek; Point Molate; Rodeo Pier; San Francisco pier #7; and Vallejo Peir (Mare Island Strait). In the 1997 evaluation, samples were collected from seven locations including: South Bay Bridges; Oakland Harbor; San Francisco Waterfront; Berkeley Pier; San Pablo Bay; Davis Point; and Suisun Bay.

Composite samples were collected at each of the identified stations. Target numbers of fish per composite, target size ranges, and total numbers of composites per species were determined by

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prioritization based on species and abundance (SFRWQCB, *et al.* 1995; SFEI 1999). Each of the composite samples was analyzed for trace metals (*e.g.*, mercury), PAHs, PCBs, pesticides, and selective analysis of dioxins and furans. The samples for the smaller fish (*e.g.*, white croaker and surfperch) were analyzed with the skin on, while larger fish had the skin removed.

### A.2 Purpose of Statistical Evaluation

The purpose of this evaluation was to determine if spatial variations exist among specific locations within San Francisco Bay. Specifically, fillet tissue samples of white croaker (*Genyonemus lineatus*) with the skin-on were analyzed for mercury (Hg) and total PCBs (tPCB), as reported in the 1995 and 1999 technical reports (SFRWQCB, *et al.* 1995; SFEI 1999), to determine if spatial variations exist. This analysis attempts to address the issue of whether or not white croaker tissue results for Hg or tPCBs collected at a given location can be used to establish a link to Hg and tPCB concentrations in environmental media (*i.e.*, sediments) in the vicinity where the samples were collected. If spatial variations are observed, the hypothesis that concentrations of contaminants in white croaker tissue may be linked to the vicinity where fish were caught may be plausible. Alternately, if no significant spatial variations are observed, such a hypothesis may not be plausible. White croaker was selected for statistical analysis because the 1995 study labeled them “highest priority” (SFRWQCB, *et al.* 1995) and the 1995 and 1999 data for this species were the most complete (*i.e.*, largest sample sizes) for all sampling stations.

### A.3 Analysis of the 1995 and 1999 Technical Report Data

A comparison was made to assess the spatial and temporal differences in concentrations of total Hg and lipid-normalized tPCBs found in skin-on fillets of white croaker collected from different San Francisco Bay locations. These tissue residue data were generated as part of the SFRWQCB and RMP studies (SFRWQCB, *et al.* 1995; SFEI 1999). White croaker was sampled at the following stations during the two RMP sampling events:

| 1995                      | 1999                     |
|---------------------------|--------------------------|
| Double Rock (Candlestick) | Berkeley                 |
| Dumbarton Bridge          | Oakland                  |
| Islais Island             | San Pablo Bay            |
| Oakland Middle Harbor     | San Francisco Waterfront |
| Point Molate              |                          |
| Rodeo                     |                          |
| San Francisco Pier #7     |                          |
| San Mateo Bridges         |                          |
| Vallejo Mare Island       |                          |

For the analyses described below, significance testing was conducted using a test size of  $\alpha=0.05$ . For both sampling events, concentrations of Hg and tPCBs were found to be approximately lognormally distributed; hence, significance testing was conducted using ln-transformed values. In addition, geometric means (as opposed to arithmetic means) are reported since they are the more appropriate measure of central tendency for lognormal data.

### A.3.1 Analyses of 1995 Data

It was found that the average total length of fish comprising the composite samples was positively correlated with Hg content in fillets ( $R=0.940$ ) and also that length differed significantly among the nine sampling stations ( $P=0.0059$ ). These results suggested that any station differences in Hg content could be due in part to differences in the mean lengths of fish caught at different stations. Figure A-1 displays box-and-whisker plots of unadjusted (raw) total Hg concentrations in croaker fillets for the 1995 and 1999 sampling locations. For each location, the box encloses the interquartile range of the data (*i.e.*, the 25th and 75th percentiles) plus the median. In addition, the extended “whiskers” on each box show extremes of the data for that location.

An analysis of covariance was conducted to adjust for bias in Hg content attributable to average total length. The result of this analysis revealed that no significant differences existed in adjusted mean concentrations of Hg in fillets among the nine stations sampled in 1995 ( $P=0.348$ ). This result must be interpreted cautiously since the adjustments imparted an element of uncertainty and involved an extrapolation. For example, the mean total lengths of fish varied between approximately 17 – 33 cm, with an average of about 24 cm. All sample stations were adjusted for an average length fish of 24cm, even though some samples (*e.g.*, Islais Island and Rodeo) may not have contained fish of this length. The interpretation of the analysis is that the adjusted means have sufficient uncertainty that only large differences in Hg content could have been detected among the locations. The overall adjusted mean concentration of Hg in fillets for the nine stations combined was about 154  $\mu\text{g}/\text{kg}$  wet wt. with upper and lower 95% confidence bounds of 161  $\mu\text{g}/\text{kg}$  wet wt. and 147  $\mu\text{g}/\text{kg}$  wet wt., respectively (Table A-1). It was also found that mean total length of fishes was positively correlated with lipid-normalized tPCBs content ( $R=0.561$ ); however, the assumption was made that lipid-normalization was sufficient to account for size differences of fish among different sample locations and no analysis of covariance was conducted. Using a one-way analysis of variance, the concentration of lipid-normalized tPCBs in fillets did not differ significantly among the nine sampling stations ( $P=0.0636$ ). Figure A-2 displays box-and-whisker plots of lipid normalized tPCB concentrations in croaker fillets for the 1995 and 1999 data. The overall mean concentration of tPCBs in fillets for the nine stations combined was about 109  $\mu\text{g}/\text{kg}/1\%$  lipid with upper and lower 95% confidence bounds of 133  $\mu\text{g}/\text{kg}/1\%$  lipid and 90  $\mu\text{g}/\text{kg}/1\%$  lipid, respectively (Table A-2).

The conclusions of the analyses performed on the 1995 data are:

- 1) white croaker fish tissue concentrations for total Hg and lipid-normalized tPCBs do not differ significantly among sampling stations, and;
- 2) spatial variations in concentrations of Hg and tPCBs in San Francisco Bay sediments cannot account for concentrations reported in white croaker fish fillets.

### A.3.2 Analyses of 1999 Data

In compiling the 1999 data for analysis, it was found that one sample from each sampling location reported an average total fish length of greater than 60cm. These samples were not considered in the analysis since they were obvious outliers when compared to lengths represented in the remaining data, based on probability plotting. Fish of those lengths were considerably outside the range targeted by the RMP for sampling (up to 30cm) and were very likely outside the range typical for the species.

Unlike the 1995 data, there was no strong correlation evident between average total fish length and Hg content in fillets ( $R=0.473$ ). In addition, it was found that length did not vary significantly among the

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four locations ( $P=0.248$ ). An analysis of variance revealed no significant differences were evident in the Hg content of fillets among locations ( $P=0.515$ ). Figure A-1 displays box-and-whisker plots of individual sampling locations for total Hg concentrations in white croaker. For all stations combined, the mean concentration of Hg was approximately 207  $\mu\text{g}/\text{kg}$  wet wt. with upper and lower 95% confidence bounds of 238  $\mu\text{g}/\text{kg}$  wet wt. and 181  $\mu\text{g}/\text{kg}$  wet wt., respectively (Table A-1).

The concentration of tPCBs in white croaker fillets was found to differ significantly among the four sampling locations ( $P=0.034$ ). Figure A-2 displays box-and-whisker plots of individual sampling locations for lipid normalized tPCB concentrations in white croaker fillets. The mean concentration at the Oakland location (76  $\mu\text{g}$  tPCBs/kg/1% lipid) was significantly higher than at the San Pablo location (36  $\mu\text{g}$  tPCBs/kg/1% lipid). The Berkeley and Waterfront locations exhibited concentrations of 41  $\mu\text{g}$  tPCBs/kg/1% lipid and 51  $\mu\text{g}$  tPCBs/kg/1% lipid, respectively, and were statistically similar to the San Pablo location (Table A-2).

The conclusions of the analyses of Hg content in croaker fillets performed on the 1999 data are similar to those for the 1995 data. That is, Hg concentration in fillets does not differ significantly among sampling locations and hence, spatial variation in sediment concentrations cannot account for levels found in these tissues. However, sampling locations were significantly different for tPCBs in fillets with this difference being largely accounted for by the comparatively higher concentrations found at the Oakland location.

#### A.4 Interpretation of Data Analysis

In comparing results between the 1995 and 1999 sampling events, a preliminary conclusion is that the mean concentration of Hg in 1999 croaker fillets is significantly higher than the concentration in 1995 fillets since the associated 95% confidence limits do not overlap. However, the uncertainty in the 1995 analysis (*i.e.*, the adjustment in Hg content to account for the effect of length) does not strongly support this conclusion. The length adjustment had the effect of lowering the variance for the 1995 data, resulting in a narrower confidence interval than would otherwise have been calculated. In addition, there were fewer stations sampled in 1999 and there was little spatial overlap of sampling stations between the two sampling events. Given these differences and uncertainties, a much more plausible conclusion may be that there is insufficient data to support the claim that Hg content increased from 1995 to 1999.

The concentration of tPCBs in white croaker fillets collected in 1999 was found to differ significantly among sampling locations, largely due to the comparatively higher concentrations found at the Oakland location. However, inspection of Table A-2 and Figure A-2 reveals that tPCB concentration at the Oakland location in 1999 did not differ significantly from the mean concentration found in 1995 for the overall data. Similarly, the San Pablo location sampled in 1999 is not significantly different from the overall mean concentration of 1995. These conclusions are supported by the fact that the confidence interval for the 1995 combined data overlaps the intervals obtained for the Oakland and San Pablo locations. Hence, for these locations, the concentration of tPCBs in fillets does not differ from concentrations found in 1995.

The confidence intervals for the remaining two 1999 locations (Berkeley and San Francisco Waterfront) do not overlap with those of the combined 1995 data. While concentrations of tPCBs in fillets collected from these locations are not statistically different than concentrations from the San Pablo location, they are significantly lower than the mean concentration found in the combined 1995 data.

### **A.5 Summary of Results**

The results of the data analysis of total Hg and lipid-normalized tPCB concentrations in white croaker fillets reported in the 1995 and 1999 RMP reports indicate the following:

- No spatial variations exist in the 1995 data for Hg and tPCB content in white croaker fillets that would support linking tissue residues to contaminant concentrations at specific locations in San Francisco Bay;
- Spatial variations do exist in the 1999 data for tPCBs in white croaker fillets, largely due to comparatively higher concentrations found at the Oakland location than were found at the San Pablo, Berkeley, and San Francisco Waterfront locations. This finding appears to support a link between historically higher levels of contamination in Oakland Harbor sediments and tissue residues at the Oakland location. However, it is also evident that the Oakland and San Pablo locations are not significantly different than overall mean tissue concentration of the 1995 data.
- The lowest concentrations of tPCBs from either sampling event occurred in fillet samples obtained in 1999 from the Berkeley and Waterfront locations. It remains to be determined if correspondingly low tPCB concentrations are also associated with sediments at these locations.

In general, the data do not support a spatial link between sediment concentrations of Hg and tPCBs and tissue residues in white croaker.

### **A.6 Uncertainty Analysis**

As with any environmental study, uncertainties are always associated with the results of data analyses. These uncertainties arise from inherent variability in natural ecosystems, physiological differences among individuals comprising a sample, sampling error, and errors in analytical measurements. Minimizing the uncertainty associated with ecosystem variation must be addressed by designing an adequate sampling program (including numbers of samples) that accounts for both temporal and spatial effects on the measurement endpoint in question. Analytical measurement error should always be minimized through careful laboratory procedures and proper Quality Control and Quality Assurance practices. In the case of measuring contaminant levels in tissues, physiological differences among individuals should be addressed by restricting samples to specific age-classes of the species.

There are several sources of uncertainty associated with results of the statistical analyses, which are presented below:

- There was a strong positive correlation between average fish length and Hg content in white croaker fillets obtained in 1995. In addition, fish length varied significantly among locations. These results suggest that more than a single age-class of croaker was sampled in 1995 and that age-classes varied among sampling locations. An analysis of covariance was necessary to properly account for differences in Hg content of fillets but such an analysis imparted uncertainty to the comparison of locations because of having to adjust concentrations for bias imparted by differences in fish length.
- Composite samples sizes at some locations in the 1995 and 1999 surveys were generally too low (n=3) for estimation of highly reliable confidence intervals. These survey data could be used to estimate sample sizes needed in future sampling events where comparison of locations is intended.

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- Locations that were sampled in 1995 were not sampled again in 1999, limiting the ability to compare tissue residues among sampling events. A consistent sampling design needs to be adopted so that such limitations can be eliminated and more straightforward comparison can be made between locations and sampling events.
- White croaker is a far ranging species and would not be expected to exhibit fidelity to a particular sampling location. Hence, contaminant concentrations in fillets would not be expected to correspond to concentrations found in sediments at a specific location.

**A.7 References**

SFRWQCB, SWRCB, and CDFG. 1995. Contaminant levels in fish tissue from San Francisco Bay. Final Report. San Francisco Regional Water Quality Control Board, State Water Resources Control Board, and California Department of Fish and Game. June.

SFEI. 1999. Contaminant Concentrations in Fish from San Francisco Bay, 1997. A technical report of the San Francisco Estuary Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute, Richmond, CA. May.

SCCWRP and MBC, 1994. Santa Monica Bay Seafood Consumption Study: Final Report. Southern California Coastal Water Research Project and MBC Applied Environmental Sciences, Westminster and Costa Mesa, CA. June, 1994.

**Table A-1. Mean Hg Concentrations for RMP 1995 and 1999 Data Plus The Associated Upper and Lower 95% Confidence Limits (UCL and LCL, Respectively)**

|                           | <b>95% LCL<br/>(µg/kg)</b> | <b>Mean<br/>(µg/kg)</b> | <b>95% UCL<br/>(µg/kg)</b> |
|---------------------------|----------------------------|-------------------------|----------------------------|
| Hg 1995 (length adjusted) | 147                        | 154                     | 161                        |
| Hg 1999                   | 181                        | 207                     | 238                        |

**Table A-2. Mean Total PCB Concentrations for RMP 1995 and 1999 Data Plus the Associated Upper And Lower 95% Confidence Limits (UCL and LCL, Respectively)**

|                              | <b>95% LCL<br/>(µg/kg/1% lipid)</b> | <b>Mean<br/>(µg/kg/1% lipid)</b> | <b>95% UCL<br/>(µg/kg/1% lipid)</b> |
|------------------------------|-------------------------------------|----------------------------------|-------------------------------------|
| tPCB 1995<br>(all locations) | 90                                  | 109                              | 133                                 |
| tPCB 1999                    | --                                  | --                               | --                                  |
| Oakland                      | 43                                  | 76                               | 133                                 |
| San Pablo                    | 11                                  | 36                               | 113                                 |
| Berkeley                     | 31                                  | 41                               | 53                                  |
| Waterfront                   | 35                                  | 51                               | 73                                  |

# Total Hg in Croaker Filets

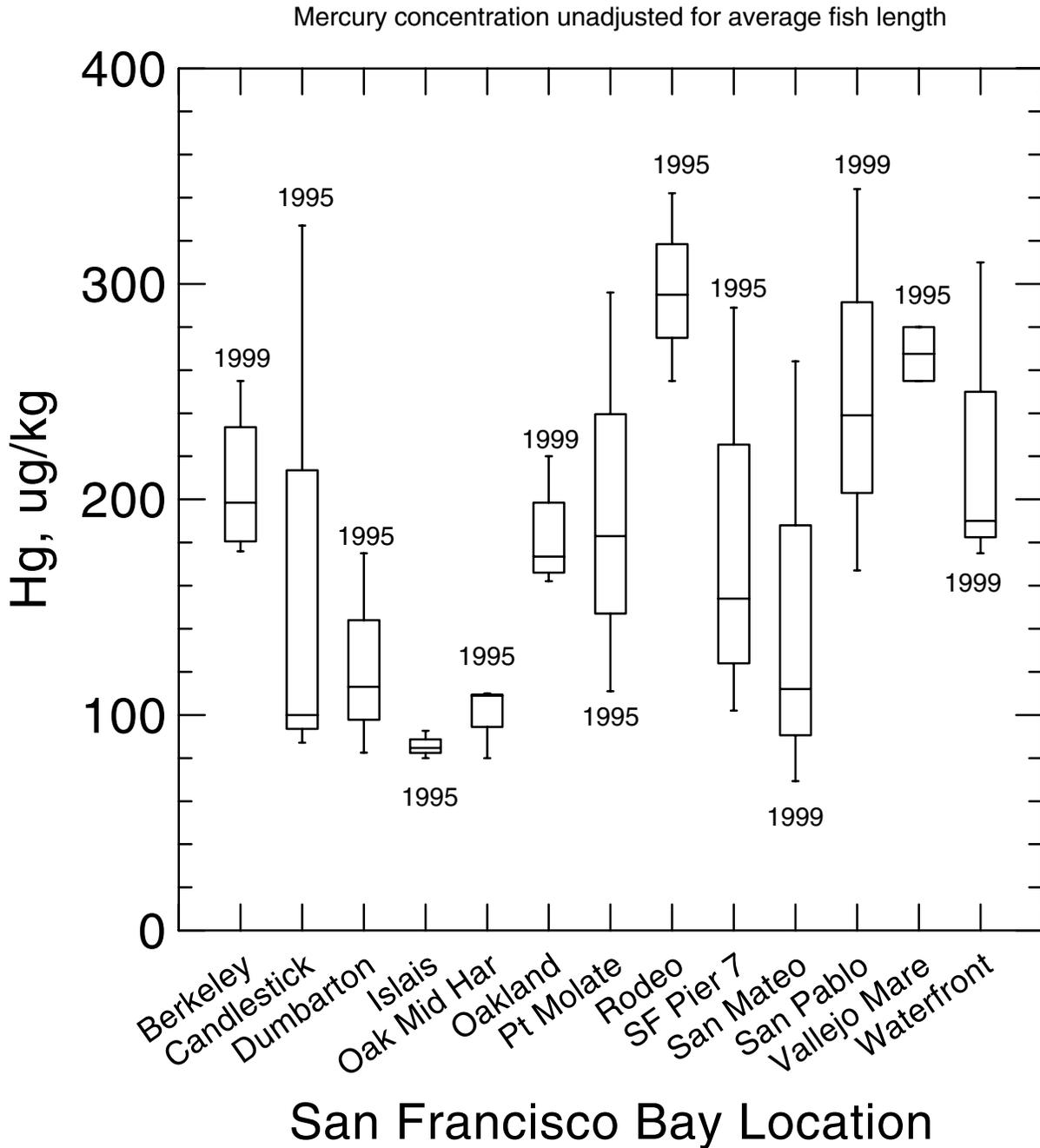


Figure A-1. Boxplots of Mercury Concentrations Unadjusted for Average Fish Lengths by Location, for 1995 and 1999 RMP Reported Datasets

## Total PCBs in Croaker Filets

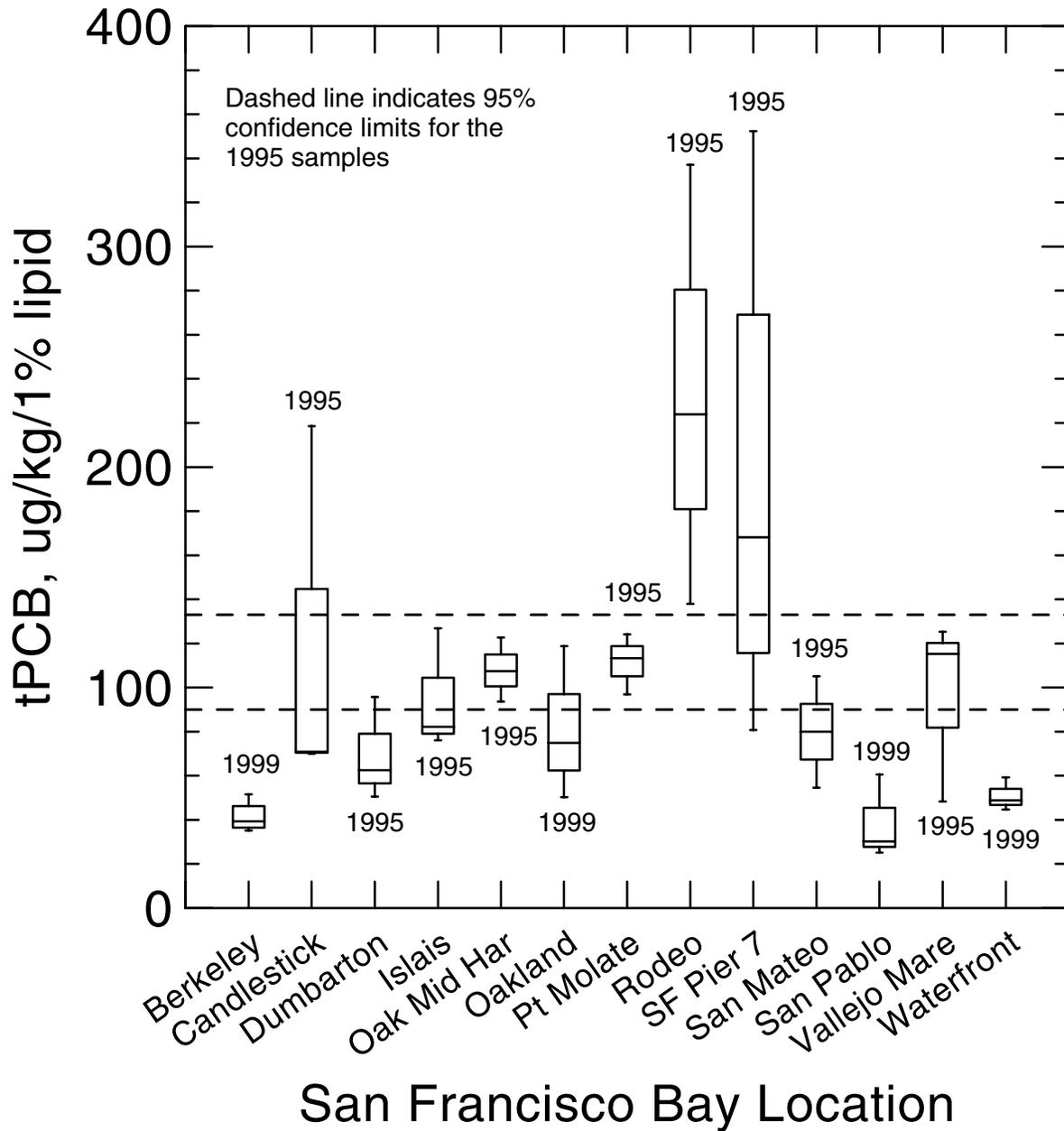


Figure A-2. Boxplots of Lipid Normalized Total PCB Concentrations by Sampling Locations for 1995 and 1999 RMP Reported Datasets.

**ATTACHMENT B**

**Abundance and Distribution of Species in the Recreational Fisheries of San Francisco Bay**

## **B.1 Introduction**

The San Francisco Bay/Estuary provides habitat for over 100 marine, estuarine and anadromous fish species (Smith and Kato 1979; Moyle 1976; Miller and Lea 1972). During the past 5 years (1993-1997), over 40 species have been recorded in the recreational fisheries for the inland marine waters of northern California, which primarily consists of San Francisco Bay (NMFS 1999). A summary of these species is provided in Table B-1. Almost 90 percent of the recreational catch during the past 5 years has been comprised of about a dozen species (or species groups). In order of abundance, these species include jacksmelt, sharks, white croaker, surfperch, striped bass, California halibut, sculpin, northern anchovy, rockfish, Pacific herring, sturgeon, and salmon. It should be noted that the abundance of these species is based on the most current 5-year record of recreational catch, and other references may provide different results based on differences in seasonal and annual abundance, historic and recent shifts in recreational catch, and record-keeping methods. A summary of the abundance of the primary species in the recreational catch records is provided in Table B-2. These recreational catch records are summarized by the method/location of fishing (*i.e.*, boat-based, shored-based, or manmade structure). Manmade structures include piers, jetties, and breakwaters.

The potential degree of exposure of these species to contaminants in specific areas around San Francisco Bay varies based on the general area of the San Francisco Bay typically occupied by the species, specific habitat utilization, and life histories.

## **B.2 San Francisco Bay**

In general, the Bay can be divided into three general areas depending on hydrology: North Bay, Central Bay, and South Bay. Table B-1 includes a qualitative summary of the relative abundance of recreational species in the three general areas of San Francisco Bay.

### **B.2.1 North Bay**

The North Bay (*i.e.*, San Pablo Bay) extends from Carquinez Straits (northeast) downstream to the Richmond-San Rafael Bridge (south). San Pablo Bay is characterized by extensive shallow water habitat, eelgrass habitat and a variable salinity regime resulting from wide fluctuations in freshwater inflow primarily from the Sacramento-San Joaquin river system. The fish assemblage of San Pablo Bay varies seasonally as a result of reproductive cycles and the volume of freshwater inflow (Armor and Herrgesell 1985; Herbold *et al.* 1992). The most abundant species is northern anchovy, but the fish composition is comprised largely of marine species when inflow is relatively low (*i.e.*, fall or dry years), and by estuarine species when freshwater inflow is relatively high (*i.e.*, spring or wet years; Herbold *et al.* 1992). The marine species include white croaker, jacksmelt, and shiner perch. Estuarine species include staghorn sculpin, and striped bass.

San Pablo Bay is seasonally used by several species of anadromous fish, including chinook salmon, striped bass, and white and green sturgeon. These species may utilize the Bay as seasonal habitat and/or a migration route during spawning runs. The abundance of many of the estuarine species that inhabit San Pablo Bay (striped bass, sturgeon, and sculpin) has decreased substantially in recent years. This decrease in estuarine species has coincided with increases in marine species, such as white croaker, which have increased in number with reductions in freshwater inflow and subsequent increases in salinity.

### **B.2.2 Central Bay**

The Central Bay is bordered by the Richmond-San Rafael Bridge in the north, the Bay Bridge in the south, and the Golden Gate Bridge in the west. The Central Bay is characterized by relatively deep, well-

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mixed marine habitat. The species diversity of the Central Bay is relatively high since it provides habitat for marine, estuarine and anadromous species. CDFG trawl surveys in the Central Bay are dominated by pelagic species (northern anchovy, Pacific herring and jacksmelt; Herbold *et al.* 1992). Shiner perch, northern anchovy, English sole and white croaker dominate the fish assemblage in otter trawl surveys. Anadromous species are transient in the Central Bay, inhabiting the Central Bay during spawning and juvenile migrations.

### **B.2.3 South Bay**

The South Bay is the portion of San Francisco Bay south of the Bay Bridge. Most of the South Bay is characterized by shallow water habitat with relatively little fluctuation in the salinity regime due to limited freshwater inflow. The fish assemblage of the South Bay is characterized by marine species and estuarine fishes that inhabit shallow water habitat. Pearson (1989) found that northern anchovy comprised an average of 62 percent of the fish, followed by English sole (16 percent), and shiner perch (14 percent). Herbold *et al.* (1992) report that the most common pelagic species collected in CDFG mid-water trawls were northern anchovy, jacksmelt, Pacific herring, and shiner perch. The most common fish collected during CDFG otter trawl surveys were northern anchovy, shiner perch, bay goby, and white croaker.

## **B.3 Habitat Types**

Habitat types of San Francisco Bay include deepwater habitat, eelgrass beds, river mouths, and tidal mudflats and channels. Deepwater habitats of San Francisco Bay are inhabited by pelagic species such as northern anchovy and Pacific herring, and demersal fish such as California halibut. Eelgrass beds provide habitat for various life stages for a wide range of species. They are utilized for spawning (*e.g.*, Pacific herring, shiner perch and topsmelt), rearing (*e.g.*, northern anchovy, Pacific herring and flatfishes), and feeding (sturgeon, bat rays, and leopard sharks). Tidal mudflats are primarily utilized as feeding habitat for species such as sturgeon, leopard sharks and white croaker. Tidal channels are utilized primarily for migration between deepwater and mudflats or eelgrass beds by species such as sturgeon, leopard sharks and flatfishes.

## **B.4 Primary Species of the Recreational Fisheries**

Life history, distribution, and habitat preferences for the primary species in the recreational fisheries are provided below. These species represent pelagic species (*e.g.*, northern anchovy, Pacific herring, and striped bass), and demersal fishes (*e.g.*, sharks, sculpins, and California halibut). In addition, these species include fish that largely feed on primary productivity (*e.g.*, jacksmelt), invertebrates (*e.g.*, surfperches), and fish (*e.g.*, California halibut).

### **B.4.1 Jacksmelt**

Jacksmelt are one of the more common fish in San Francisco Bay, especially in turbid water. Jacksmelt seasonally utilize the Bay from spring through fall (Wang 1986). The species tends to concentrate at depths between 1.5 and 15 m, and may be found in relatively large schools (Feder *et al.* 1974). Adults are typically found over sandy bottoms, and feed on algae, crustaceans, and detritus (Feder *et al.* 1974). The volume of freshwater entering the Bay influences the distribution of jacksmelt resulting in higher abundance of jacksmelt in Central and South Bay during high Sacramento River flow, and increased abundance in the North Bay during periods of low inflow. Jacksmelt are the most abundant species in the recreational fisheries accounting for approximately 18 percent of the total catch (NMFS 1999). The majority of jacksmelt are captured by fishing from manmade structures (over 70 percent).

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#### **B.4.2 Sharks**

Sharks that inhabit San Francisco Bay include brown smoothhound, leopard shark, sevengill, and dogfish shark (Smith and Kato 1972). Leopard shark and brown smoothhound are the most common shark species in San Francisco Bay with the greatest abundance in the South Bay (Ebert 1986). The two species are typically found in relatively shallow water with a sand or mud substrate (Love 1991; Eschemeyer *et al.*, 1983; Feder *et al.* 1974). These sharks typically feed on benthic and epibenthic crustacea and fish (Eschemeyer *et al.* 1983; Russo 1975). There is an active recreational fishery for leopard sharks in San Francisco Bay, and sharks account for approximately 17 percent of the total recreational catch (NMFS 1999). Over 90 percent of the shark catch is from charter and private boats.

#### **B.4.3 White croaker**

The white croaker is generally an epibenthic species, although it may be found in midwater or near the surface (Love 1991). The species is a schooling fish, and is generally found in shallow water with a sand bottom (Eschemeyer *et al.* 1983). Adult white croaker feed primarily on fish and epibenthic invertebrates. The species is common in San Francisco Bay, and accounts for over 15 percent of the recreational catch (NMFS 1999). The species is sometimes considered a nuisance species, and is often captured incidentally. However, the catch is utilized for human consumption (Love 1991). Almost all white croaker are caught from boats (67 percent) or manmade structures (almost 30 percent).

#### **B.4.4 Surfperches**

There are 18 surfperch species along the coast of California and approximately a dozen surfperch species inhabit San Francisco Bay. Smith and Kato (1972) reported the most common surfperches in San Francisco Bay were pile perch, black perch, and shiner perch. Surfperch identified in the recreational catch in recent years include barred surfperch, black perch, pile perch, redbait surfperch, shiner perch, silver surfperch, striped seaperch, walleye surfperch, and white seaperch. In general, surfperches are found in relatively shallow water in association with rocky outcroppings, structures, and/or the surfzone. They typically feed on macroinvertebrates. Similar to the rockfishes, the most common surfperch in the recreational fisheries during the past 5 years was “other surfperches.” Of the surfperches that were identified to species, the most common species was the shiner perch. The shiner perch is typically found in calm, shallow water associated with piers or eelgrass beds (Moyle 1976; Eschemeyer *et al.* 1983). Shiner perch caught in the Bay are used as bait and as food (Smith and Kato 1979; Love 1991). The fishery for surfperch is spread throughout the Bay and occurs throughout the year. The recreational catch of surfperch accounts for 10 percent of the total recreational catch, and fishing occurs from manmade structures (44 percent), shore (29 percent), and boats (27 percent).

#### **B.4.5 Striped Bass**

Striped bass are an introduced species found throughout the San Francisco Bay/Estuary during various life stages. Striped bass appear to spend the majority of their adult life within the San Francisco Bay/Estuary (Emmett *et al.* 1991). Adult fish are generally pelagic, and feed on fish and invertebrates. They have considerable tolerance for a wide range of temperature, salinity, and dissolved oxygen levels (Moyle 1976). They may be found in shallow or relatively deep water over rock, sand, or mud substrates. There has been a substantial decline in the striped bass population in recent years that may be related to freshwater diversions in the Delta, reduced freshwater outflow, increased toxicity in Bay and Delta habitats, and reduced egg production (CDFG 1992). There is an active recreational fishery for striped bass focused in the Central Bay and San Pablo Bay. The fishery is most intensive during the upstream migration period. Striped bass account for approximately 8 percent of the recreational catch with the majority of fish captured by boat (86 percent; NMFS 1999).

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**B.4.6 California halibut**

The California halibut is the most common flatfish reported in the recreational fishery of San Francisco Bay. However, the species is considered rare in the Bay (Emmett *et al.* 1991). The species is found on sand substrate primarily in the Central Bay where it feeds on fish (Herbold *et al.* 1992; Eschemeyer *et al.* 1983). There is a very active recreational fishery targeting California halibut. Although the species is considered rare and the residence in the Bay is relatively short, the recreational catch of the species accounts for 6 percent of the total recreational catch in San Francisco Bay (NMFS 1999). The large majority of California halibut are captured from boats (over 97 percent) primarily in the Central Bay.

**B.4.7 Sculpins**

There are approximately 40 sculpin species along the Pacific coast. Most species are demersal fish and inhabit shallow water habitat. The species are generally smaller than approximately 8 inches in length. The Pacific staghorn sculpin is the most common sculpin species in San Francisco Bay (Herbold *et al.* 1992; Armor and Hergesell 1985). They are generally found in shallow water with sandy substrate, and adults feed on fish and crustaceans (Emmett *et al.* 1991; Love 1991). Sculpins comprise approximately 5 percent of the recreational catch (NMFS 1999). Sculpins are captured from manmade structures (50 percent), boats (28 percent), and shore (22 percent). Due to their small size and ready capture, sculpins are incidentally caught in the recreational fishery, and are used primarily for bait (Love 1991; Reish 1968). The only sculpin species typically targeted in the recreational fishery is the cabezon. The cabezon inhabits shallow water, and prefers rock substrate (Love 1991). The cabezon comprises less than 1 percent of the recreational fishery (NMFS 1999).

**B.4.8 Northern Anchovy**

Northern anchovy are typically the most abundant fish species in the Bay, especially in the Central Bay. Northern anchovy have been found to comprise between about 60 and 95 percent of the Bay's fish assemblage (Aplin 1967; Pearson 1989). Northern anchovy are pelagic species that use the Bay primarily for feeding. They feed primarily on zooplankton and phytoplankton in the water column (Love 1991). Northern anchovy are one of the most important prey fish in the Bay. Northern anchovy comprise approximately 3 percent of the recreational catch with most fish captured from manmade structures (over 90 percent; NMFS 1999). Over 98 percent of the catch is used for bait (Love 1991).

**B.4.9 Rockfishes**

There are over 60 species of rockfish along the Pacific coast, and 11 species have been reported in the recreational fisheries of San Francisco Bay in the past 5 years (Eschemeyer *et al.* 1983; NMFS 1999). These include black, blue, bocaccio, brown, canary, chilipepper, copper, olive, quillback, widow, and yellowtail rockfish. The greatest abundance of rockfish in the NMFS database is categorized as "other rockfishes." The most abundant species in the recreational fisheries of San Francisco Bay appear to be blue, black, and brown rockfish. The life history of rockfish in general, and these species in particular, is quite varied (Love 1991; Eschemeyer *et al.* 1983). They may be found at depths from the surface to over 1,000 feet, and over rock, sand, or mud habitat. They tend to school at times, and remain solitary at other times. In general, they are marine species and the greatest abundance is in the Central Bay. According to NMFS (1999), rockfishes comprise about 2 percent of the recreational catch of San Francisco Bay and are captured from boats (52 percent), shore (29 percent), and manmade structures (19 percent).

#### **B.4.10 Pacific Herring**

Pacific herring are one of the most abundant fish species in San Francisco Bay. Pacific herring utilize the Bay habitat for spawning between November and March. Most spawning occurs in intertidal and shallow habitat in the vicinity of the San Francisco waterfront, Oakland-Alameda, and the Tiburon Peninsula (Spratt *et al.* 1992). Pacific herring are seasonally found throughout most habitat types of San Francisco Bay (Herbold *et al.* 1992). They feed on zooplankton near the water surface (Love 1991). Pacific herring are important prey for birds and other fish (Love 1991). The recreational catch of Pacific herring comprises about 2 percent of the total catch with almost all of the catch from manmade structures (over 99 percent; NMFS 1999). The majority of the catch is used for bait although there is some human consumption (Emmett *et al.* 1991).

#### **B.4.11 Sturgeon**

There are two species of sturgeon that inhabit San Francisco Bay: the white sturgeon and the green sturgeon. The two species have similar life histories and habitat preferences. Adult sturgeon are typically found along the bottom in subtidal habitats (Emmett *et al.* 1991; Love 1991). Sturgeon typically feed on benthic and epibenthic invertebrates and fish (Radtke 1966). Sturgeon may live as long as 100 years (Emmett *et al.* 1991; Love 1991). The recreational fishery targets the white sturgeon, and green sturgeon may incidentally be captured in the white sturgeon fishery. Sturgeon only comprise about 1 percent of the recreational catch (NMFS 1999). The recreational fishery for white sturgeon is primarily focused in San Pablo Bay with almost all sturgeon captured by charter and private boats (99 percent).

#### **B.4.12 Salmon**

The salmon fishery in San Francisco Bay focuses primarily on fall-run chinook salmon since other species have been protected under the Endangered species Act (ESA; *e.g.*, coho salmon, winter-run chinook salmon). Chinook salmon utilize the Bay as a migration corridor primarily during fall (upstream migration of adults) and the spring and early summer (downstream migration of juveniles). Salmon are most prevalent in the Central and North Bay as they migrate from and to the Sacramento-San Joaquin River system. Chinook salmon historically supported a significant commercial and sportfishery; however, declines in native populations have resulted in the fall-run chinook salmon being proposed for listing under the ESA. In recent years, the salmon fishery only accounts for 0.2 percent of the recreational fishery in San Francisco Bay (NMFS 1999), and this fishery will decrease or possibly disappear completely due to additional population declines and potential ESA listings. During the past 5 years, almost half of the recreational salmon catch has been from boats (47 percent) with substantial capture from manmade structures (29 percent) and shore-based fishing (24 percent).

### **B.5 Home/Foraging Ranges for Recreational Sport Fish Species**

Table B-3 presents a summary of food habits and movements of several primary recreational sport fish species. Based on the movement patterns of several recreational sport fish species, it is clear that home/foraging ranges for these species cover a large span of area; larger than any one Naval facility. For example, white croaker's migratory pattern includes the entire Bay Region. Depending on the season and age of the species, they can be found in various Bay locations. They spawn in the Gulf of the Farallones and Central Bay during the Spring. Juveniles migrate out of the Bay in the Fall and re-enter and congregate in the South Bay in May. In addition, adult croakers reside in different areas depending on the salinity.

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Table B–1. Summary of Fishes Captured in the Recreational Fisheries of San Francisco Bay

| NAME                |                                 | UTILIZATION | RELATIVE ABUNDANCE <sup>1</sup> |                  |                  |
|---------------------|---------------------------------|-------------|---------------------------------|------------------|------------------|
| Common              | Scientific                      |             | North Bay                       | Central Bay      | South Bay        |
| Northern anchovy    |                                 |             |                                 |                  |                  |
| Dogfish shark       | <i>Squalus acanthias</i>        | R           | U                               | U                | U                |
| Other sharks        | Unknown genera/species          | R,S         | -                               | -                | -                |
| Skates/rays         | Unknown genera/species          | R           | A                               | A                | H                |
| Pacific tomcod      |                                 |             |                                 |                  |                  |
| Queenfish           | <i>Seriphus politus</i>         | R           | U                               | U                | U                |
| White croaker       | <i>Genyonemus lineatus</i>      | R           | C                               | A                | A                |
| Other croakers      | Unknown genera/species          |             | -                               | -                | -                |
| California halibut  |                                 |             |                                 |                  |                  |
| Speckled sanddab    | <i>Citharichthys stigmaeus</i>  | R           | A                               | A                | A                |
| Starry flounder     |                                 |             |                                 |                  |                  |
| Other flounders     | Unknown genera/species          |             | -                               | -                | -                |
| Kelp greenling      |                                 |             |                                 |                  |                  |
| Lingcod             | <i>Ophiodon elongatus</i>       | S/R         | U                               | U                | U                |
| Other greenlings    | Unknown genera/species          | R           | -                               | -                | -                |
| Pacific herring     |                                 |             |                                 |                  |                  |
| Jacks               | Unknown genera/species          |             | -                               | -                | -                |
| Black rockfish      |                                 |             |                                 |                  |                  |
| Blue rockfish       | <i>Sebastes mystinus</i>        | R           | U                               | C                | U                |
| Boccaccio           | <i>Sebastes paucispinis</i>     |             | U                               | U                | U                |
| Brown rockfish      | <i>Sebastes auriculatus</i>     | R           | U                               | C                | U                |
| Canary rockfish     | <i>Sebastes pinniger</i>        |             | U                               | U                | U                |
| Chilipepper         | <i>Sebastes goodei</i>          |             | U                               | U                | U                |
| Copper rockfish     | <i>Sebastes caurinus</i>        |             | U                               | U                | U                |
| Olive rockfish      | <i>Sebastes serranoides</i>     |             | U                               | U                | U                |
| Quillback rockfish  | <i>Sebastes maliger</i>         |             | U                               | U                | U                |
| Widow rockfish      | <i>Sebastes entomelas</i>       |             | U                               | U                | U                |
| Yellowtail rockfish | <i>Sebastes flavidus</i>        |             | U                               | U                | U                |
| Other rockfish      | <i>Sebastes spp.</i>            |             | -                               | -                | -                |
| Sculpin             | Unknown genera/species          | R           | H <sup>2</sup>                  | H <sup>2</sup>   | A <sup>2</sup>   |
| Cabezon             |                                 |             |                                 |                  |                  |
| Halfmoon            | <i>Medialuna californiensis</i> |             | U                               | U                | U                |
| Kelp bass           | <i>Parabalax clathratus</i>     |             | U                               | U                | U                |
| Barred sand bass    | <i>Parabalax nebulifer</i>      |             | U                               | U                | U                |
| Other sea basses    | Unknown genera/species          |             | -                               | -                | -                |
| Jacksmelt           |                                 |             |                                 |                  |                  |
| Other silversides   | Unknown genera/species          | R           | -                               | -                | -                |
| Sturgeon            | <i>Acipenser spp.</i>           | M           | A/U <sup>3</sup>                | A/U <sup>3</sup> | C/U <sup>3</sup> |
| Barred surfperch    |                                 |             |                                 |                  |                  |
| Black perch         | <i>Embiotica jacksoni</i>       | R           | U                               | C                | C                |
| Pile perch          | <i>Damalichthys vacca</i>       | R           | U                               | C                | C                |

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| NAME<br>Common    | Scientific               | UTILIZATION | RELATIVE ABUNDANCE <sup>1</sup> |             |           |
|-------------------|--------------------------|-------------|---------------------------------|-------------|-----------|
|                   |                          |             | North Bay                       | Central Bay | South Bay |
| Redtail surfperch | Amphitichus rhodoterus   | R           | U                               | U           | U         |
| Shiner perch      | Cymatogaster aggregata   | R           | H                               | H           | A         |
| Silver surfperch  | Hyperprosopon ellipticum | R           | U                               | C           | C         |
| Striped seaperch  | Embiotica lateralis      | R           | U                               | U           | U         |
| Walleye surfperch | Hyperprosopon argenteum  | R           | U                               | U           | A         |
| White seaperch    | Phanerodon furcatus      | R           | U                               | U           | U         |
| Other surfperches | Unknown genera/species   | R           | -                               | -           | -         |
| Striped bass      |                          |             |                                 |             |           |
| Tuna/mackerels    | Unknown genera/species   |             | U                               | U           | U         |

Based on the NMFS Marine Recreational Fisheries Statistics Survey for the inland waters of northern California (1993-1997; NMFS 1999).

Relative abundance primarily based on Emmett *et al.* 1991, Herbold *et al.* 1992, and SFRWQCB 1995 trawl data

(H=Highly abundant; A=abundant; C=Common; and U=Uncommon). Utilization of the Bay is generally based on ENTRIX 1997 and Herbold *et al.* 1992, (R=resident, S/R=spawning/rearing, M=migrational corridor, S=seasonal)

<sup>1</sup> Relative abundance is a qualitative value based on the relative occurrence of the species compared primarily to other locations and secondarily to other species.

<sup>2</sup> Pacific staghorn sculpin are abundant to highly abundant throughout the Bay. The abundance of other sculpin species is varied, but is generally lower.

<sup>3</sup> White sturgeon are relatively abundant or common. The green sturgeon is relatively rare.

<sup>4</sup> Adults are seasonally common during spawning season, larvae and juveniles utilize the estuary for rearing.

**Table B-2 Summary of the Primary Species Caught by the Recreational Fisheries in San Francisco Bay Based on NMFS Records, 1993-1997; Recreational Fisheries are Divided into Manmade (Piers, Jetties and Breakwaters), Shore (Bank or Beach), or Boat (Party or Private)**

| SPECIES               | 1993    |       |        | 1993    | 1994    |       |        | 1994   | 1995    |       |        | 1995   | 1996    |       |       | 1996    | 1997    |         |       | 1997  | ANNUAL AVERAGE |         |           |      |
|-----------------------|---------|-------|--------|---------|---------|-------|--------|--------|---------|-------|--------|--------|---------|-------|-------|---------|---------|---------|-------|-------|----------------|---------|-----------|------|
|                       | Manmade | Shore | Boat   | Total   | Manmade | Shore | Boat   | Total  | Manmade | Shore | Boat   | Total  | Manmade | Shore | Boat  |         | Total   | Manmade | Shore | Boat  |                | Total   | Number    | %    |
|                       |         |       |        |         |         |       |        |        |         |       |        |        |         |       | Party | Private |         |         |       | Party | Private        |         |           |      |
| Northern anchovy      | 98852   |       | 2174   | 101026  |         | 2354  |        | 2354   | 5258    | 2914  |        | 8172   | 116010  |       |       | 12941   | 128951  | 24126   |       |       | 4701           | 28827   | 53866     | 3.2  |
| Shark spp.            | 30610   | 12101 | 476374 | 519085  | 6641    | 486   | 203225 | 210352 | 6717    | 2248  | 324164 | 333129 | 6599    | 6255  | 474   | 188432  | 201760  | 13099   | 2816  | 3117  | 136611         | 155643  | 283993.8  | 17.0 |
| Salmon spp.           | 2500    | 3200  | 700    | 6400    | 100     | 400   | 1400   | 1900   | 300     | 600   | 2000   | 2900   | 1100    | 400   | 0     | 3900    | 5500    | 1500    |       |       | 1000           | 2500    | 3840      | 0.2  |
| White croaker         | 102395  | 5199  | 252435 | 360029  | 58711   |       | 94375  | 153086 | 64418   | 2735  | 112067 | 179220 | 97506   | 38546 | 377   | 185608  | 322037  | 57474   |       | 19519 | 204535         | 281528  | 259180    | 15.5 |
| California halibut    | 1529    |       | 14633  | 16162   | 737     | 371   | 48039  | 49147  | 1238    | 3197  | 291072 | 295507 | 6344    | 656   | 2942  | 104753  | 114695  | 1314    |       | 8001  | 37675          | 46990   | 104500.2  | 6.2  |
| Pacific herring       | 49877   |       | 707    | 50584   | 1447    |       |        | 1447   | 1004    |       |        | 1004   | 97737   |       |       |         | 97737   | 242     |       |       |                | 242     | 30202.8   | 1.8  |
| Rockfishes            | 18212   | 13085 | 16518  | 47815   | 3995    | 1997  | 1764   | 7756   | 4173    | 9934  | 17779  | 31886  | 7261    | 31705 | 11102 | 32299   | 82367   | 5593    | 1359  |       | 24792          | 31744   | 40313.6   | 2.4  |
| Sculpin               | 44074   | 21193 | 19526  | 84793   | 14378   | 1932  | 7372   | 23682  | 41074   | 34048 | 30628  | 105750 | 47765   | 24413 |       | 33417   | 105595  | 73640   | 14240 | 9799  | 21483          | 119162  | 87796.4   | 5.2  |
| Jacksnelt             | 532051  | 99320 | 10234  | 641605  | 46739   | 4987  | 14162  | 65888  | 195592  | 54596 | 44265  | 294453 | 264836  | 47237 |       | 56829   | 368902  | 36374   | 59337 |       | 4193           | 99904   | 294150.4  | 17.6 |
| Sturgeon              | 564     |       | 20520  | 21084   |         |       | 1608   | 1608   | 315     |       | 43300  | 43615  |         |       | 863   | 9400    | 10263   |         |       | 5577  | 11201          | 16778   | 18669.6   | 1.1  |
| Surfperches           | 83794   | 38048 | 48436  | 170278  | 34205   | 4799  | 13083  | 52087  | 58719   | 43293 | 88725  | 190737 | 91611   | 96539 |       | 48361   | 236511  | 103477  | 60260 |       | 23062          | 186799  | 167282.4  | 10.0 |
| Striped bass          | 4573    | 1898  | 90342  | 96813   | 5313    | 14983 | 88387  | 108683 | 4994    | 13495 | 128236 | 146725 | 11551   | 14082 | 2436  | 140505  | 168574  | 11267   | 13126 | 20835 | 116736         | 161964  | 136551.8  | 8.2  |
|                       |         |       |        |         |         |       |        |        |         |       |        |        |         |       |       |         |         |         |       |       |                |         |           |      |
| PRIMARY SPECIES CATCH |         |       |        | 2115674 |         |       |        | 677990 |         |       |        |        | 1633098 |       |       |         | 1842892 |         |       |       |                | 1132081 | 1480347   |      |
| TOTAL CATCH           |         |       |        | 2339696 |         |       |        | 796283 |         |       |        |        | 1794238 |       |       |         | 2062906 |         |       |       |                | 1377359 | 1674096.4 |      |

B-B-10

Hunters Point Shipyard Human Health Evaluation  
Appendix B - Position Papers to Support Human Health Evaluation

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**Table B–3. Summary of Food Habits and Movements of Several Primary Recreational Sport Fish Species (Adapted from SFEI 1999)**

| Species   | Adult Diet   | Movements in Bay/Delta   | References                                   |
|---|--|--|--|
| <b>California halibut</b><br>( <i>Paralichthys californicus</i> ) | Pacific sardine, northern anchovy, white croaker, topsmelt, killifish, CA market squid, crustaceans  | Coastal, but adults also occur in SFB year- round. Spawn in coastal waters year round in southern California, but near SFB from Jan– July. Male juveniles may stay in the Bay until they reach ~200mm; females mature later and stay in Bay longer.                            | [1], [2], [3], [4], [5]                      |
| <b>white sturgeon</b><br>( <i>Acipenser transmontanus</i> )       | Fish, fish eggs (herring), shellfish, crayfish, various aquatic invertebrates, clams, amphipods, and shrimp  | Spawning migration from the lower (Courtland/ Freeport) Sacramento to between Knights Landing and several miles above Colusa. Many adults spend most of lives in the Estuary (even though anadromous)— primarily Suisun and San Pablo Bays.                                    | [4], [15], [25], [26], [27], [28], [29]      |
| <b>leopard shark</b><br>( <i>Triakis semifasciata</i> )           | Cancer crabs, innkeeper worms, graspid crabs, squid, bay shrimp, ghost shrimp, clams, fish (such as anchovies), fish eggs, octopus spp.  | Most are resident in SFB but a portion of population moves out of Bay in fall and winter. Some exchange between SFB and Elkhorn Slough populations.  | [9], [10], [11], [12], [13], [14], [15], [4] |
| <b>shiner perch</b><br>( <i>Cymotogaster aggregata</i> )          | Gammarid amphipods comprise bulk of year round diet in SFB, also algae, cumaceans, cyclopoid copepods, bivalve mollusks, polychaetes, smelt eggs, small shiner   | Females immigrate from nearshore into SFB to give birth (live-bearers) in June or July. Males mature and emigrate soon after birth, females stay in the Bay for 1 st year and give birth before 1 st emigration.   | [4], [7], [16], [17], [18]                   |
| <b>striped bass</b><br>( <i>Morone saxatilis</i> )                | Northern anchovy, shiner perch, bay shrimp, striped bass young of the year, and herring. Diet varies greatly with location in the Bay and Delta  | Spawn April- May in two areas— Sacramento River between Colusa and western Delta, San Joaquin between Antioch and Venice Island. Distribution has changed substantially in recent years. Now spend more time in Delta than Bay. Increased summer use of the ocean by adults.   | [4], [19], [20], [21], [22]                  |
| <b>white croaker</b><br>( <i>Genyonemus lineatus</i> )            | Wide variety of fish (mostly northern anchovy), squid, octopus, polychaetes, crabs, clams, detritus and dead organisms   | Spawning occurs in the Gulf of the Farallones, and Central Bay in spring. Juveniles migrate out of the Bay in fall; re- enter and congregate in South Bay in May. Year- round adult population in deep areas of South Bay. Adults in San Pablo Bay during high salinity years. | [8], [23], [24]                              |
| <b>jacksmelt</b><br>( <i>Atherinopsis californiensis</i> )        | Algae (Ulothrix spp., Melosiramoniliformis, Enteromorpha spp.), copepods, mysids, cirripedian nauplius larvae, small northern anchovy, gammarid amphipods, jacksmelt eggs, heteronereid polychaetes, sessile diatoms, foraminifera | Late winter/ early spring immigrate from nearshore into SFB to spawn. Juveniles remain in Bay through summer then emigrate to coast in fall. During low freshwater flows use San Pablo Bay and Carquinez Strait, and in high flow years use South and Central Bay.             | [4], [6], [7], [8]                           |

[1] Haaker, 1975; [2] Wertz and Domeier, 1997; [3] Pattison and McAllister, 1990; [4] CA Dept. of Fish and Game Marine Sportfish webpage: [http:// www.dfg.ca.gov/Mrd/msfindx0.html](http://www.dfg.ca.gov/Mrd/msfindx0.html);  
 [5] Marine Science Institute South Bay Monitoring Program: [http:// www.sfbaymsi.org](http://www.sfbaymsi.org); [6] Clark, 1929; [7] Boothe, 1967; [8] Emmett et al.,1991; [9] Russo, 1975; [10] Talent, 1976;  
 [11] Ebert, 1986; [12] Smith and Abramson, 1990; [13] Kusher et al., 1992; [14] Webber and Cech, 1998; [15] CA Dept. of Fish and Game Delta webpage: [http:// www.delta.dfg.ca.gov/](http://www.delta.dfg.ca.gov/);

**ATTACHMENT C**

**Sensitivity Analysis for Fish Consumption Risk Evaluation**

Fish Consumption Health Risks in San Francisco Bay

March 17, 2000

To identify the key issues associated with evaluating potential risks from consuming fish, it is necessary to understand the methodology for quantifying the potential risks and to identify the key exposure parameters. To that end, this Attachment presents the methodology for the quantification of risks (both non-cancer and cancer endpoints) associated with the consumption of fish/shellfish and provides a sensitivity analysis based on the ranges of potential values for an exposure dose calculation. The purpose of the sensitivity analysis is to identify the key parameters associated with calculation of an ingestion exposure dose that may be worth evaluating on a more accurate, site-specific basis. This perspective will be used to make recommendations for future data collection activities to provide more realistic estimates of risk for specific sites.

### C.1 Calculation of Ingestion Exposure Dose and Risk Estimates

Daily exposure doses are calculated for the ingestion of fish contaminated with COPCs by multiplying the intake factor (in g/kg-day) by a unit conversion factor (1.0E-03 kg/g) and corresponding fish tissue concentration of a COPC (in mg/kg). The resulting ingestion dose (in mg/kg-day) is then multiplied by a COPC-specific oral cancer slope factor (CSF<sub>o</sub>) or divided by an oral reference dose (RfD<sub>o</sub>) in order to estimate associated cancer or non-cancer health risks, respectively. These risks are expressed as excess lifetime cancer risks (ELCRs) for carcinogens and hazard indexes (HIs) for non-carcinogens. Calculations are summarized in the following algorithms:

Daily dose (in mg/kg-day):

$$\begin{aligned} &= \text{Intake Factor (InF)} \times \text{Conversion Factor (CF)} \times \text{Fish Tissue} \\ &\quad \text{Concentration (C}_{\text{fish}}), \text{ summarized with units as} \\ &= \text{InF (g/kg-day)} \times \text{CF (1.0E-03 kg/g)} \times \text{C}_{\text{fish}} \text{ (mg/kg)} \end{aligned} \quad (\text{C-1})$$

Unit Risk:

$$\text{ELCR (cancer)} = \text{Daily dose (mg/kg-day)} \times \text{CSF (1/(mg/kg-day))} \quad (\text{C-2})$$

$$\text{HI (non-cancer)} = \text{Daily dose (mg/kg-day)} / \text{RfD (mg/kg-day)}. \quad (\text{C-3})$$

### C.2 Calculation of Ingestion Intake Factor

Daily oral intake factors for an individual (*i.e.*, recreational angler) are calculated for the ingestion pathway using a standard intake algorithm (USEPA, 1989a) which uses both generic and site-specific exposure assumptions and considerations:

$$\text{InF} = \frac{\text{IR} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}; \quad (\text{C-4})$$

where:

- InF = intake factor (g/kg-day);
- IR = ingestion rate (total dietary intake in grams fish/day);
- FI = fraction ingested (of the total dietary intake of fish) from the site (unitless)
- EF = exposure frequency (days/year);
- ED = exposure duration (years);
- BW = body weight (kg); and
- AT = averaging time (days) (non-cancer = ED \* 365; cancer = 25,550).

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As mentioned in Section C.1, this intake factor (in g/kg-day) may be converted into an ingestion exposure dose (in mg/kg-day) by multiplying the intake factor with an appropriate fish tissue level (in mg/kg) for selected chemicals of potential concern (COPCs) and a unit conversion factor ( $10^{-3}$  kg/g).

### C.3 Sensitivity Analysis

The purpose of this sensitivity analysis is to identify the “key” parameters associated with the calculation of an ingestion exposure dose (in mg/kg-day) representative of a potential exposure scenario associated with the consumption of contaminated fish.

#### C.3.1 The Ingestion Exposure Dose

An ingestion exposure dose is calculated by multiplying an intake factor (InF), discussed in Section C.2, by the concentration of a COPC in fish tissue (*i.e.*, the “concentration term”). Exposure dose calculations for both non-cancer and cancer will be evaluated in following sections.

#### C.3.2 The Concentration Term

To evaluate sensitivity associated with the concentration term in calculating an exposure dose, data from the 1995 and 1999 Regional Monitoring Program (SFRWQCB *et al.* 1995; SFEI 1999) for the San Francisco Bay Area was used. Specifically, a range of fish tissue concentrations in white croaker reported by the RMP for representative non-cancer and cancer COPCs was used. White croaker was selected because it was associated with the largest data set reported for all sampled fish species. The ranges of concentrations (in mg/kg) used in the sensitivity analysis represent the arithmetic mean versus the maximum concentration reported. These values, along with the 95 percent UCL of the mean, are summarized in Table C-1.

#### C.3.3 Ingestion Intake Factor

In addition to evaluating the concentration term, this sensitivity analysis focused on each of the variables used in the calculation of an ingestion intake factor, as defined in Section C.2. Variables for which several input parameters or ranges of input parameters exist include ingestion rate (IR), fraction ingested (FI), exposure frequency (EF), and exposure duration (ED). The values for each of these parameters, with references, are listed in Table C-2. These values include representative lower- and upper-bound ranges from guidance and studies focused on fish consumption issues.

For the purposes of this sensitivity analysis, the IR value will be considered the complete dietary intake rate for fish and shellfish, regardless of the source. Fish consumption could be contributed from fishing at the site, purchase of commercially available products in stores or markets, fishing at other locations in the Bay, and other fishing locations outside the Bay. The FI term will be considered to represent the portion of the ingestion rate which is attributable to the site alone.

### C.4 Results of Sensitivity Analysis

Uncertainty analysis results, based on the ranges of intake parameters listed above for mercury and PCB concentration terms, are shown in Figures C-1 and C-2, respectively. Each figure displays the potential ranges of calculated exposure dose values in mg/kg-day (vertical axis) for the minimum and maximum values for each exposure parameter (horizontal axis). Since the body weight (BW) exposure parameter is not a site-specific variable, the value was held constant. Body weight values may vary with different populations, but is not directly related to the site. As recommended by regulatory guidance (USEPA 1991) a value of 70kg was used to represent an adult’s body weight. In addition, the concentration terms

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( $C_{\text{fish}}$ ) in each figure represents the average and maximum values for a specified COPC from the RMP dataset.

The results of this analysis indicate that the largest contributors to uncertainty for both cancer and non-cancer dose estimates are the concentration term ( $C_{\text{fish}}$ ), ingestion rate (IR), and fraction ingested (FI) parameters. The exposure duration (ED) for the cancer dose estimate (total PCBs) shows an increased sensitivity when compared to the ED for the non-cancer dose estimate. This is due to the fact that ED, in the non-cancer dose algorithm, is present in the numerator (as ED) and denominator (as  $AT = ED \times 365$ ), which nullifies its contribution to the dose estimate. In the cancer dose estimate, ED is only present in the numerator since AT, in the denominator, is a fixed value representing the lifetime average daily intake. Ultimately, by examining the algorithm for calculating an intake factor and subsequent exposure dose, it becomes clear that parameters with the largest range of potential input values will likely result in the largest range of uncertainties (*i.e.*, greatest sensitivity).

The analysis results suggest that the most efficient technique for maximizing accuracy and minimizing uncertainty in ingestion intake factors, exposure doses, and ultimate risk estimates is to focus on determining, as accurately as possible, the key variables  $C_{\text{fish}}$ , IR, and FI for exposed individuals on a site-specific basis. Ultimately, depending on site-specific conditions and uses, data collection may be designed to focus on one or more of these sensitive parameters to address site-specific uncertainty.

## **C.5 Key Parameters For Estimating Fish Consumption Risk**

### **C.5.1 Concentration Term**

The concentration term ( $C_{\text{fish}}$ ) refers to the concentration of a chemical in the edible portions of fish or shellfish that is used to estimate the daily dose. The concentration of chemicals in fish tissue is affected by a variety of chemical and physical factors that regulate the uptake of chemicals from sediments and water into the tissues of the organism (*i.e.*, the bioavailability). Other factors such as the trophic level, mobility, diet of the fish species evaluated, as well as the methodology used for evaluating COPCs in fish tissue can also impact the concentration term. Factors such as these introduce additional variability into the exposure assumptions that must be addressed in order to provide realistic assessment of exposure point concentrations and exposure doses. Although based on the concentration of COPC measured in fish tissue, the actual value for  $C_{\text{fish}}$  incorporated into the dose equation may be modified by a variety of factors to more closely relate the parameter to site-specific conditions.

### **C.5.2 Ingestion Rate**

Due to the potential variability of fish consumption rates, site-specific ingestion rates will be used whenever possible to evaluate this pathway. In the event that resident fish or shellfish populations are identified at a particular site, the SWG will attempt to identify and define the population of anglers using that resource. Historically, fish consumption estimates ranging from 1.2 to 180 g/day have been used or recommended for use by EPA in risk assessments and regulatory proceedings (EPA 1986; 1989a,b,c; 1991a,b; 1992; 1994). The differences in these consumption rates reflect variations in waterbody type, target population, fishery type, region, and study methodology.

An attempt was made to locate information regarding studies that may include fish consumption data specific to the San Francisco Bay Region. The San Francisco Bay Estuary Institute (SFEI), California Department of Fish and Game (CDFG), and CalEPA Office of Environmental Health Hazard Assessment (OEHHA) were contacted and questioned regarding this issue. Only one study conducted by Wong (1997) provided information of SFB-specific consumption rates. However, several of the agency contacts

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referred to a study currently being performed by the SFEI and California Department of Health Services (DHS), which was confirmed by DHS (Lee, 1999) as following a design similar to the 1991-92 Santa Monica Bay Seafood Consumption Study (SCCWRP and MBC 1994). This study is ongoing and data are anticipated to be available for publication in 2000. If these data are timely to the SWG evaluation, they will be considered.

In a subsequent evaluation based on the same raw data obtained from the Santa Monica Bay study, Wilson *et al.* (1999) used a different approach from OEHHA's and estimated fish consumption rates based on a probabilistic evaluation. In place of the conservative extrapolations used by OEHHA to derive the default intake values, Wilson *et al.* (1999) relied upon the full range of consumption rates measured in the study for single fishing trips. The probabilistic technique employed allowed Wilson *et al.* (1999) to incorporate information collected during the survey regarding age-related differences in body weight, seasons fished, variations in fishing location, as well as fishing success. As a result, this evaluation provides a much more realistic evaluation of actual exposures and avoids the use of conservative extrapolations, which have a tendency to overestimate upper end exposures (USEPA 1992).

Based on Wilson *et al.* (1999) the mean fish consumption rate for pier (*i.e.*, shore anglers) was 3.4 g/day, with a 95<sup>th</sup> percentile of 12 g/day. These rates are consistent with those recommended by the U.S. EPA Exposure Factors Handbook (1997) which suggests a fish consumption rate ranging from 2 g/day (mean intake) to 6.8 g/day (95<sup>th</sup> percentile) for recreational marine anglers on the Pacific Coast. These rates are based on regional fish and shellfish consumption data collected by the National Marine Fisheries Survey (NMFS 1993). Therefore, the consumption rates derived by Wilson *et al.* (1999) were determined to be appropriately conservative for the purpose of evaluating fish consumption in SF Bay.

### **C.5.3 Fraction Ingested**

The fish ingestion rates discussed in Section 4.2 define the total dietary intake of recreationally caught fish for a given population of anglers. However, these ingestion rates do not delineate the source of the fish consumed. Therefore, consideration of the fraction of fish from this dietary intake that is actually likely to have been exposed at the site (FI) is an important consideration. Any or all of the following factors can influence the amount of fish eaten, which have been impacted by the site: angler behavior, species preferences, and abundance and distribution of preferred species. Factors such as these introduce additional variability into the exposure assumptions that must be addressed in order to provide a realistic assessment of exposure point concentrations and exposure doses.

### **C.6 References**

SCCWRP and MBC, 1994. *Santa Monica Bay Seafood Consumption Study: Final Report*. Southern California Coastal Water Research Project and MBC Applied Environmental Sciences. Westminster and Costa Mesa, CA. June, 1994.

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U.S. Environmental Protection Agency (USEPA). 1994. *Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories, Volume 2: Risk Assessment and Fish Consumption Limits*. Office of Water, Washington, D.C. EPA-823-B-94-004.

USEPA (United States Environmental Protection Agency), 1997. *Exposure Factors Handbook, Volume II: Food Ingestion Factors*. Office of Research and Development, Washington DC.

**Table C–1. Summary of Concentration Term ( $C_{fish}$ ) Values**

| Compound   | n  | Arithmetic Mean Value | 95% UCL of the Mean | Maximum | Cancer Status | Units |
|------------|----|-----------------------|---------------------|---------|---------------|-------|
| Hg         | 42 | 0.1934                | 0.221               | 0.414   | Non-cancer    | mg/kg |
| Total PCBs | 46 | 0.320                 | 0.367               | 0.867   | Cancer        | mg/kg |

**Table C–2. Summary of Intake Factor Parameters**

| Parameter    | Minimum Value   | Maximum Value   | Average | Units      |
|--------------|-----------------|-----------------|---------|------------|
| $IR_{adult}$ | 2 <sup>a</sup>  | 21 <sup>b</sup> | 11.5    | g fish/day |
| FI           | 0.25            | 1.0             | 0.625   | unitless   |
| EF           | 350             | 365             | 358     | days/year  |
| ED           | 9 <sup>c</sup>  | 30              | 19.5    | years      |
| BW           | 70 <sup>a</sup> | 70              | 70      | kg         |

<sup>a</sup> Exposure Factors Handbook, USEPA, 1997.

<sup>b</sup> SCCWRP and MBC, 1994.

<sup>c</sup> RAGS (Part A), USEPA, 1989a.

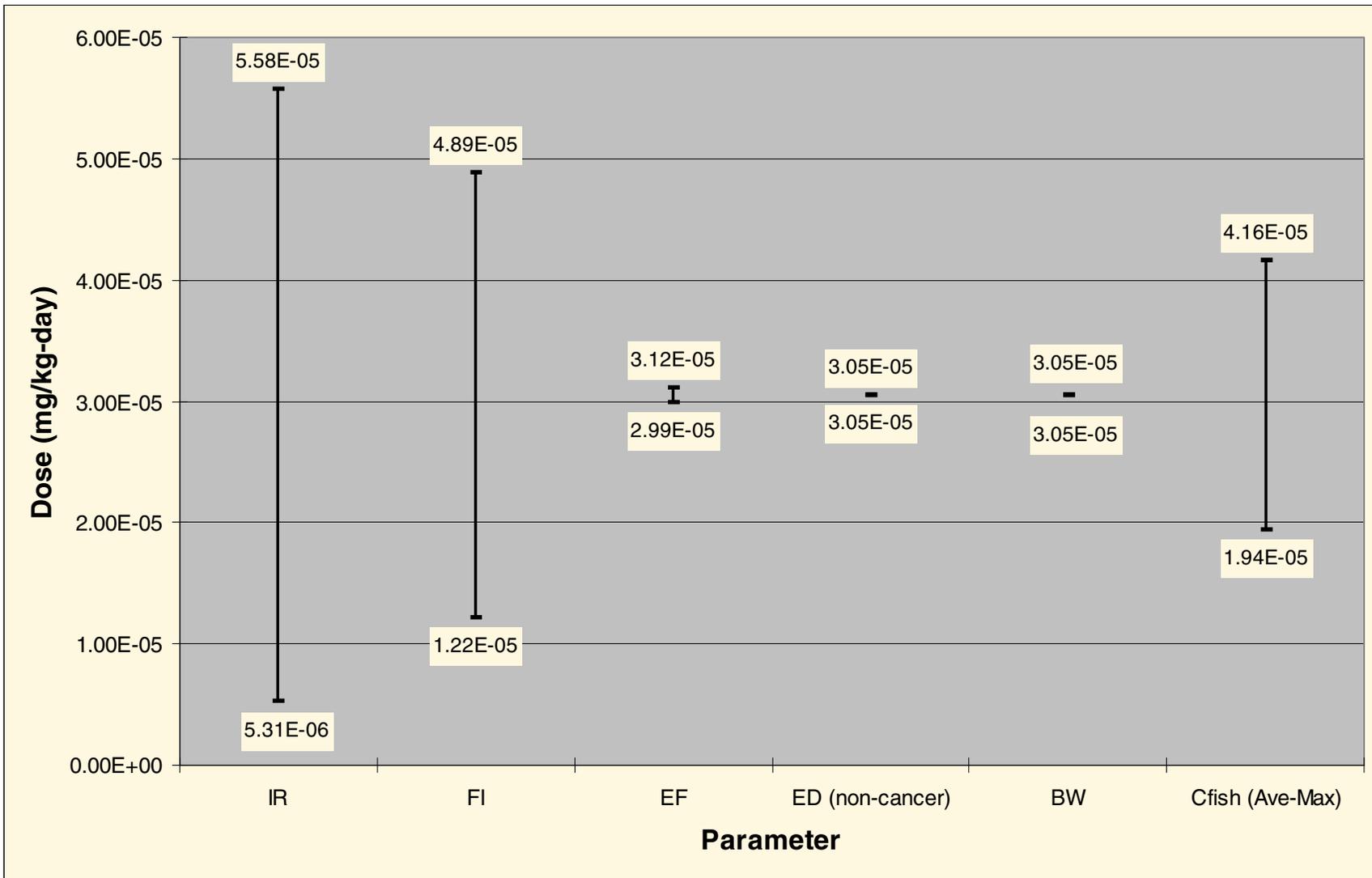


Figure C-1. Impact of Individual Exposure Parameters on Noncancer Dose Estimates (Using RMP Mercury Results in the Concentration Term)

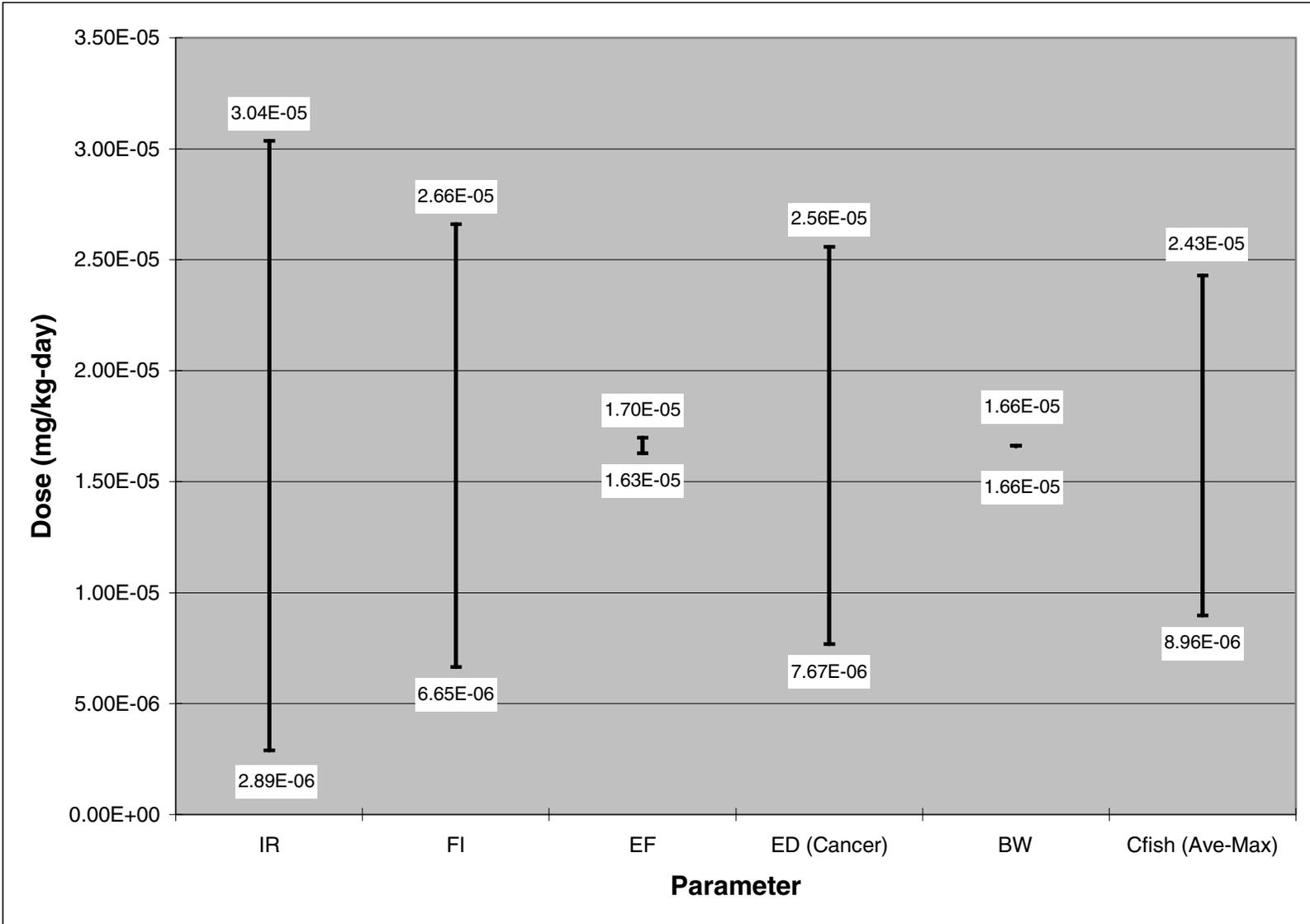


Figure C-2. Impact of Individual Exposure Parameters on Cancer Dose Estimates (Using RMP Total PCB Results in the Concentration Term)

## **APPENDIX C**

### **Development of Risk-Based Screening Concentrations (RBSCs) for Use in the Human Health Evaluation**

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## **Development of site-specific Risk-Based Screening Concentrations (RBSCs) for use in the Human Health Evaluation**

Site-specific risk-based screening concentrations (RBSCs) were developed for shellfish tissue using standard information and risk calculations typically used to develop risk estimates (U.S. EPA, 1989). In contrast to risk estimates, for which the media concentration is one of the input terms, the media concentration is the variable for which the equation is solved in the development of RBSCs. Thus these values represent site-specific media concentrations that do not pose a potential risk based on the assumed site-specific exposure parameters.

A target cancer risk of  $1 \times 10^{-5}$  was used to evaluate carcinogenic risks and a target hazard index of one (1.0) was used for evaluation of noncarcinogenic risks, based on guidance provided by the State of California. For each COPC, RBSCs were calculated for both cancer and noncancer endpoints, and the minimum value for each chemical assigned as the final RBSC for the refined screening evaluation.

To evaluate shellfish consumption, a range of RBSCs were developed based on varying consumption rates. Specifically, four values were considered representing the average or and maximum consumption rates among the general population as well as among individuals identified as “shellfish consumers” indicating that they consume more shellfish than the general population. The four values are defined as the “typical” and reasonable maximum exposure (RME) of the general population and the subpopulation identified as “shellfish consumers.”

Table C-1 summarizes the specific equations and exposure parameters used to derive the site-specific RBSCs for shellfish. Table C-2 lists the full range of RBSC values calculated. A summary of the key exposure parameters is provided below.

Shellfish Ingestion Rate (IR): Consumption rates for the typical (i.e., 0.0007 kg/day or 0.7 g/day) and RME (0.001 kg/day, or 1 g/day) for the general population were based on per capita consumption rates reported by U.S. EPA (1997). The “shellfish consumer” consumption rates were based on information presented by the Office of Environmental Health Hazard Assessment (OEHHA, 1997) regarding an U.S. Food and Drug Administration (FDA) study on shellfish consumption. For that subpopulation, a typical consumption rate of 0.012 kg/day (i.e., 12 g/day) was assumed, with a maximum consumption rate of 0.018 kg/day (i.e., 18 g/day).

Fraction Ingested (FI): To estimate the RBSC for the typical individual, it was assumed that one-half of the total shellfish consumed was obtained from the site. For the RME, it was assumed that 100 percent of the shellfish consumed was obtained from Alameda Point.

Exposure Frequency (EF): The consumption rates used are annualized and presented on a daily basis. Therefore the exposure frequency is assumed to be 365 days per year (U.S. EPA, 1989).

Exposure Duration (ED): An assumed exposure duration of 9 years was used to estimate the RBSCs for ‘typical’ individuals. For the RME, an exposure duration of 30 years was assumed. These assumptions were based on recommendations by U.S. EPA (1989).

Body Weight (BW): Based on information presented by U.S. EPA (1991) body weights of 70 kg and 15 kg were assumed for the adult and child receptors, respectively.

**Table C-1. Development of RBSCs for Shellfish**

| <b>CARCINOGENIC RISKS</b>   |                    |                         |                    |                    |                           |
|---|--------------------|-------------------------|--------------------|--------------------|---------------------------|
| RBSC (mg/kg wet weight) =   |                    | RL x BW x AT            |                    |                    |                           |
|   |                    | CSF x IR x FI x EF x ED |                    |                    |                           |
| Where:  |                    |                         |                    |                    |                           |
| CSF = Chemical-specific Cancer Slope Factor (mg/kg/day) <sup>-1</sup>             |                    |                         |                    |                    |                           |
| IR = Ingestion Rate (kg/day)  |                    |                         |                    |                    |                           |
| FI = Fraction Ingested (unitless)   |                    |                         |                    |                    |                           |
| EF = Exposure Frequency (days/year)   |                    |                         |                    |                    |                           |
| ED = Exposure Duration (years)  |                    |                         |                    |                    |                           |
| BW = Body Weight (kg)   |                    |                         |                    |                    |                           |
| AT <sub>c</sub> = Averaging Time (period over which exposure is averaged - days)  |                    |                         |                    |                    |                           |
| RL = Acceptable Risk Level (assumed to be 1x 10 <sup>-5</sup> )                   |                    |                         |                    |                    |                           |
| Exposure Variable   | General Population |                         | Shellfish Consumer |                    | Reference                 |
|   | Typical            | RME                     | Typical            | RME                |                           |
| CSF   | TBD <sup>(a)</sup> | TBD <sup>(a)</sup>      | TBD <sup>(a)</sup> | TBD <sup>(a)</sup> | IRIS, 2000                |
| IR  | 0.0007             | 0.001                   | 0.012              | 0.018              | USEPA, 1998 & OEHHA, 1997 |
| FI  | 0.5                | 1                       | 0.5                | 1                  | Professional Judgement    |
| EF  | 365                | 365                     | 365                | 365                | U.S. EPA 1989             |
| ED  | 9                  | 30                      | 9                  | 30                 | U.S. EPA 1989             |
| BW  | 70                 | 70                      | 70                 | 70                 | U.S. EPA 1989             |
| AT <sub>c</sub>   | 25,550             | 25,550                  | 25,550             | 25,550             | U.S. EPA 1989             |
| <b>NON-CARCINOGENIC RISKS</b>   |                    |                         |                    |                    |                           |
| RBSC (mg/kg wet weight) =   |                    | HQ x RfD x BW x AT      |                    |                    |                           |
|   |                    | IR x FI x EF x ED       |                    |                    |                           |
| Where:  |                    |                         |                    |                    |                           |
| RfD = Chemical-specific Reference Dose (mg/kg/day)                                |                    |                         |                    |                    |                           |
| IR = Ingestion Rate (kg/day)  |                    |                         |                    |                    |                           |
| FI = Fraction Ingested (unitless)   |                    |                         |                    |                    |                           |
| EF = Exposure Frequency (days/year)   |                    |                         |                    |                    |                           |
| ED = Exposure Duration (years)  |                    |                         |                    |                    |                           |
| BW = Body Weight (kg)   |                    |                         |                    |                    |                           |
| AT <sub>nc</sub> = Averaging Time (period over which exposure is averaged - days) |                    |                         |                    |                    |                           |
| HQ = Acceptable Hazard Quotient (assumed to be 1)                                 |                    |                         |                    |                    |                           |
| Exposure Variable   | General Population |                         | Shellfish Consumer |                    | Reference                 |
|   | Typical            | RME                     | Typical            | RME                |                           |
| CSF   | TBD <sup>(a)</sup> | TBD <sup>(a)</sup>      | TBD <sup>(a)</sup> | TBD <sup>(a)</sup> | IRIS, 2000                |
| IR  | 0.0007             | 0.001                   | 0.012              | 0.018              | USEPA, 1998 & OEHHA, 1997 |
| FI  | 0.5                | 1                       | 0.5                | 1                  | Professional Judgement    |
| EF  | 365                | 365                     | 365                | 365                | U.S. EPA 1989             |
| ED  | 9                  | 30                      | 9                  | 30                 | U.S. EPA 1989             |
| BW  | 70                 | 70                      | 70                 | 70                 | U.S. EPA 1989             |
| AT <sub>nc</sub>  | 3,285              | 10,950                  | 3,285              | 10,950             | U.S. EPA 1989             |

(a) TBD To be determined. Value is chemical-specific.

Table C-2. RBSCs Values

| COPCs                      | Per Capita RBSCs (mg/kg) |         | Consumer Only RBSCs (mg/kg) |         | RBSCs (mg/kg) |         |
|----------------------------|--------------------------|---------|-----------------------------|---------|---------------|---------|
|                            | Min                      | Max     | Min                         | Max     | Min.          | Max.    |
| <b>INORGANICS</b>          |                          |         |                             |         |               |         |
| Arsenic                    | 1.1E-00                  | 6.0E+01 | 6.0E-02                     | 3.5E-00 | 6.0E-02       | 6.0E+01 |
| Antimony                   | 2.8E+01                  | 8.0E+01 | 1.6E-00                     | 4.7E-00 | 1.6E-00       | 8.0E+01 |
| Cadmium                    | 3.5E+01                  | 1.0E+02 | 1.9E-00                     | 5.8E-00 | 1.9E-00       | 1.0E+02 |
| Chromium                   | 2.1E+02                  | 6.0E+02 | 1.2E+01                     | 3.5E+01 | 1.2E+01       | 6.0E+02 |
| Copper                     | 2.6E+03                  | 7.4E+03 | 1.4E+02                     | 4.3E+02 | 1.4E+02       | 7.4E+03 |
| Lead                       | NA                       | NA      | NA                          | NA      | NA            | NA      |
| Mercury                    | 2.1E+01                  | 6.0E+01 | 1.2E-00                     | 3.5E-00 | 1.2E-00       | 6.0E+01 |
| Nickel                     | 1.4E+03                  | 4.0E+03 | 7.8E+01                     | 2.3E+02 | 7.8E+01       | 4.0E+03 |
| Selenium                   | 3.5E+02                  | 1.0E+03 | 1.9E+01                     | 5.8E+01 | 1.9E+01       | 1.0E+03 |
| Silver                     | 3.5E+02                  | 1.0E+03 | 1.9E+01                     | 5.8E+01 | 1.9E+01       | 1.0E+03 |
| Zinc                       | 2.1E+04                  | 6.0E+04 | 1.2E+03                     | 3.5E+03 | 1.2E+03       | 6.0E+04 |
| <b>SVOCs</b>               |                          |         |                             |         |               |         |
| 2-Methyl naphthalene       | NA                       | NA      | NA                          | NA      | NA            | NA      |
| Acenaphthene               | 4.2E+03                  | 1.2E+04 | 2.3E+02                     | 7.0E+02 | 2.3E+02       | 1.2E+04 |
| Acenaphthylene             | NA                       | NA      | NA                          | NA      | NA            | NA      |
| Anthracene                 | 2.1E+04                  | 6.0E+04 | 1.2E+03                     | 3.5E+03 | 1.2E+03       | 6.0E+04 |
| Benzo(a)anthracene         | 2.2E-00                  | 2.1E+01 | 1.2E-01                     | 1.2E-00 | 1.2E-01       | 2.1E+01 |
| Benzo(a)pyrene             | 2.2E-01                  | 2.1E-00 | 1.2E-02                     | 1.2E-01 | 1.2E-02       | 2.1E-00 |
| Benzo(b)fluoranthene       | 2.2E-00                  | 2.1E+01 | 1.2E-01                     | 1.2E-00 | 1.2E-01       | 2.1E+01 |
| Benzo(g,h,i)perylene       | NA                       | NA      | NA                          | NA      | NA            | NA      |
| Benzo(k)fluoranthene       | 2.2E+01                  | 2.1E+02 | 1.2E-00                     | 1.2E+01 | 1.2E-00       | 2.1E+02 |
| Chrysene                   | 2.2E+02                  | 2.1E+03 | 1.2E+01                     | 1.2E+02 | 1.2E+01       | 2.1E+03 |
| Dibenz(a,h)anthracene      | 2.2E-01                  | 2.1E-00 | 1.2E-02                     | 1.2E-01 | 1.2E-02       | 2.1E-00 |
| Fluoranthene               | 2.8E+03                  | 8.0E+03 | 1.6E+02                     | 4.7E+02 | 1.6E+02       | 8.0E+03 |
| Fluorene                   | 2.8E+03                  | 8.0E+03 | 1.6E+02                     | 4.7E+02 | 1.6E+02       | 8.0E+03 |
| Indeno(1,2,3-cd)pyrene     | 2.2E-00                  | 2.1E+01 | 1.2E-01                     | 1.2E-00 | 1.2E-01       | 2.1E+01 |
| Naphthalene                | 1.4E+03                  | 4.0E+03 | 7.8E+01                     | 2.3E+02 | 7.8E+01       | 4.0E+03 |
| Phenanthrene               | NA                       | NA      | NA                          | NA      | NA            | NA      |
| Pyrene                     | 2.1E+03                  | 6.0E+03 | 1.2E+02                     | 3.5E+02 | 1.2E+02       | 6.0E+03 |
| <b>PCBs/PESTICIDES</b>     |                          |         |                             |         |               |         |
| Alpha-Chlordane            | 4.7E-00                  | 1.0E+02 | 2.6E-01                     | 5.8E-00 | 2.6E-01       | 1.0E+02 |
| Gamma-Chlordane            | 4.7E-00                  | 1.0E+02 | 2.6E-01                     | 5.8E-00 | 2.6E-01       | 1.0E+02 |
| 4,4'-DDD                   | 6.8E-00                  | 6.5E+01 | 3.8E-01                     | 3.8E-00 | 3.8E-01       | 6.5E+01 |
| 2,4'-DDD <sup>1</sup>      | 6.8E-00                  | 6.5E+01 | 3.8E-01                     | 3.8E-00 | 3.8E-01       | 6.5E+01 |
| 4,4'-DDE                   | 4.8E-00                  | 4.6E+01 | 2.7E-01                     | 2.7E-00 | 2.7E-01       | 4.6E+01 |
| 2,4'-DDE <sup>1</sup>      | 4.8E-00                  | 4.6E+01 | 2.7E-01                     | 2.7E-00 | 2.7E-01       | 4.6E+01 |
| 4,4'-DDT                   | 4.8E-00                  | 1.0E+02 | 2.7E-01                     | 5.8E-00 | 2.7E-01       | 1.0E+02 |
| 2,4'-DDT <sup>1</sup>      | 4.8E-00                  | 1.0E+02 | 2.7E-01                     | 5.8E-00 | 2.7E-01       | 1.0E+02 |
| Dieldrin                   | 1.0E-01                  | 1.0E+01 | 5.7E-03                     | 5.8E-01 | 5.7E-03       | 1.0E+01 |
| Endosulfan II <sup>2</sup> | 4.2E+02                  | 1.2E+03 | 2.3E+01                     | 7.0E+01 | 2.3E+01       | 1.2E+03 |
| Endrin                     | 2.1E+01                  | 6.0E+01 | 1.2E-00                     | 3.5E-00 | 1.2E-00       | 6.0E+01 |
| Heptachlor                 | 3.6E-01                  | 1.0E+01 | 2.0E-02                     | 5.8E-01 | 2.0E-02       | 1.0E+01 |
| Cl <sub>2</sub> (8)        | NA                       | NA      | NA                          | NA      | NA            | NA      |
| Total PCBs <sup>3</sup>    | 8.2E-01                  | 7.8E-00 | 4.5E-02                     | 4.5E-01 | 4.5E-02       | 7.8E-00 |

Table C-2. (continued)

| COPCs                        | Per Capita RBSCs<br>(mg/kg) |     | Consumer Only RBSCs<br>(mg/kg) |     | RBSCs (mg/kg) |      |
|------------------------------|-----------------------------|-----|--------------------------------|-----|---------------|------|
|                              | Min                         | Max | Min                            | Max | Min.          | Max. |
| <b>ORGANOTINS</b>            |                             |     |                                |     |               |      |
| TBT                          | NA                          | NA  | NA                             | NA  | NA            | NA   |
| DBT                          | NA                          | NA  | NA                             | NA  | NA            | NA   |
| Total Butyltins <sup>4</sup> | NA                          | NA  | NA                             | NA  | NA            | NA   |

<sup>1</sup>The RBSC values for 4,4'-DDx's are applied to 2,4'-DDx's.

<sup>2</sup>The RBSC values for Endosulfan II were calculated using the Oral Reference Dose and RBSC values for Endosulfan.

<sup>3</sup>Total PCB will be based on the sum of the 19 PCB congeners defined for the NOAA Status and Trends Program.

<sup>4</sup>Total butyltins is the sum of TTBT, TBT, DBT, and MBT. All four compounds will be measured but only TBT and DBT are COPCs.

**APPENDIX D**

**Field Sampling Plan (FSP) for HPS Human Health Evaluation**

**DRAFT**

**HUNTERS POINT SHIPYARD PARCEL F  
HUMAN HEALTH EVALUATION  
FIELD SAMPLING PLAN**

**Contract No. N62474-94-D-7609**

**Delivery Order No. 0127**

*Prepared for:*

**U.S. NAVY  
SOUTHWEST DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND  
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**January 9, 2001**

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**DRAFT**

**HUNTERS POINT SHIPYARD PARCEL F**

**HUMAN HEALTH EVALUATION**

**FIELD SAMPLING PLAN**

*Prepared for:*

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**SOUTHWEST DIVISION**  
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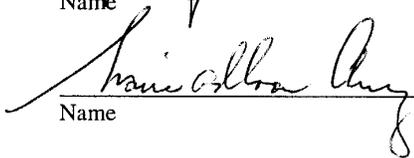
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## ACRONYMS AND ABBREVIATIONS

|        |  |
|--------|--|
| COPC   | Contaminant of Potential Concern       |
| dGPS   | differential Global Positioning System |
| FS     | Feasibility Study                      |
| FSP    | Field Sampling Plan                    |
| HPS    | Hunters Point Shipyard                 |
| NAVFAC | Naval Facilities Engineering Command   |
| PAH    | Polycyclic Aromatic Hydrocarbons       |
| PCBs   | Polychlorinated Biphenyls              |
| QAPP   | Quality Assurance Project Plan         |
| RBSC   | Risk-based Screening Concentrations    |
| RMP    | Regional Monitoring Program            |
| SFEI   | San Francisco Estuary Institute        |
| SOP    | Standard Operating Procedure           |
| SWDIV  | Southwest Division                     |
| SWG    | Sediment Work Group                    |
| VS     | Validation Study                       |

## D.1 BACKGROUND

The Southwest Division (SWDIV) Naval Facilities Engineering Command (NAVFAC) is performing a human health evaluation at the Hunters Point Shipyard (HPS) in San Francisco Bay for offshore sediments (Parcel F), to clearly identify areas that require consideration in the Feasibility Study (FS) of remedial alternatives for Parcel F sediments. This Field Sampling Plan (FSP) documents the sampling procedures to be implemented specifically for the HPS human health study. The FSP is incorporated as Appendix D to the work plan for the offshore human health evaluation, and is not an independent document. The associated Quality Assurance Project Plan (QAPP) for the HPS human health evaluation is provided as Appendix E.

## D.2 OBJECTIVES

The primary objective of the human health evaluation is to define the extent of sediments that pose an unacceptable risk to human health and that require evaluation in the FS of remedial options. To achieve this objective, the human health evaluation will focus on areas referred to as the low-volume footprint, as identified in the draft Parcel F FS report (Tetra Tech-EMI and LFR, 1998). The results of this investigation will be integrated with the ecological evaluation described in the Validation Study (VS) work plan (Battelle *et al.*, 2000), to determine the sediment areas that require evaluation in the FS. Additionally, at the request of the regulatory agencies, the difference in risk posed by consuming fish from HPS relative to consuming fish from other locations within San Francisco Bay will be evaluated for the purposes of risk communication. Specific objectives of the HPS Human Health Evaluation are as follows:

1. Compare measured levels of chemicals in tissue from the *Macoma nasuta* bioaccumulation study being implemented as part of the HPS VS to risk-based screening concentrations (RBSCs) in support of validating the FS footprint.
2. Collect and analyze fish tissue from the vicinity of HPS and other Regional Monitoring Program (SFEI, 1999) sample sites throughout San Francisco Bay for statistical comparison in support of risk communication.

The HPS human health evaluation tasks include:

- Review of body burden data analyzed for the HPS VS 28-day *Macoma nasuta* bioaccumulation test.
- Collection and analysis of fish from the vicinity of Hunters Point Shipyard and from each of three locations in San Francisco Bay, and,
- Chemical analysis of all tissue samples for polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, butyltin compounds, and 11 trace metals (Ag, Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, and Zn);

Once data collection is complete then the assessment tasks will include

- Compilation of data;
- Comparison of body burden data analyzed for the HPS VS 28-day *Macoma nasuta* bioaccumulation test to RBSCs;
- Statistical comparison of HPS and San Francisco Bay tissue data;
- Preparation of a final report

### D.3 PROJECT MANAGEMENT

The project management structure for the Human Health Evaluation is presented in Figure D-1. The QAPP in Appendix E defines the roles and responsibilities of each person in the organizational chart.

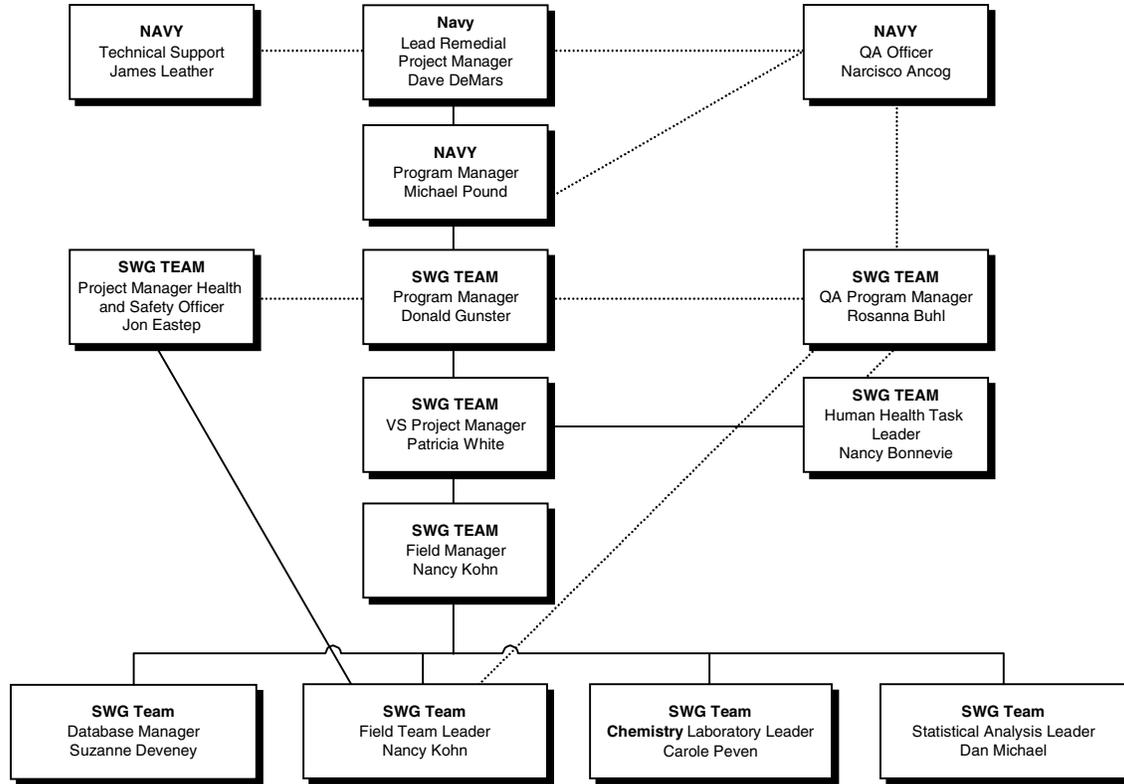


Figure D-1. Organizational Structure for the Hunters Point Shipyard Human Health Study

### D.4 SAMPLE COLLECTION

To better identify areas of surface sediments that pose an unacceptable risk to humans based on comparisons to RBSCs, the human health evaluation will be conducted based on the results of the *Macoma nasuta* bioaccumulation study being implemented as part of the HPS VS (Battelle *et al.*, 2000). The complete description of the collection of these data is described in Appendix D of the HPS VS (Battelle *et al.*, 2000) but in summary, surface sediment samples will be collected from 59 stations at HPS for chemical/physical analyses and bioassay/bioaccumulation testing. The results of the *Macoma nasuta* bioaccumulation testing will be used in the human health evaluation.

In addition to the *Macoma nasuta* bioaccumulation results, fish tissue samples will be collected and analyzed for the purpose of risk communication as described in Section 2.2 of the work plan. The methods associated with the collection of these samples is described below.

Sampling “containers” in the field will be pre-ashed aluminum foil (section D.5.1). Sample preservation in the field will be icing and freezing (section D.5.1). There are no quality control samples associated with field activities (see QAPP section E.3.5.1).

#### **D.4.1 Field Measurements**

Navigation coordinates and water depth will be recorded at each station. Station locations will be measured at each station using a differential Global Positioning System (dGPS) and recorded during sampling following the procedure identified in Section 4.1.9 of the *Suggested Methods for Environmental Sampling and Analysis in San Francisco Bay (Methods Manual)* (Ward *et al.*, 1994); this section is provided in Attachment 1 to this FSP. The dGPS unit will be inspected and tested prior to use in the field. The calibration of each GPS unit will be checked by the field team prior to each day of sampling using a reference location identified by the Field Team Leader. The location of the reference point will be documented in the field log. If the GPS fails to attain a reading that is within 100 meters of the actual position, then the manual should be consulted for sources of error and the reference position verified. All GPS units have a design positional accuracy of 15 meters. Calibration information will be recorded in the field logbook.

General information such as, field location, type of vessel, type of equipment, and weather, will be recorded on the Field Log Form shown on Figure D-2, and maintained in a paginated and bound field logbook (see Section D.6). This Field Log Form will be used each day for each field location sampled that day.

#### **D.4.2 Fish Sample Collection**

The tissue samples will be collected for the HPS Human Health Evaluation according to standard protocols as described in *Contaminant Concentrations in Fish from San Francisco Bay* (SFEI 1999). These protocols are appropriate for the collection of tissue for measurement of chemical constituents. The selection of sampling methods will be determined by the sample type as well as the characteristics of the sampling area (*e.g.*, deep vs. shallow). The contaminant study conducted by the San Francisco Estuary RMP (described in SFEI 1999) collected and analyzed seven fish species that are local recreational fishing targets. The target fish species for the HPS Human Health Evaluation were selected based on the following three criteria:

- species previously evaluated by the RMP;
- species known to be caught and consumed by anglers in San Francisco Bay; and,
- species for which measured tissue concentrations exceed health-based guidelines based on the previous RMP data (RWQCB *et al.* 1995; SFEI 1999).

The three species previously evaluated by the RMP that best fit these three criteria are: white croaker (*Genyonemus lineatus*), shiner surfperch (*Cymatogaster aggregata*), and jacksmelt (*Atherinopsis californiensis*) (SFEI 1999). Therefore, the proposed sampling for the HPS human health risk communication evaluation will target these species. Other species identified by the RMP may be evaluated in the event that these target species are not available and they include, California halibut (*Paralichthys californicus*), leopard sharks (*Triakis semifasciata*), white sturgeon (*Acipenser transmontanus*), and striped bass (*Morone saxatilis*).

White croaker is the preferred species, however, individuals of all priority species will be retained for each location until the minimum number, based on fish weight, is achieved for at least one species at all locations. Six composites of fish will be collected from several areas around HPS and two composites will be collected from each of three ambient locations throughout San Francisco Bay including San Francisco Waterfront, Berkeley Pier, and San Mateo Bridge. Individuals of the three target species will be retained from each location until the minimum whole body weight is achieved for at least one species at all locations. San Pablo Bay will be used as a surrogate sampling location in the event that sufficient



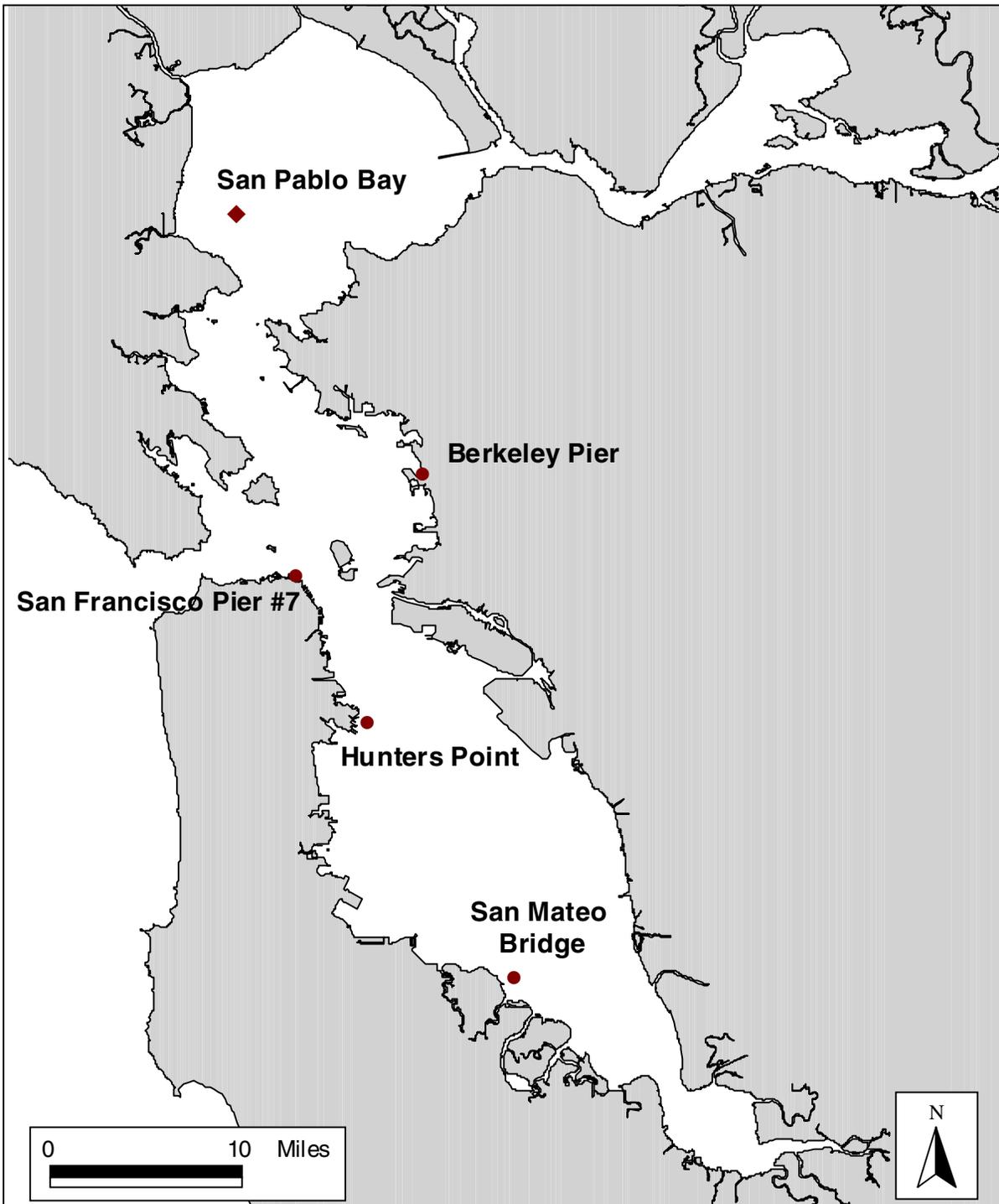


Figure D-3. Fish Tissue Sampling Locations for HPS Human Health Evaluation

**Table D-1. HPS Human Health Evaluation Testing Design**

| Species          | Size Range (cm) | Whole Body Weight of Fish Required to Achieve 100 grams Fillet per Composite <sup>1,2</sup> |                                      |                                 |                                     |
|------------------|-----------------|---|--------------------------------------|---------------------------------|-------------------------------------|
|                  |                 | Hunters Point Shipyard (g) (6 composites)   | San Francisco Pier(g) (2 composites) | Berkley Pier (g) (2 composites) | San Mateo Bridge (g) (2 composites) |
| White croaker    | 20-30           | 2400  | 800                                  | 800                             | 800                                 |
| Shiner surfperch | 10-15           | 2400  | 800                                  | 800                             | 800                                 |
| Jacksmelt        | 21-30           | 2400  | 800                                  | 800                             | 800                                 |

<sup>1</sup>Assumes a ratio of whole body weight:fillet of 4:1. Therefore, 400 grams of whole fish are required in order to achieve 100 grams of fillet per composite.

<sup>2</sup>2400 g of each species should be collected for one composite so that a laboratory matrix spike/spike duplicate can be prepared.

tissue cannot be obtained from one of the designated locations. Selection of the ambient locations was based on information reported by the RMP (SFEI, 1999) regarding important recreational fishing locations within San Francisco Bay, as well as an attempt to geographically represent all areas of the Bay in the sampling program. Table D-1 shows the testing design for relevant fish species, including the targeted size range and minimum weight of each species of whole fish per composite.

The primary collecting method for these species of fish will be a 12-ft to 16-ft otter trawl, with an approximate 1” mesh size nylon stretch. Other fishing techniques (*e.g.*, hook and line, trammel or gill nets) will be used, if needed, to capture sufficient numbers of at least one of the target species at every location. Each fishing technique will be documented.

Trawl speeds will be approximately 2-3 knots. Trawl time will be determined using a digital clock, determined as the difference between the trawl start time and trawl end time, recorded to the nearest minute. Trawl length will be estimated based on the boat speed and trawl duration. Depending on sampling technique, the dGPS coordinates, start time and finish time of sampling, speed of boat, and direction of trawling, for each sample collection will be recorded on the Fish Sample Collection Form shown in Figure D-4. The low and high tide times will be recorded on the Field Log Forms. The tide phase will be determined by correcting for local tide differences and reported in relation to the high or low tide (*e.g.*, 2 hours after high tide). A copy of the tide chart should be included with the field notes in order for tidal corrections to be made when the data is entered into the database.

For each location, sufficient numbers of fish of the same species and size class will be composited to achieve a whole body weight of 800–2400 grams. This provides 400 grams whole body weight collected per species composite for analysis of the full COPC list.

The boat will be positioned upwind when the trawl is brought aboard to eliminate the potential for contamination by exhaust gases. Fish will be identified to species using a taxonomically accurate identification key (*e.g.* Miller and Lea, 1972), by an experienced biologist familiar with fish species found in the San Francisco Bay area.

**BATTELLE  
 FISH SAMPLING DATA SHEET**

Trawl/Sampling Event Number \_\_\_\_\_ Date (mm/dd/yy) \_\_\_\_\_  
 Sampling Location \_\_\_\_\_  
 Weather conditions \_\_\_\_\_  
 Time of High Tide (hh:mm) \_\_\_\_\_ Time of Low Tide (hh:mm) \_\_\_\_\_

**Trawl**  
 Boat speed (knots)      Boat direction (N,S, etc)      Approximate distance covered

| PARAMETER <sup>1</sup> | START | STOP |
|------------------------|-------|------|
| Time (hh:mm)           |       |      |
| Latitude (hh:mm:ss)    |       |      |
| Longitude (hh:mm:ss)   |       |      |
| Northing               |       |      |
| Easting                |       |      |

<sup>1</sup> GPS Coordinates Using CA Zone III NAD 83

**Other:** \_\_\_\_\_

**Catch Results**

| FISH             | TARGET SIZE RANGE (CM) | NUMBER CAUGHT | WHOLE BODY WEIGHT (g) |
|------------------|------------------------|---------------|-----------------------|
| White croaker    | 20-30                  |               |                       |
| Shiner surfperch | 10-15                  |               |                       |
| Jacksmelt        | 21-30                  |               |                       |

**Sample Observations**

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

Page \_\_\_\_\_

**Figure D-4. Fish Sample Collection Form**

## D.5 SAMPLING PROCESSING

### D.5.1 Sample Handling

Field sampling activities are the responsibility of the Battelle Sequim Laboratory with assistance from other SWG Team members, as needed. Field personnel will wear pre-washed fabric gloves while handling fish. Gloves should be changed between stations. Gloves must be washed in hot water without detergents prior to use. The boat will be positioned upwind when the trawl is brought aboard and the fish will be sorted and packaged, to eliminate the potential for contamination by exhaust gases. After each trawl, fish will be sorted by species and size class. Fish that meet the target criteria for species and size class will be retained; other fish will be released overboard. Each species will then be weighed and the weight per species per trawl recorded on the Fish Data Sheet. The purpose of this gross weight is to monitor the accumulated weight for each species at each sampling location. After the fish are weighed, they will be rinsed with seawater, wrapped in pre-washed aluminum foil, labeled, placed in a plastic bag, put on ice and frozen as soon as possible.

### D.5.2 Sample Labeling

Sample containers (*i.e.*, Ziploc<sup>®</sup> plastic bags) will be labeled with waterproof, adhesive-back tape or labels and waterproof ink. Additional labels will also be included inside the bags to avoid any confusion. Sample labels provide sufficient detail to uniquely identify fish from each trawl and allow tracking of field activities. An example is provided below.

|                      |       |                          |       |
|----------------------|-------|--------------------------|-------|
| <b>Sample ID</b>     | _____ | <b>Trawl No.</b>         | _____ |
| <b>Sampling Area</b> | _____ |                          |       |
| <b>Species ID</b>    | _____ |                          |       |
| <b>Container</b>     | _____ | of                       | _____ |
| <b>Date</b>          | _____ | <b>Name of Collector</b> | _____ |

### D.5.3 Sample Storage and Shipping

If samples are not shipped within 24 hours of collection, then they will be held with fresh ice on site at HPS in a locked  $4\pm 2^{\circ}\text{C}$  refrigerated truck in a secure area until ready for shipping. The temperature of the refrigerated truck will be monitored daily using a minimum/maximum thermometer following Battelle Duxbury Laboratory SOP-3-169-01, *Operation of Digital Thermometers*. The temperature will be recorded in a bound logbook maintained on a clipboard attached to the truck. The thermometer will be calibrated against a National Institute of Standards and Technology thermometer at the Battelle Duxbury Laboratory for the ranges of temperatures expected to be encountered in the refrigerated truck and coolers.

Fish samples will be packaged and shipped in accordance with the procedures in the Battelle Duxbury Laboratory Standard Operating Procedure (SOP) 5-210, *Packaging and Shipping of Samples*. (Field

SOPs are provided in Attachment 1). The whole body fish samples will be shipped directly from the field to the Battelle Duxbury Laboratory sample custodian at:

Mr. Michael Meara (Custodian)  
Battelle Duxbury Operations  
397 Washington Street  
Duxbury, MA 02332  
(781) 952-5270

Attention: Carole Peven

Fish will be stored frozen until processing begins in Duxbury. At that time, each fish will be thawed, measured and weighted, filleted with skins on, homogenized, and split for analysis. The sample aliquot for organic compound analysis will remain at Battelle Duxbury Laboratory in the custody of Michael Meara. The aliquot for trace metals analysis will be shipped to the sample custodian at Battelle's Sequim Laboratory at:

Ms. Carolynn Suslick  
Battelle Marine Sciences Laboratory  
1529 Sequim Bay Road  
Sequim, WA 98382  
(360) 681-3604

Attention: Elizabeth Barrows

The HPS Human Health Evaluation QAPP contains full details of sample processing and analysis.

#### **D.5.4 Sample Custody**

Sample custody will be documented throughout collection, shipping, analysis, and disposal of the sample. Samples will not be left unattended unless properly secured. Chain-of-custody procedures will be in accordance with the Battelle Marine Sciences Laboratory (Battelle Sequim Laboratory) SOP MSL-A-002, *Sample Chain-of-Custody* and SOP 6-010 *Sample Receipt, Custody, and Handling*. The chain-of-custody form (Figure D-5) provides a record of the samples collected and analyses requested. The chain-of-custody form for each cooler will be placed in a Ziploc plastic bag and taped to the inside of the cooler lid. If more than one cooler is sent in one shipment to the laboratory, then each cooler will contain a separate chain-of-custody record for the samples in that cooler and the chain-of-custody form will include the number of coolers in the shipment (*e.g.*, 1 of 2, 2 of 2). In addition, the outside of the coolers will also be marked to indicate the number of coolers in the shipment (*e.g.*, 1 of 2, 2 of 2). All coolers must be shipped under the same bill of lading.

#### **D.6 SAMPLE DOCUMENTATION**

Sample collection information, compiled at each sampling location, will be hand-recorded on paginated data forms in a bound, paginated field logbook. An example of this form is provided in Figure D-4. Field samples will be labeled by field personnel as described in Section D.5. Sampling data collected in the field is initially hand recorded in logbooks, then keyed into the Sediment Work Group (SWG) regional database and 100 percent verified by the HPS Human Health Evaluation Project Manager or designee. All sample collection forms will be completed using indelible ink, and documentation errors will be corrected by drawing a single line through the error, making the correction, and initialing, dating, and justifying the error.



## D.7 EQUIPMENT DECONTAMINATION

No decontamination activities will be required. Each sample will be handled with clean gloves and packaged in pre-ashed aluminum foil.

## D.8 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Field sampling and sample preparation activities will be conducted to minimize generation of waste materials. Any solvent waste generated in the laboratory will be contained in appropriately labeled containers and disposed of in compliance with state and federal waste handling regulations. Wastewater generated during sample preparation will be managed in compliance with a project-specific wastewater treatment plan as required by that facility. Excess samples will be stored until such time as they are no longer of use to the project and incinerated as waste.

## D.9 DOCUMENTATION

The field team members will maintain bound field logbooks to provide a daily record of field activities, observations, and measurements during sampling. All information pertinent to sampling will be recorded as a chronology in the logbooks or on activity-specific data forms (*e.g.*, Figures D-2 and D-4). To ensure that samples and data are traceable and defensible, field records and documentation will comply with the documentation standards provided in the HPS Human Health Evaluation QAPP (Appendix E).

A field report describing field survey activities will be due within 3 weeks of completion of all field sampling. The field report will include a chronology of events and tabulated sample collection information including: trawling ID, location coordinates, trawling time, speed and direction of boat during trawling, sampling date and time, number of fish collected, species of fish collected, and any field measurements made during sampling. The report will also contain a summary of problems encountered, deviations, and corrective actions. The Field Team Leader is responsible for preparing the report.

Any changes that are not anticipated (*i.e.*, deviations from the QAPP, FSP, or SOPs) must be documented in writing, approved by the SWG team leader, and communicated appropriately within 4 hours of the deviation. Documentation and communication include an assessment by the appropriate SWG Team Leader of the impact that the deviation has on data quality and the corrective action. Minor deviations (*e.g.*, those that would not impact the study objectives, design, or data quality) will be reported to and approved by the appropriate SWG Team Leader, the SWG Team Human Health Task Leader, and the SWG Team VS Project Manager. Major deviations (*e.g.*, those that could impact the study objectives, design, or data quality) will additionally be reported to the SWG Team Program Manager, the SWG Team QA Program Manager, the Navy Project Manager, and the Navy QA Officer. A discussion of major deviations and potential impact on the project objectives will be included in the final report.

If sampling requirements cannot be met due to sampling or measurement system failure, field conditions or other factors that cannot be controlled, corrective action will be discussed with the HPS Human Health Evaluation QA Program Manager and Field Team Leader. A corrective action will be agreed upon based on the critical/non-critical nature of the parameter, it will be documented in the field log, and the action will be communicated to the sampling team. In general, if critical measurements or samples cannot be collected, then sampling will be re-scheduled. If a non-critical measurement or sample cannot be collected, then the deviation will be documented. The HPS Human Health Evaluation QA Program Manager will review corrective actions to assess their effectiveness. The documentation and communication of any deviations from the QAPP or FSP is discussed in Section E.2.6.5.

## D.10 REFERENCES

Miller, D. J., and R. N. Lea. 1972. Guide to the coastal marine fishes of California. Fish Bulletin 157, 249 pp.

RWQCB, SWRCB, and CDFG ([San Francisco] Regional Water Quality Control Board, State Water Resources Control Board, and California Department of Fish and Game). 1995. *Contaminant Levels in Fish Tissue from San Francisco Bay. Final Report.* June 1995.

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**ATTACHMENT 1**

**Field Standard Operating Procedures**

#### 4.1.9 GLOBAL POSITIONING SYSTEMS

**Application** Global Positioning Systems (GPS) determine positions by receiving digital codes from satellite systems, computing time and distance, and then calculating an earth-based position. Theoretically, three satellite signals are required to determine an exact position, although four or more signals are typically monitored by GPS receivers to determine a true three-dimensional position. At present, a constellation of 24 satellites orbit the earth in support of this system.

Standard GPS is capable of extremely high accuracy ( $\pm 2\text{m}$ ); differential GPS systems are capable of positioning measurements at the centimeter level. Hardware configurations range from single channel, hand-held units capable of determining position and target direction, to extremely sophisticated multi-channel systems, employing digitized navigational charts, the ability to plot course and speed to targets, and hardware and software to interface with research vessel autopilot systems, onboard computers, radar, depth sounders, and sampling equipment.

**Equipment** • GPS receiver (hand-held or fixed unit).

**Requirements** • Some GPS systems require 110 volt AC power and the mounting of an antenna. Hand-held systems are completely portable.

**Procedure**

1. Enter station location into GPS system as latitude/longitude or other appropriate coordinate system.
2. Follow GPS direction relative to magnetic course to approach selected station.
3. Record exact station coordinates during sampling from GPS unit.

**Battelle Duxbury Operations  
Standard Operating Procedure  
for  
Operation of Digital Thermometer**

**Battelle Duxbury Operations  
Standard Operating Procedure**

for

**OPERATION OF DIGITAL THERMOMETERS**

**1.0 APPLICATION**

The purpose of this standard operating procedure (SOP) is to describe the calibration and use of the digital thermometers. Digital thermometers range in complexity from hand-held probe units with a digital (LED or LCD) read-out or thermometer probes built into temperature control units (e.g., walk-in freezers, incubators) to complex meters with selectable probes. Hand-held units have applications in both the laboratory and the field. This SOP covers only the use of simple probe units that are either simple, hand-held units or that are part of built-in monitoring for complex equipment. The calibration and operation of complex meters (such as the Fluke 52 K/J) are described in unit-specific SOPs.

Digital thermometers are available from retail and scientific suppliers; the selection of a unit should be based on the required accuracy, range, and the intended use of the thermometer. Of specific importance are:

- Units: the thermometer must provide readings in °C (centigrade)
- Accuracy: units intended for monitoring refrigerators, freezers, water baths, or sample condition must be accurate to  $\pm 1.0^{\circ}\text{C}$ . Units intended to monitor thermal reactions, incubation temperatures, or technical processes which define temperature accuracy to  $\leq 1.0^{\circ}\text{C}$  must report temperature to the nearest 10<sup>th</sup> (0.1°C).
- Range: the temperature range must bracket the expected range of the intended use of the thermometer.

**2.0 CALIBRATION**

Digital thermometers are calibrated annually according to the procedures defined in SOP 3-018. The thermometer is assigned a unique ID number and calibrated at the intended temperature range using a NIST-traceable thermometer. If the temperature reading of the digital thermometer does not agree with the NIST-traceable thermometer then a calibration factor is calculated.

**The unit ID and the correction factor are documented directly on the unit. Temperature records must specify that the correction factor has been applied.**

Calibration records at Battelle Duxbury Operations (BDO) are maintained in a bound logbook according to SOP 3-018.

**3.0 OPERATION**

The analyst must review the literature provided with the digital thermometer prior to use to determine proper use of the features. Of critical importance is selection of the correct units if the thermometer has

a °F (Fahrenheit) option. Unless specified in the project-specific Quality Assurance Project Plan (QAPP), temperature is always recorded in °C. In most cases the thermometer operation follows these steps.

1. Turn the unit on.
2. Verify that the LED display is complete. This is typically a self-test of the unit as the reading "188.8."
3. Allow the unit to equilibrate. Many units perform an initial self-test.
4. Verify that °C units are selected.
5. Begin temperature monitoring. The response of the thermometer may vary based on the temperature being measured. The analyst must observe the display to determine when the temperature has stabilized.
6. When the digital display is stable (on fluctuation) for 15 seconds then the temperature is considered stable and is recorded.
7. Temperatures are recorded directly on the proper data sheet.
8. To preserve the battery, turn off the unit if the time between measures is greater than 15 minutes.

Some thermometers may include a low-battery warning. Back-up batteries should be carried with the unit to avoid the loss of data.

Temperature monitoring units that are built into temperature-controlled equipment may have no "Operating" functions. They are typically continuous-read units. However, it is critical that if the temperature monitoring unit includes a positionable probe that the probe be placed in the appropriate matrix to avoid sudden temperature fluctuations. These matrices are: water for temperatures > 4°C and sand for temperatures < 4°C.

#### 4.0 MAINTENANCE

Other than annual calibration and cleaning of the probe with water and lint-free paper, no maintenance is required for digital thermometers. Use of a digital thermometer must be discontinued if any part of the LED display fails. Care should be taken to protect the thermometer probe if it protrudes from the unit.

#### 5.0 TRAINING

Each trainee must read and fully understand this SOP, and then demonstrate to the satisfaction of the Laboratory or Field Manager, or designee, that he/she understands the operation of the thermometer of interest. When training is complete, the trainee will be issued a Certificate of Training (Attachment 1). Original copies of the individual's completed training certificate is provided to the Quality Assurance Office.

Several types of digital thermometers are in use at Battelle. Once training is complete on one type, and the analyst understands the principles of operations, additional units may be used without re-training.

#### 6.0 SAFETY

There are no safety considerations associated with the operation of a digital thermometer. The project manager should be consulted for safety issues related to samples or the sampling site.

**ATTACHMENTS**

Attachment 1. Certificate of Training

---

**APPROVAL**

|  |                        |                |
|--|------------------------|----------------|
| Author                                     | <u>Norma Bahl</u>      | <u>6-20-00</u> |
| Laboratory Manager                         | <u>Robert Lyth</u>     | <u>6-20-00</u> |
| Field Manager                              | <u>Wayne R. Trulli</u> | <u>6-23-00</u> |
| Quality Systems Manager                    | <u>Norm Bahl</u>       | <u>6-23-00</u> |
| Environmental Chemistry<br>Section Manager | <u>CS McCarney</u>     | <u>6/23/00</u> |
|  | Name                   | Date           |



**Battelle Duxbury Operations  
Standard Operating Procedure  
for  
Packaging and Shipping of Samples**

**Battelle Duxbury Operations  
Standard Operating Procedure  
For  
Packaging and Shipping of Samples**

**Summary of changes in this version:** The procedures for maintenance of certificates for pre-cleaned sample bottles are added to this SOP (from SOP 6-010).

**1.0 OBJECTIVE**

The purpose of this SOP is to define the procedures, responsibilities, and documentation associated with the packaging and shipping of samples.

**2.0 RESPONSIBILITIES**

The sample custodian or designee is responsible for the proper packaging and shipping of samples from the laboratory. The Project Managers are responsible for informing the sample custodian or designee as to when and where the samples or sample containers are going to be shipped. The project manager or designee is responsible for contacting the recipient of the materina to be shipped to notify them of a pending delivery.

**3.0 EQUIPMENT**

**Field Pack Equipment**

Bubble Wrap  
Teflon Tape  
Black Ball Point Pens "NO SHARPIES"  
Blank COC forms

Proper Jars for sampling  
Packaging Tape  
COC Seals

**Sample Transmittal Equipment**

Bubble Wrap  
Sample Transmittal Forms  
Samples  
Cover Letter

Zip Lock Bag

**3.0 PREPARTION**

Coolers should be washed inside and outside to avoid any possible contamination of the samples. The coolers should have two handles, a working top, and be in good shape. Do not send any coolers that are badly damaged or are grossly contaminated.

**4.0 PROCEDURE**

There are two types of shipping performed by the sample custodian or designee. The most common is Sample Transmittal or sample transfer, this occurs when the laboratory custodian ships samples to an outside contractor.

The sample custodian or designee packs the samples securely in a cooler with bubble wrap and adds blue ice or crushed ice to achieve the proper temperature and to ensure that the samples stay at a constant temperature for their entire trip. The cooler should have at least one inch of bubble wrap placed on the bottom of the cooler and the samples should be wrapped in bubble wrap if breakable or crushable containers are used. The samples must not be able to move freely in the cooler; they must be secure. All paper work is signed, placed in a zip lock bag, and taped to the top of the cooler to avoid moisture. Copies of all paper work are stored in the COC logbook for tracking purposes. Note that it is Battelle policy that all cover letters receive one-over-one approval.

The second form of shipping is a "field pack." In this type of shipping the empty jars and coolers are sent to clients for sampling in the field. They might consist of just an empty cooler or go as far as PC (certified) grade jars, pens, packing tape, bubble wrap, Teflon tape, COC forms and warm blue ice to be frozen in the field. This type of packaging needs to be secured in the same manner as actual samples (described above).

If the sample jars are shipped from Battelle, the certificate which comes with the jars certifying that they are precleaned must be maintained in the Sample Jar Logbook. The custodian notes the jar lot on the sample custody forms that are shipped to the client. If the sample jars are drop-shipped directly to the field then Battelle is not responsible for retaining the jar certificates unless they are shipped to Battelle with the samples.

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**APPROVALS**

Author

*Arthur Smith, Jr.*

12 6 99

Laboratory Manager

*Arthur Smith, Jr.*

12-6-99

QA Coordinator

*Maureen Bull*

12-6-99

Environmental Chemistry  
Section Manager

*Maureen Bull*

12/7/99

Name

Date

**Attachment 1**

**RECORD OF TRAINING  
For  
SOP No. 5-210-01, Packaging of Samples for Shipment**

The above mentioned SOP is relevant to your work. Your signature below signifies that you have read and understand the requirements associated with this procedure.

Trainee \_\_\_\_\_

Instructor \_\_\_\_\_

Date SOP read and understood \_\_\_\_\_

Comments:

Approval \_\_\_\_\_

Date \_\_\_\_\_

**Battelle Pacific Northwest National Laboratories  
Marine Sciences Laboratory  
Standard Operating Procedure  
MSL-A-002-02  
Sample Chain-of-Custody**



**Marine Sciences Laboratory**

EFFECTIVE DATE: 4-27-00

Battelle Pacific Northwest National Laboratories  
Marine Sciences Laboratory

**STANDARD OPERATING PROCEDURE  
MSL-A-002-02**

**SAMPLE CHAIN-OF-CUSTODY**

| <b>Approvals:</b>                             |                           |         |
|---|---------------------------|---------|
| AUTHOR:<br>Deborah Coffey                     | <i>Original Signature</i> | 4-26-00 |
|   | <i>Signature</i>          | Date    |
| TECHNICAL REVIEWER:<br>Carolynn Suslick       | <i>Original Signature</i> | 4/27/00 |
|   | <i>Signature</i>          | Date    |
| QA OFFICER:<br>Deborah Coffey                 | <i>Original Signature</i> | 4-26-00 |
|   | <i>Signature</i>          | Date    |
| TECHNICAL GROUP<br>MANAGER:<br>Eric Crecelius | <i>Original Signature</i> | 4-27-00 |
|   | <i>Signature</i>          | Date    |

**SAMPLE CHAIN-OF-CUSTODY**



Marine Sciences Laboratory

EFFECTIVE DATE: 4-27-00

Battelle Pacific Northwest National Laboratories  
Marine Sciences Laboratory

**STANDARD OPERATING PROCEDURE**  
**MSL-A-002-02**

**SAMPLE CHAIN-OF-CUSTODY**

| Approvals:                                    |                                      |                 |
|---|--------------------------------------|-----------------|
| AUTHOR:<br>Deborah Coffey                     | <i>Deborah Coffey</i><br>Signature   | 4-26-00<br>Date |
| TECHNICAL REVIEWER:<br>Carolynn Sustick       | <i>Carolynn Sustick</i><br>Signature | 4/27/00<br>Date |
| QA OFFICER:<br>Deborah Coffey                 | <i>Deborah Coffey</i><br>Signature   | 4-26-00<br>Date |
| TECHNICAL GROUP<br>MANAGER:<br>Eric Crecelius | <i>E A Crecelius</i><br>Signature    | 4-27-00<br>Date |

## 1.0 SCOPE AND APPLICATION

This procedure defines the methods for establishing the traceability of samples transferred to the Battelle Marine Science Laboratory (MSL) for chemical and/or biological testing. This process ensures the integrity of the samples from the time of collection through sample disposal. The sequential custody of samples will be documented using this procedure. Each custodian of the samples shall comply with the procedures described below.

## 2.0 DEFINITIONS

- **Custody** - Having control of the sample in one or more of the following manners: 1) physical possession; 2) in person's view after taking possession; 3) secured by a person in a manner that prevents tampering of sample; and/or 4) secured by a person in an area restricted to authorized personnel.
- **Sample Custodian** - The person assigned, at a given field site, laboratory, or testing facility, for having responsibility for custody of the sample.
- **LRB** - Laboratory Record Book
- **CoC** – Chain of Custody

## 3.0 RESPONSIBLE STAFF

Marine Sciences Laboratory (MSL) Staff as Sample Custodian or as Sample Recipient or as MSL Contact  
Project Manager or Task Leader  
MSL Manager  
MSL Quality Assurance Officer or Representative

## 4.0 PROCEDURE

### 4.1 **Custody Procedures in the Field or Laboratory**

- 4.1.1 The sample custodian may be a member of the sampling crew or a person that works with those who are collecting the samples. The sample custodian ensures that sample labels are filled out and affixed to the appropriate sample containers before or at the time of sample collection. Information on the sample labels may include, but not be limited to, a code number identifying the sample, date, time, and location of sample collection, and name of sample collector.

- 4.1.2 Once the samples are collected, the sample custodian records pertinent sample collection information on required raw data documentation (i.e., sample log, LRB, etc.). Information may include, but not be limited to, a code number identifying the sample, date, time, and location of sample collection, and name of sample collector.

Record in permanent ink all pertinent information about each sample on a Chain-of-Custody Form (Attachment 1 or 2). Press hard when making entries and assure transfer to carbon copies. Multiple samples collected on the same date may be recorded on one Chain-of-Custody Form, provided each sample is identified individually on the form.

**Note:** The Field Sample Chain of Custody (Attachment 1) is used primarily when transferring samples from the field to the MSL for processing. The Sample Custody Record (Attachment 2) is used when transferring samples from the field or the MSL to another laboratory or testing facility. For the purpose of this SOP, the term "Chain-of-Custody Form" can mean either of the two forms.

- 4.1.3 If required by a project-specific protocol, the sample custodian attaches custody seals to the samples or to the shipping container (e.g., ice chest) immediately on sample collection. The seal is attached in such a way that the sample cannot be opened without breaking the seal.
- 4.1.4 If there are special storage requirements (i.e., temperature requirements), the sample custodian ensures that samples are immediately stored using the required method and appropriate containers.
- 4.1.5 The sample custodian is responsible for the samples during delivery to the MSL, laboratory or testing facility until custody of the samples can be transferred to the sample recipient or until release of the samples during shipment (e.g., if samples have to be shipped via overnight carrier, etc.). If custody of the samples cannot be transferred to the sample recipient or shipped on the same day as sample collection, the samples must be stored in a locked or secured storage area until the transfer can be made.

**Note:** Chain-of-Custody Forms shall remain with samples during transfer.

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## 4.2 Transferring Custody of Samples to a Laboratory or Testing Facility

- 4.2.1 Upon arrival at the laboratory or testing facility or just prior to releasing samples for shipment, the sample custodian examines the sample container(s) to ensure that the sample seals are intact and the sample containers have not been damaged.
- 4.2.2 The sample custodian relinquishes custody by signing, dating, and noting the time in the "Relinquished By" space on the Chain-of-Custody Form. The sample custodian tears off the bottom copy (pink) of the Chain-of-Custody Form and retains it for filing with project files.
- 4.2.3 The sample recipient takes custody of the samples by signing, dating, and noting the time in the "Received By" space on the Chain-of-Custody Form. The sample recipient now becomes the laboratory sample custodian, completing the transfer of sample custody. The contents of the shipping container must be checked against the information on the chain-of-custody form for anomalies. If any discrepancies are noted, or if laboratory acceptance criteria or project-specific criteria are not met, the laboratory must contact the client's designated point of contact for resolution of the problem. The discrepancy, its resolution, and the identity of the person contacted must be documented in the project file. If any seals have been broken and/or the sample containers are damaged, the sample recipient records the condition of the seals and containers in the remarks section of the Chain-of-Custody Form.
- 4.2.4 The Chain-of-Custody Forms travel with the samples during the transfer, and are filed in the laboratory or testing facility's project files.

## 4.3 Internal Chain of Custody

MSL does not routinely invoke a formal internal chain of custody process. Access to the building is limited by requiring all staff members to have electronic access cards to enter the building (refer to MSL-A-011, Marine Sciences Laboratory Access Control.) Visitors are issued daily badges. After hours site access is maintained by a gated fence to the grounds and the presence of a security guard. Non-analytical staff are not encouraged to be in areas when they have no reason to be there.

The laboratories are physically located in close proximity to one another and samples are within the physical control of the analysts during digestion and analysis activities. Samples are received in the shipping and receiving area, and logged in per procedure MSL-A-001, Sample Log-In Procedure, and stored until digestion (if required) and analysis. MSL does not store digestate for re-analysis. Instead, if a sample requires re-analysis it is digested from an archived sample. Access to sample archive refrigerators and freezers is restricted.

A Log-in Checklist (see Appendix of MSL-A-001) is used to document sample receipt activities, verification of field sample preservation, sample filtration and preservation when required, and to document any deviations related to sample receipt and sample log-in.

MSL documentation provides the location of the sample post-receipt on the Sample Log-In Form. Digestion sheets provide a record of sample digestion dates. Analysis times are documented on raw data print outs. Sample disposition is determined by the client and is documented on the Log-In Checklist in the section completed by the Project Manager. Sample disposition processes are documented in MSL-I-026, Use of Laboratory Refrigerators and Freezers. When an internal chain of custody report is desired, it can be generated from data sheets in the sample analysis data file, and verified against the data file documentation by the Project Manager and MSL QA Officer.

#### 4.4 Subdividing Samples

Once at the MSL laboratory or testing facility, if samples have to be subdivided and submitted to a subcontractor laboratory, this information will be noted on the original Chain-of-Custody Form (from sample collection), and a new Chain-of-Custody Form is initiated. With each transaction, the sample custodian relinquishes custody to the sample recipient, who then becomes the next sample custodian. (See Sections 4.2.2 through 4.2.4 above.) The requirements for chain of custody and sample disposition will be noted on the Chain-of-Custody form.

#### 4.5 Disposal of Samples

4.5.1 When samples are disposed of by the subcontractor laboratory:

- If the subcontractor laboratory or testing facility is responsible for disposing of the samples, the subcontractor is asked to notify the MSL Project Manager before final disposition. The MSL Contact will notify the originator that the samples are scheduled to be destroyed, or will define customer requirements for an extended period of storage.
- After destruction of samples, the subcontractor laboratory or testing facility is asked to return a copy of the Chain-of-Custody Form to the MSL Contact for placement in project files. The originator may be forwarded a copy of the final Chain-of Custody documentation if requested.
- The MSL Contact records the date of receipt on the Chain-of-Custody Form in the "Received by" section of the form space and indicates the samples were destroyed ending the chain of possession.

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#### 4.5.2 When samples are disposed of by the Marine Sciences Laboratory (MSL):

- If the laboratory or testing facility is not responsible for disposal of the samples, MSL personnel will obtain custody of the samples from the subcontractor laboratory or testing facility along with the Chain-of-Custody Form.

For returned samples or samples that have never left MSL custody, the MSL Contact will notify the originator that the samples are scheduled to be destroyed, or will define customer requirements for an extended period of storage.

If extended storage is not requested, then MSL will dispose of the samples following the guidelines specified in the Pacific Northwest National Laboratory's (PNNL's) Standards-Based Management System (SBMS). This system provides a framework for logging in reagents, chemicals and solutions into the associated Chemical Management System (CMS). This system provides the PNNL Laboratory with the policies and procedures regarding tracking and inventory, storage and disposal of completed samples and analytical wastes, as well as chemical use and disposal. The CMS is used to provide an up-to-date inventory to facilitate emergency response, monitor the location of various classes of materials and identify situations where acceptable limits for the building/facility determined by the assigned chemical hazard group and fire zone might be exceeded before a violation occurs.

- After destruction of samples, MSL personnel responsible for sample destruction returns a copy of the Chain-of-Custody Form to the MSL Contact and the Sample Disposal Log Book entry is updated.
- The MSL Contact records the date of receipt on the Chain-of-Custody Form in the "Received by" space next to the Sample Custodian's signature and indicates the samples were destroyed ending the chain of possession.

#### 4.5.3 When samples are returned to the customer for disposal:

- Samples may be returned to the customer (or the sampling site) by customer request. Samples are shipped to meet Department of Transportation regulations. Generally, the samples are shipped in the same way that they were initially shipped to MSL. Sample disposition should be documented in the central file of each project.

#### 4.5.4 The MSL Contact shall ensure that completed Chain-of-Custody Forms are filed in the appropriate project files. The originator may be forwarded a copy of the final Chain-of-Custody documentation if requested.

## 5.0 DATA ANALYSIS AND CALCULATIONS

There are no calculations applicable to this procedure.

## 6.0 QUALITY CONTROL

It is the responsibility of each individual taking or relinquishing custody of the samples to ensure that Chain-of-Custody Forms are filled out accurately and completely for each transaction, and that the forms are filed in the appropriate project files.

If the Chain of Custody is broken at any time when the sample is in the control of MSL, this deviation must be documented in the data report narrative.

## 7.0 SAFETY

Not applicable.

## 8.0 TRAINING REQUIREMENTS

All staff responsible for sample custody (i.e., sample relinquisher or sample recipient) shall first read this procedure and document the training as a completed reading assignment on an Individual Training Assignment Form or a Group Training Documentation Form as described in MSL-A-006, Marine Sciences Laboratory Training.

## 9.0 REFERENCES

|           |   |
|-----------|---|
| MSL-A-001 | Sample Log-In Procedure                           |
| MSL-A-006 | Marine Sciences Laboratory Training               |
| MSL-A-011 | Marine Sciences Laboratory Access Control         |
| MSL-D-004 | Data Reporting, Reduction, Back Up, and Archiving |
| MSL-I-026 | Use of Laboratory Refrigerators and Freezer       |

**Attachment 1**

|  |  |                      |                    |
|--|--|----------------------|--------------------|
| <b>Battelle</b><br>Marine Sciences Laboratory<br>1529 W. Sequim Bay Rd.<br>Sequim, WA 98382  | <b>EXAMPLE<br/>FIELD SAMPLING CHAIN OF<br/>CUSTODY</b> | Page _____ of _____  |                    |
| Shipped To: _____ Method of Shipment: _____<br>Company: _____ Shipped From: _____ By: _____<br>Address: _____ Telephone: _____     |  |                      |                    |
| SPECIAL INSTRUCTIONS:<br><br>_____<br>_____  |  |                      |                    |
| Container No.: _____<br>Sampling Location: _____<br><br>Samples Collected By: _____ Date: _____<br>Remarks :<br><br>_____<br>_____ |  |                      |                    |
| <b>SAMPLE IDENTIFCATION</b>  |  |                      |                    |
|  |  |                      |                    |
|  |  |                      |                    |
|  |  |                      |                    |
|  |  |                      |                    |
|  |  |                      |                    |
| _____<br>Relinquished by   | _____<br>Date/Time                                     | _____<br>Received by | _____<br>Date/Time |
| _____<br>Relinquished by   | _____<br>Date/Time                                     | _____<br>Received by | _____<br>Date/Time |
| _____<br>Relinquished by   | _____<br>Date/Time                                     | _____<br>Received by | _____<br>Date/Time |



**Battelle Duxbury Operations  
Standard Operating Procedure  
for  
Packaging and Shipping of Samples**

**Battelle Duxbury Operations  
Standard Operating Procedures**

for

**SAMPLE RECEIPT, CUSTODY, AND HANDLING**

**Summary of changes in this version:** Additions about VOC refrigerator blanks, delivery of samples outside of normal hours, and other minor edits.

**1.0 OBJECTIVE**

Sample control is a vital aspect of any environmental monitoring program which generates data that may be used for regulatory purposes or as evidence in a court of law. Additionally, the complexity of many environmental sampling programs, which may involve the collection and analysis of samples of various media from different sites to be analyzed for several parameters, makes a sample control system essential. This standard operating procedure (SOP) defines the procedures, organizational responsibilities, and documentation requirements associated with the Laboratory sample control system.

The routine flow of samples through the laboratory is illustrated in Attachment 1. Additional sample control procedures may be required to meet the needs of specific projects. These procedures will be defined in the project plan.

**2.0 DEFINITIONS**

*Custody Records* — The administrative records associated with the possession history of each sample from the time of collection, through analysis, to final disposal.

*Chain-of-Custody Records* — The administrative records associated with the physical possession and/or storage history of each individual sample from the purchase and preparation of each sample container and sampling apparatus to the final analytical result and sample disposal.

*Legal or Evidentiary Chain of Custody (COC)* — A special type of sample custody which requires that the physical possession, transport and storage of a sample be documented in writing. The records must account for all periods of time from sample container acquisition through sample disposal.

*Sample control* — The formal system designed to provide sufficient information to reconstruct the history of each sample, including collection, shipment, receipt and distribution within the laboratory, analysis, storage or disposal, and data reporting.

*Sample custody* — Samples are considered to be in a person's custody if

- The samples are in a person's actual possession
- The samples are in a person's view after being in that person's possession

- The samples were in a person's possession and then were locked or sealed up to prevent tampering
- The samples are in a secure area

### 3.0 RESPONSIBILITIES

*Sample Collector* — The person collecting the samples is responsible for

- Collecting and preserving samples in accordance with approved procedures, as specified in the project-specific plan and SOPs
- Adjusting the pH to  $< 2$  if the sample is intended for volatile organics analysis (and also adding sodium thiosulfate if total residual chlorine is present)
- Assigning a number or code at the time of collection that uniquely identifies that sample
- Labeling each sample container with the sample number, project identification, date of collection, collector's initials, and storage requirements (room temperature, frozen, chilled)
- Documenting sample collection and preservation
- Packaging samples for shipment in a manner that minimizes the risk of breaks and leaks and to ensure that the samples are maintained at the appropriate temperature
- Completing and signing the chain-of-custody records accurately and legibly
- Ensuring integrity of the samples by sealing or locking the shipping container(s) and applying custody tape (if required)
- Arranging timely transportation of samples to the laboratory, including identifying on the shipping label the name of the person to whom the samples should be delivered

*Laboratory Sample Custodian* — The responsibilities of the Laboratory Sample Custodian include:

- Receiving samples (for details see Section 4.1).
- Maintaining records of sample receipt, movement in and out of storage, and release, archival, and disposal
- Distributing completed custody forms according to Section 4.1.5.
- Returning the shipping cooler to the client or shipper.
- Communicating sample custody problems to the project manager and implementing corrective action as directed (Section 4.8).

*Alternate Sample Custodian* — The Alternate Sample Custodian is responsible for assisting the Laboratory Sample Custodian and for performing the above tasks in the absence of the Laboratory Sample Custodian.

*Project Manager* — The Project Manager is responsible for communicating

- expected receipt dates and project-specific receipt requirements to the Sample Custodian
- the potential presence of total residual chlorine to the Sample Custodian
- sample custody-related problems to the client
- corrective action to the sample custodian and laboratory manager

*Laboratory Manager* — The Laboratory Manager is responsible for designating the Laboratory Sample Custodian and the Alternate Sample Custodian and for ensuring that these individuals are trained to perform the tasks specified in this SOP.

## 4.0 PROCEDURES

### 4.1 SAMPLE RECEIPT

#### 4.1.1 Hours

Samples that are admitted to the laboratory during normal business hours are either delivered to the front desk or to a designated area in the Chemistry North Building. The Sample Custodian is notified immediately.

It is Battelle policy that samples are not received outside of regular business hours unless the project manager has made specific arrangements with the laboratory manager and the sample custodian in advance. Samples that are delivered outside of regular business hours should be treated equally as samples received during the week. Receipt temperatures should be recorded and the proper storage of the samples should occur. The project manager should coordinate deliveries with the lab manager and the custodian assigned to receive the samples *before such deliveries are scheduled*. The project manager should also make every effort to be available (be able to be reached), in case unexpected problems occur.

- If samples are transported from the field to the laboratory by Battelle sampling personnel, the samples should be placed in a pre-arranged, secure location until they can be formally relinquished to the Laboratory Sample Custodian.

In either case, on the next business day, the Laboratory Sample Custodian logs in the samples. (Note that the receipt form allows for separate entries of receipt and log-in date).

Upon receipt of the samples, the Laboratory Sample Custodian will move the shipping containers to the sample custody room.

#### 4.1.2 Sample Handling

The shipping container should only be opened under the vented hood. The sample custodian must determine whether the sample condition upon receipt is acceptable. That is, that the sample temperatures, pH, and containers, are appropriate for the intended analysis; and that the samples have been received within the required holding times. Attachment 2 defines acceptable sample handling and holding times. If sample containers, preservation, or timely delivery do not meet the criteria in Attachment 2 and section 4.1.3, then the sample custodian must notify the project manager who in turn must notify the client (section 4.8).

The sample custodian must review and document the following for proper receipt of the samples:

1. Method of delivery (*i.e.* commercial carrier, hand delivered) and presence/absence of chains-of-custodies.
2. Inspect the shipping container(s) for the presence/absence and condition of custody seals.

3. Inspect each sample for the presence/absence and condition of samples and custody seals.
4. Inspect each sample for breaks or leaks (see Section 5.0 for safety instructions).
5. Review the accompanying records for completeness and accuracy of sample labels and sample transmittal forms.
6. Measure and record the temperature of each container to document whether or not the samples were maintained at the appropriate temperature (frozen, cool, or room temperature) during shipment. The temperature of a cooler blank (if available), melt water, or the external temperature of the sample containers should be measured and documented. (Thermometers or probes are never inserted into a sample container).
7. Measure and record initial pH of water samples unless otherwise directed by the laboratory manager, project manager, or QAPP (see Section 4.2.1).
8. If the project manager indicates that TRC may be present, measure samples for total residual chlorine (TRC) and treat samples with sodium thiosulfate (Section 4.2.2).
9. Inspect VOC vials for bubbles of sizes greater than 1% of the vial volume. If present, notify the Project Manager immediately.  
\*A refrigerator blank must be made for all VOA samples received. This blank should travel with the samples and be included with the sample analysis.
10. Upon completion of the sample inspection, the Laboratory Sample Custodian formally acknowledges receipt of the samples by signing, dating, and noting the current time on the sample transmittal form(s).
11. Log-in and assign unique laboratory identification numbers to each sample (see Section 4.3).
12. Storage of samples in the appropriate storage location until samples are ready to be further processed. VOC samples to be stored in a separate storage location than samples for other organic analyses. This includes releasing samples to the laboratory and to outside contractors.
13. Communicate sample custody problems to the project manager and implement corrective action as directed.
14. Distribute completed custody forms according to Section 4.1.5.
15. Return the shipping coolers to the client or shipper, if necessary.

#### **4.1.3 Sample Acceptance/Rejection Criteria**

Under some circumstances Battelle will place itself at risk by accepting samples for analysis because data that are generated from samples that do not meet chain of custody or handling requirements (Section 4.1.1) may be rejected by EPA. Battelle may currently analyze samples for the following regulatory programs:

- Resource Conservation and Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation and Liability Act (Superfund) (CERCLA)
- Clean Water Act (CWA)

It is the responsibility of the sample custodian to ensure that the following conditions are recorded on the Sample Receipt Form. The Laboratory Sample Custodian will notify the Project Manager and Laboratory Manager in writing (See Section 4.8 and Attachment 3) of sample receipt, condition, and problems (e.g., breakage, leakage, missing samples, excessive temperatures). Upon completion of sample inspection, the Laboratory Sample Custodian formally acknowledges receipt of the samples by signing, dating, and noting the current time on the sample transmittal form(s).

It is the responsibility of the project manager to specify in the QAPP that project samples are being analyzed for compliance monitoring. In these cases samples could be rejected if:

- The integrity of the samples is compromised (leaks, cracks, grossly contaminated container exteriors or shipping cooler interiors, obvious odors, etc.)
- The identity of the container cannot be verified
- The proper preservation of the container cannot be established
- VOC vials contain bubbles of sizes greater than 1% of the vial volume
- Incomplete sample custody forms: the sample collector is not documented or the custody forms are not signed and dated by the person who relinquished the samples
- The sample collector did not relinquish the samples.
- Samples are designated for VOA analysis but no VOA trip blank is provided.

If the sample custodian identifies any of the above conditions the project manager must be notified (Section 4.8).

#### **4.1.4 Documentation**

Documentation of sample receipt includes the original sample custody forms (or copies if the originals are returned to the shipper), any additional records of transmittal, the shipper's air bill (if applicable), and the Sample Receipt form. Sample custody records are filed by date in the Custody Logbook which is kept in the access controlled sample custody room. A record of Battelle Laboratory ID numbers, including cross-reference to original field IDs, is entered into the custody database and hard copies are stored in the custody room.

The condition of the samples, integrity of the custody seals, discrepancies between sample labels and transmittal forms, and unusual events or deviations from the project work plan or SOPs are documented in detail on a Sample Receipt Form (Attachment 4). Any problems are also recorded on the original custody forms, if present.

Occasionally, samples are received with only a letter of transmittal or no transmittal forms at all. In these cases the Sample Custodian should complete the sample log-in procedures (Section 4.3) and attach a printout from the Chemistry Laboratory Sample Receipt Database to the Sample Receipt form to provide a record in the Custody Log of the samples received.

#### 4.1.5 Distribution

The sample custodian will provide the Project Manager, the QAU, and Lab Manager with a copy of all documentation that accompanied the samples.

The custodian should make the following distribution of custody forms:

- Copies of the sample receipt and custody forms are provided to the project manager (2 copies), laboratory manager, and the quality assurance officer.
- If the custody forms that are received with the samples are multi-copied then the copies should be distributed as indicated on each copy (e.g., laboratory, customer (client), shipper).
- If the custody forms that are received with the samples are not multi-copied then the custodian should consult the project manager to determine if a copy of the custody records should be returned to the client and/or shipper.

## 4.2 SAMPLE PRESERVATION ADJUSTMENTS

### 4.2.1 pH Measurement and Adjustment

If water samples will not be extracted within 72 hours then the pH is typically adjusted according to the preservation requirements in Attachment 2. To measure pH, withdraw a small volume of water (0.1 mL) from the sample container using a baked Pasteur pipette. Place 1 drop on a narrow range pH paper strip and follow the instructions included with the pH paper to read the results. Record the pH on the Sample Receipt form (Attachment 4). If water sample pH is NOT between pH 5 and 9 consult the project and/or laboratory manager and make pH adjustments as directed by these managers. The decision to adjust sample pH is based on the target analyte list and is therefore made on a case-by-case basis.

To adjust the sample pH, sulfuric or hydrochloric acid (1+1) or 10 N NaOH is added until the sample pH is between 5 and 9. (Note that NaOH solutions must be pre-extracted prior to use to prevent sample contamination). The final pH and the volume of solution added in making the pH adjustment is recorded on the Sample Receipt form.

**Samples intended for VOA analysis should NOT be opened. pH adjustments must be made in the field.**

### 4.2.2 Total Residual Chlorine Measurement and Treatment.

If the project manager indicates that samples may contain total residual chlorine (TRC) then the sample must be treated with sodium thiosulfate according to Attachment 2 (PCB/Pest, PAH). The sample custodian must work directly with the project manager in these cases. Ideally, the sample is treated for chlorine in the field. However, the sample custodian should verify the absence of TRC using a commercial test kit. If TRC is detected then sodium thiosulfate is added at the ratio of 80 mg/L sample. This treatment is documented on the sample receipt form.

**Samples intended for VOA analysis should NOT be opened. Treatment for TRC must be performed in the field.**

#### 4.3 SAMPLE LOG-IN

The receipt of all samples received by the Chemistry Laboratory will be recorded in the Chemistry Laboratory Sample Receipt Database (SOP 6-007). Each incoming sample is assigned a unique ID number, which is clearly and indelibly marked on each sample container and the custody form. Samples that contain more than one jar for the same analysis will be labeled with the same Lab ID and the jar number (e.g. 1 of 2 and 2 of 2). Alternatively, a separate ID number can be assigned to each container. The full ID including the jar number will be called out in the preparatory records. Upon completion of log-in procedures, samples are placed in a limited-access area at the appropriate temperature. The storage area is documented on the Sample Receipt form.

#### 4.4 SAMPLE STORAGE

Upon completion of sample log-in procedures, samples are transferred to a secure location for storage. This location may be a room, refrigerator, or freezer, depending on the storage requirements of the samples, but must be an area that can be locked from the outside. The initial storage location is documented on the Sample Receipt form. Only the sample custodian and the facilities manager have keys to these controlled-access areas.

The following storage requirements are applied to samples received at Battelle unless otherwise specified in the QAPP: tissue and sediment samples:  $\leq 20^{\circ}\text{C}$ ; water samples:  $4 \pm 2^{\circ}\text{C}$ . Samples collected for compliance monitoring according to EPA regulatory methods are stored according to the conditions specified in Attachment 2 and should be specified in the QAPP.

Samples that are to be analyzed for volatile organic compounds must be stored in a separate storage location from the samples being analyzed for semi-volatile organic compounds.

#### 4.5 SAMPLE TRACKING

Sample custody is transferred from the Sample Custodian to the sample prep Task Leader when sample preparation is initiated. The transfer of custody to laboratory personnel and all sample movement within the laboratory is documented on Daily Sample Tracking forms (Attachment 5) that are maintained with the prep records. Each technician is responsible for the care and appropriate storage of the samples in his/her custody, and for documenting the conditions under which the samples are maintained. Labs/areas which house samples in-progress must be controlled-access (locked) during non-working hours.

#### 4.6 SAMPLE SPLITTING

The aliquotting of samples for multiple analyses is documented on Sample Split and Transfer Logs (Attachment 6). Split samples retain their original Laboratory Sample identification number. Sample Split Logs are maintained with the original sample custody records. Lab IDs are distinguished by the analyses for which the sample was split.

#### 4.7 SHIPMENT OF SAMPLES

Distribution of samples that are aliquotted at Battelle and shipped to external laboratories for analyses is normally documented on the Battelle Sample Split and Transfer Log. If the samples were collected or generated by Battelle, sample custody is tracked on Battelle Custody forms (Attachment 7) that are shipped with the samples. In either case the person who has custody of the samples is responsible for

- packing the samples for shipment such that temperatures requirements are maintained and samples are protected from breaks or leaks
- arranging for transportation.

A *copy* of the transfer or custody form should be retained with the original custody records for tracking purposes. The custodian at the receiving laboratory documents sample receipt and condition on the form and retains the yellow copy. The white (original) and pink copies are returned to Battelle. The original is maintained with the original custody records and the pink copy is sent to the client, if requested. The preparation of field kits, custody of sample containers, and sample packing procedures are defined in SOP 5-210.

#### 4.8 CLIENT NOTIFICATION

The client must be notified immediately if problems are noted during sample receipt and log-in so that corrective action may be initiated. The sample custodian may communicate directly with the client custodian or representative if discrepancies between sample labels and custody forms are noted or if samples are missing. The project manager should communicate other problems (e.g., holding time exceedences, preservation issues, incomplete or improper custody records – see Section 4.1.3). This notification and the clients directions for corrective action is documented on the Corrective Action form (Attachment 3). It must be specifically documented if the client approves analysis of the samples. All corrective action is communicated to the sample custodian or laboratory manager in writing.

Specific samples may include other client notification requirements (e.g., if permit thresh hold limits are exceeded the client must be notified within 24 hours of verified sample data). The project manager should define requirements these in the QAPP.

#### 4.9 SAMPLE ARCHIVAL AND DISPOSAL

Sample extracts and unextracted field samples are returned to the custody of the sample custodian. Once sample analysis is considered final the samples can be archived.

The decision to archive samples should be made by the client and the Project Manager when the project is initiated. Sample disposition and the length of storage should be defined in the project plan. In the absence of other directives, unexpended samples are archived for six months after the delivery of the final data. Unless otherwise specified by the client, the samples will be discarded in the proper waste stream after this period. The project manager will be notified prior to the disposal of samples.

Sample extracts are held for one month after delivery of the final data. Unless otherwise specified by the client the extracts will be discarded in the proper waste stream after this period. The project manager is not notified of extract disposal. It is the responsibility of the project manager to include sample disposition requirements in the QAPP and to communicate them to the sample custodian. The following documentation is required:

1. Samples or extracts for archival are boxed by batch.
2. The project numbers, title/clients, batch numbers, and extract fractions are labeled on the box.
3. A copy of the label is filed in the Sample Archival logbook and the archive location of the box (box number and freezer number) is documented in the logbook.

Sample disposal is documented in the Sample Archival Log Book by documenting "Discarded" with the date and initials of the custodian directly on the label copy. The appropriate handling and disposal procedures for sample and sample extract are discussed in SOP 5-114.

## 5.0 SAFETY

Sample handling must always assume that samples are potentially "contaminated." Therefore, sample shipping containers are always opened in a vented fume hood, and personnel protective equipment is worn when unpacking samples (safety glasses, lab coat, and gloves).

Occasionally, samples are received broken. Because the potential hazard may be unknown all spills must be treated as if the material is hazardous. Clean-up materials should be maintained in the sample custody room, or easily accessible. These consist of

|                              |                              |
|------------------------------|------------------------------|
| absorbent (e.g., speedi-dry) | paper towels                 |
| dust pan and brush           | plastic bags                 |
| glass disposal container     | solid waste stream container |
| heavy-duty gloves            |                              |

The hazardous waste coordinator should be contacted to determine the proper disposal procedures for spilled sample. In general, water samples are absorbed into chemical absorbent; sediment, soil, or tissues are placed in heavy-duty plastic bags. These are both disposed of in the laboratory's solid waste stream. Broken glass containers are placed in the glass disposal container.

## 6.0 TRAINING

A person who is being trained as a sample custodian must first read this SOP. The person may then perform specific tasks under the supervision of a qualified instructor (Laboratory Sample Custodian or Alternate). Tasks performed by the trainee are reviewed and co-signed by the Laboratory Sample Custodian or Alternate until it has been established that the trainee is able to perform these tasks without supervision. A certificate of training (Attachment 8) is issued upon completion of training and provided to the Quality Assurance Unit.

## ATTACHMENTS

1. Sample Flowchart
2. Sample Handling Requirements
3. Sample Custody Corrective Action Form
- 4a. Sample Receipt Form
- 4b. Sample Receipt Auxiliary Form
5. Daily Sample Tracking Form
6. Sample Split and Transfer Log
7. Battelle Chain-of- Custody Record
8. Certificate of Training

---

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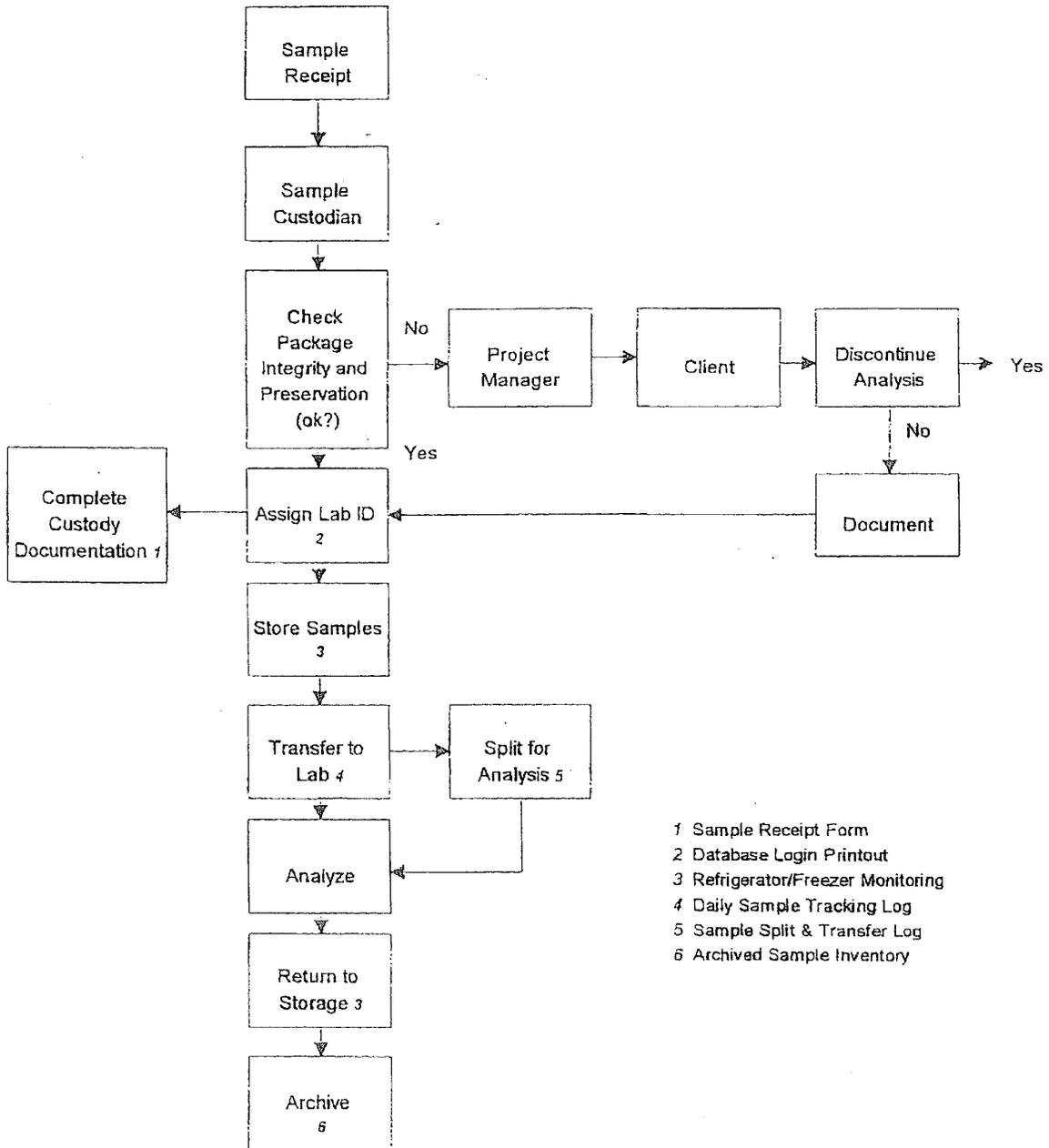
*Donna Carley*

8/7/2000

Name

Date

**ATTACHMENT 1**  
**Battelle Duxbury Operations**  
**Sample Flowchart**



**ATTACHMENT 2  
Sample Handling Requirements**

**WATER**

| Compound Class  | Containers                         | Preservation     |   | Holding Time   |
|---|------------------------------------|------------------|---|--|
|   |                                    | Temperature      | Other   |  |
| PESTICIDES <sup>1</sup><br>PCBs <sup>1</sup>  | Glass with<br>Teflon lined<br>caps | Cool 4°C<br>±2°C | pH 5-9 if held<br>longer than 72<br>hours<br>Store in dark<br>Store in dark | 7 days until extraction, 40 days<br>after extraction |
| PAH <sup>1</sup>  |                                    |                  |   |  |
| Other SVOA<br>• Haloethers<br>• Phthalate Esters<br>• Nitroaromatics<br>• Isophorones<br>• Nitrosamines |                                    |                  |   |  |
| TPH or<br>FINGERPRINT<br>VOA <sup>1</sup>   |                                    |                  |   |  |
| TBT   | Polycarbonate                      | Freeze ≤20°C     | pH<2<br><br>Headspace ≤1%<br>of sample                                      | 14 days<br><br>90 days                               |

<sup>1</sup>If Residual Chlorine is present in the sample it must be treated with sodium thiosulfate.

**SEDIMENT/SOIL**

| Compound Class        | Containers                         | Preservation      |       | Holding Time  |
|-----------------------|------------------------------------|-------------------|-------|---|
|                       |                                    | Temperature       | Other |   |
| PESTICIDES<br>PCBS    | Glass with<br>Teflon lined<br>caps | Cool 4°C<br>± 2°C |       | 14 days until extraction, 40 days<br>after extraction |
| PAH<br>SVOA           |                                    |                   |       |   |
| VOA                   |                                    | Freeze ≤20°C      |       | 1 Year  |
| TPH or<br>FINGERPRINT |                                    | Cool 4°C<br>± 2°C |       | 14 days   |
| TBT                   |                                    | Cool 4°C<br>± 2°C |       | 14 days until extraction, 40 days<br>after extraction |
|                       |                                    | Freeze ≤20°C      |       | 1 Year  |

All tissue samples are stored frozen (≤20°C).

**ATTACHMENT 3**  
**Battelle Duxbury Operations**  
**Sample Custody Corrective Action Form**

Project Number \_\_\_\_\_ Client \_\_\_\_\_

**Description of Problem (continue on back, if needed):**

The sample custodian must contact the project manager on the day that problems are identified. If the project manager is not in the office the laboratory manager must be notified.

---

**Documentation of project manager notification:**

|                   |           |       |
|-------------------|-----------|-------|
| Sample Custodian: | _____     | _____ |
|                   | Signature | Date  |
| Project Manager   | _____     | _____ |
|                   | Signature | Date  |

---

**Documentation of client notification (to be completed by project manager):**

On \_\_\_\_\_ I contacted \_\_\_\_\_ at \_\_\_\_\_  
Date Name of client contact Name of client organization

Results of communication with client (Describe any corrective action directed by the client):

RETURN THIS ORIGINAL TO THE SAMPLE CUSTODIAN. THE SAMPLE CUSTODIAN WILL PROVIDE COPIES TO THOSE ON THE ORIGINAL SAMPLE CUSTODY DISTRIBUTION LIST.

Date that this form was received by the custodian: \_\_\_\_\_

**ATTACHMENT 4a**  
**Battelle Duxbury Operations**  
**Sample Receipt Form**

Project Number \_\_\_\_\_ Client \_\_\_\_\_  
No. of Shipping Containers \_\_\_\_\_ Date/Time Received \_\_\_\_\_

**SHIPMENT**

**Method of Delivery:** \_\_\_\_\_ Commercial Carrier (Air bill No. \_\_\_\_\_)  
\_\_\_\_\_ Hand Delivered  
\_\_\_\_\_ US Mail (RPS No. \_\_\_\_\_)

**COC Forms:** \_\_\_\_\_ Shipped with samples \_\_\_\_\_ No forms  
**Cooler(s)\Box(es) were sealed with:** \_\_\_\_\_ Tape \_\_\_\_\_ Custody Seals \_\_\_\_\_ (Other specify)  
Were the seals intact for each shipping container \_\_\_\_\_ Yes \_\_\_\_\_ No  
If seals were broken (list impacted samples):

**SAMPLES**

**Sample Labels:** \_\_\_\_\_ Sample labels agree with COC forms \_\_\_\_\_ Discrepancies (see COC forms)

**Container Seals:** \_\_\_\_\_ Tape \_\_\_\_\_ Custody Seals \_\_\_\_\_ (Other specify)  
\_\_\_\_\_ Seals intact for each shipping container  
\_\_\_\_\_ Seal broken (list impacted samples):

**Condition of Samples:** \_\_\_\_\_ Sample containers intact  
\_\_\_\_\_ Sample containers broken/leaking (see COC forms)

**Temperature upon receipt (°C):** \_\_\_\_\_ Temperature blank used \_\_\_\_\_ Yes \_\_\_\_\_ No  
(Note: If temperature upon receipt differs from required conditions, list impacted samples):

**Initial pH 5 - 9? (Y/N):** \_\_\_\_\_ *If no, individual sample adjustments on the Auxiliary Sample Receipt Form.*

**Total Residual Chlorine Present?(water ) (Y/N):** \_\_\_\_\_  
*If yes, individual sample adjustments on the Auxiliary Sample Receipt Form.*

**Head Space <1% in samples for VOC analysis** \_\_\_\_\_ Yes \_\_\_\_\_ No  
*Individual sample deviations listed below.*

**Sample Containers:**  
Samples returned in PC-grade sampling jars (Yes/No). \_\_\_\_\_ Lot No. \_\_\_\_\_  
All but the following samples were returned in Battelle-prepped bottles:

**Storage Location:** \_\_\_\_\_ **BDO IDs Assigned:** \_\_\_\_\_  
Additional Comments:

Samples logged in by: \_\_\_\_\_ Date/Time: \_\_\_\_\_



**ATTACHMENT 5**  
**Battelle Duxbury Operations**  
**Example Daily Sample Tracking Form<sup>1</sup>**

|                                       |        |       |
|---------------------------------------|--------|-------|
| Samples Relinquished by Custodian :   | Date : | Time: |
| Location from which retrieved :       | Date : | Time: |
| Samples received for sample prep by : | Date : | Time: |
| Storage until prep initiated :        | Date : | Time: |
| Samples Returned to Custodian :       | Date : | Time: |
| Location Stored :                     | Date : | Time: |

|                          |           |                        |
|--------------------------|-----------|------------------------|
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |
| Date Extracts Removed :  | Initials: | Location removed from: |
| Date Extracts Returned : | Initials: | Storage Location:      |

Comments:

**VALIDATION CHECKLIST**

|   |  |
|---|--|
| Check sample custody records to verify client Ids                                       |  |
| Verify all samples in batch are reported and all samples reported are in the prep batch |  |
| Complete surrogate and internal standard spiking forms                                  |  |
| Check sample dilution, grav weights, and correction factors                             |  |
| Check HPLC tables 100%  |  |
| Check dry weight and lipid weight tables  |  |
| Ensure sample transfer and documented by proper sign-off                                |  |

<sup>1</sup> Separate forms should be initiated for each sample prep batch and for each analysis.  
If sample is not consumed, document the storage of the remainder.

**ATTACHMENT 6  
Battelle Duxbury Operation  
Sample Split and Transfer Log**



**Sample Split and Transfer Log**

|  |                    |
|--|--------------------|
| Project Number _____   | Date of Work _____ |
| Project Title _____  |                    |
| Analysis Type(s) _____   |                    |
| Splitting Procedure _____  |                    |
| (include description of amount or weight of split, packaging, storage) |                    |
| Name _____   | Date _____         |

| Sample ID |
|-----------|-----------|-----------|-----------|-----------|-----------|
|           |           |           |           |           |           |
|           |           |           |           |           |           |
|           |           |           |           |           |           |
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|           |           |           |           |           |           |

|                                    |                                    |
|------------------------------------|------------------------------------|
| <b>Released</b>                    | <b>Received</b>                    |
| Signature/Date: _____              | Signature/Date: _____              |
| Storage Location/Conditions: _____ | Storage Location/Conditions: _____ |
| <b>Released</b>                    | <b>Received</b>                    |
| Signature/Date: _____              | Signature/Date: _____              |
| Storage Location/Conditions: _____ | Storage Location/Conditions: _____ |



**ATTACHMENT 8**  
**Battelle Duxbury Operations**  
**Certificate of Training**

SOP No. 6-010

SOP Title: Chemistry Laboratory Sample Control

Trainee \_\_\_\_\_

Instructor: \_\_\_\_\_

SOP Read: \_\_\_\_\_  
Signature

\_\_\_\_\_ Date

Date Training Completed: \_\_\_\_\_

The above mentioned trainee has satisfactorily completed the training requirements associated with this SOP. Supporting documentation (if applicable) is attached.

Comments:

Approved By/Date: \_\_\_\_\_

**APPENDIX E**

**Draft Quality Assurance Project Plan for Hunters Point Shipyard  
Parcel F Human Health Evaluation**



# **APPENDIX E**

## **Draft**

### **Quality Assurance Project Plan for Hunters Point Shipyard Parcel F Human Health Evaluation**

**January 9, 2001**

**Contract No. N62474-94-D-7609**

**Delivery Order No. 0084**

*Prepared for:*

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DRAFT

QUALITY ASSURANCE PROJECT PLAN FOR  
HUNTERS POINT SHIPYARD PARCEL F  
HUMAN HEALTH EVALUATION

SAN FRANCISCO BAY, CALIFORNIA

Prepared by:

Sediment Work Group Members

BATTELLE

NEPTUNE AND COMPANY

January 9, 2001

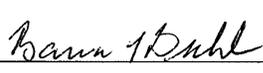
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Name

Date: 1-9-01

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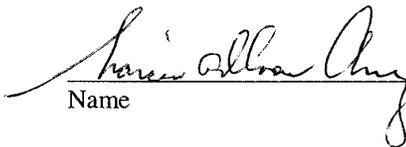
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| Donald Gunster    | Jeff Ward           |
| Jennifer Holder   | Patricia White      |
| Nancy Kohn        | Greg Williams       |
| James Leather     |                     |

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**ACRONYMS AND ABBREVIATIONS**

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|          |   |
|----------|---|
| BDO      | – Battelle Duxbury Operations   |
| BRAC     | – Base Realignment and Closure  |
| BSL      | – Battelle Sequim Laboratory  |
| CERCLA   | – Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR      | – Code of Federal Regulations   |
| CLP      | – Contract laboratory program   |
| cm       | – Centimeter  |
| COPC     | – Contaminant of potential concern                                      |
| CRDL     | – Contract required detection limit                                     |
| CVAA     | – Cold vapor atomic absorption  |
| dGPS     | – Differentially-corrected global positioning system                    |
| DOD      | – Department of Defense   |
| DQA      | – Data quality assessment   |
| DQC      | – Data quality criteria   |
| DQO      | – Data quality objective  |
| ECD      | – Electron-capture detector   |
| EDD      | – Electronic data deliverable   |
| ELAP     | – Environmental Laboratory Assessment Program                           |
| EPA      | – U.S. Environmental Protection Agency                                  |
| FID      | – Flame ionization detector   |
| FPD      | – Flame photometric detector  |
| FS       | – Feasibility Study   |
| FSP      | – Field sampling plan   |
| g        | – Gram  |
| GC       | – Gas chromatography  |
| GC/FPD   | – Gas chromatography/Flame Photometric Detector                         |
| GC/ECD   | – Gas chromatography/ Electron-capture detector                         |
| GC/MS    | – Gas chromatography/mass spectrometry                                  |
| GC/MSD   | – Gas chromatograph/mass-selective detector                             |
| GFAA     | – Graphite furnace atomic absorption                                    |
| HAZWOPER | – Hazardous waste operations and emergency response                     |
| HPLC     | – High performance liquid chromatography                                |
| HPS      | – Hunters Point Shipyard  |
| ICP      | – Inductively coupled plasma  |
| ICP-AES  | – Inductively coupled plasma-Atomic Emission Spectroscopy               |
| ICP-MS   | – Inductively coupled plasma-mass spectroscopy                          |
| ID       | – Identification  |
| LCS      | – Laboratory control sample   |
| LCSD     | – Laboratory control sample duplicate                                   |
| MB       | – Method or procedural blank  |
| MDL      | – Method detection limit  |
| mg/kg    | – Milligrams per kilogram   |

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|              |   |
|--------------|---|
| mL           | – Milliliter                                      |
| MS           | – Matrix spike                                    |
| MSL          | – Marine Sciences Laboratory ( <i>i.e.</i> , BSL) |
| MSD          | – Matrix spike duplicate                          |
| NA           | – Not applicable                                  |
| NAVFACENGCOM | – Naval Facility Engineering Command              |
| NEDTS        | – National Environmental Data Transfer Standards  |
| NFESC        | – Naval Facilities Engineering Service Center     |
| NIST         | – National Institute of Standards and Technology  |
| NOAA         | – National Oceanic and Atmospheric Administration |
| NPL          | – National priorities list                        |
| NQAR         | – Navy QA Representative                          |
| PAH          | – Polycyclic aromatic hydrocarbon                 |
| PCB          | – Polychlorinated biphenyl                        |
| PD           | – Percent difference                              |
| PE           | – Performance evaluation                          |
| PFTBA        | – Perfluorotributylamine                          |
| PT           | – Performance test                                |
| QA           | – Quality assurance                               |
| QADU         | – Quality assurance (laboratory) duplicate sample |
| QAPP         | – Quality assurance project plan                  |
| QC           | – Quality control                                 |
| QL           | – Quantitation limit                              |
| RAG          | – Risk Assessment Guidelines                      |
| RBSC         | – Risk-based screening concentration              |
| RF           | – Response factor                                 |
| RIS          | – Recovery internal standard                      |
| RPD          | – Relative percent difference                     |
| RMP          | – Regional Monitoring Program                     |
| RSD          | – Relative standard deviation                     |
| RSWGF        | – Regional sediment working group facility        |
| SA           | – Selective availability                          |
| SARA         | – Superfund Amendments and Reauthorization Act    |
| SFEI         | – San Francisco Estuary Institute                 |
| SIM          | – Selective Ion Monitoring                        |
| SIS          | – Surrogate internal standard                     |
| SOP          | – Standard operating procedure                    |
| SRM          | – Standard reference material                     |
| STW          | – SampTrack for the Web                           |
| SW DIV       | – Southwest Division                              |
| SWG          | – Sediment work group                             |
| TIC          | – Tentatively identified compound                 |
| UCL          | – Upper Confidence Limit                          |
| VS           | – Validation Study                                |

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## E.1.0 INTRODUCTION

The Hunters Point Shipyard (HPS) Human Health Evaluation Quality Assurance Project Plan (QAPP) has been prepared for the U.S. Department of the Navy under Contract No. N47408-95-D-0730/DO-0127 in support of an offshore evaluation for regional sediment working group facilities (RSWGFs) in San Francisco Bay, California. This QAPP documents policies, the project organization, quality assurance (QA) requirements, and quality control (QC) procedures to be implemented for the HPS Human Health Evaluation. The QAPP is incorporated as Appendix E to the work plan for the offshore HPS Human Health Evaluation, and is not an independent document. The document follows the requirements of EPA QA/R-5 (1999). The associated Field Sampling Plan (FSP) for the HPS Human Health Evaluation is provided as Appendix D.

The primary objective of the HPS Human Health Evaluation is to define the extent of sediments that pose an unacceptable risk to human health and that require evaluation in the FS of remedial options. To achieve this objective, the HPS Human Health Evaluation will focus on areas referred to as the low-volume footprint, as identified in the draft Parcel F FS report (Tetra Tech-EMI and LFR, 1998). The results of this investigation will be integrated with the ecological evaluation described in the Validation Study (VS) work plan (Battelle *et al.*, 2000), to determine the sediment areas that require evaluation in the FS. Additionally, at the request of the regulatory agencies, the difference in risk posed by consuming fish from HPS relative to consuming fish from other locations within San Francisco Bay will be evaluated for the purposes of risk communication. Specific objectives of the HPS Human Health Evaluation are as follows:

1. Compare measured levels of chemicals in tissue from the *Macoma nasuta* bioaccumulation study being implemented as part of the HPS VS to risk-based screening concentrations (RBSCs) in support of validating the FS footprint.
2. Collect and analyze fish tissue from the vicinity of HPS and other Regional Monitoring Program (SFEI, 1999) sample sites throughout San Francisco Bay for statistical comparison in support of risk communication.

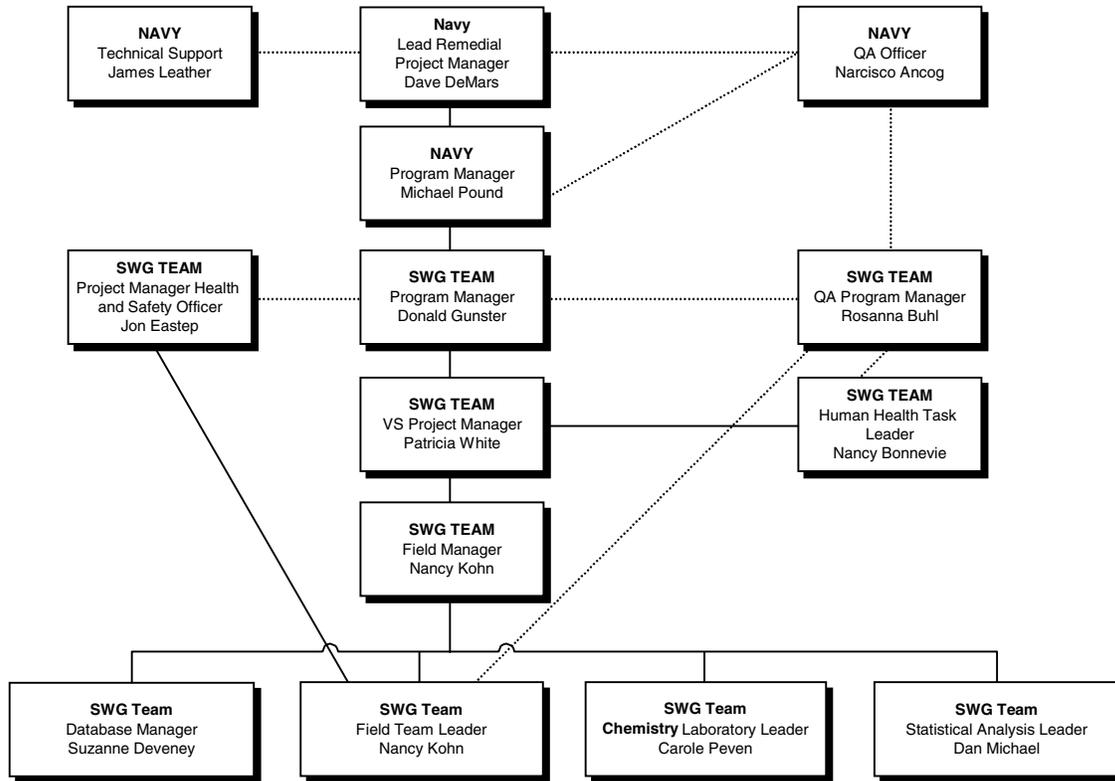
The work to be completed to achieve the project objectives is described in the HPS Human Health Evaluation work plan to which this QAPP is appended. This QAPP is one of three documents that describe the HPS Human Health Evaluation (Table E-1). (All tables are located in the back of this document). The survey design requirements, and description and anticipated use of the data are discussed in the HPS Human Health Evaluation work plan. The field sampling plan (FSP) (Appendix D) includes a description of sample types, locations, collection methods, handling, and custody requirements. The QAPP defines the sampling and analysis methods, quality control (QC) procedures, and QC criteria that must be implemented for the HPS Human Health Evaluation to ensure data comparability. Data quality objectives (DQOs) specific to each component of the evaluation are discussed in the work plan. Guidance on the development of each DQO can be found in EPA's Guidance for the Data Quality Objectives Process (EPA QA/G-4, 1994a).

## E.2.0 PROJECT MANAGEMENT

### E.2.1 Project and Task Organization

Figure E-1 presents the organizational structure of the HPS Human Health Evaluation. Mr. Michael Pound is the Navy Program Manager. He is responsible for providing final approval for conducting all

field activities, oversight of the Sediment Work Group (SWG) Technical Team, and Health and Safety Officer, approving selected subcontractors, executing contracts, and approving the release of study reports. He is responsible for the oversight of field and analytical activities associated with the validation studies.



**Figure E-1. Organizational Structure for the Hunters Point Shipyard Human Health Evaluation.**

Mr. David DeMars is the Navy Lead Remedial Project Manager. He is responsible for coordinating the onshore and offshore activities at Hunters Point Shipyard and communicates, as necessary, with the Navy Program Manager.

Mr. Narciso Ancog is the Navy Quality Assurance Officer. He is responsible for QA oversight of the entire HPS Human Health Evaluation project. His responsibilities include review and approval of the work plan, QAPP, and FSP for completeness, consistency, and adequate quality control; review of the design process to ensure that it is complete, technically sound, and well-documented; ensuring that all contractors are certified for the work being performed; communicating with the SWG Team QA Program Manager and identifying programmatic issues; reviewing the results of data validation and addressing issues that could compromise the project; and communicating issues to the Navy Project Manager and the SWG Team QA Program Manager. Mr. Ancog performs an independent QA function and is authorized to suspend field activities if Southwest Division (SW DIV) QA requirements are not met.

The SWG Technical Team is comprised of approximately 30 representatives from the U.S. Navy, SW DIV personnel, Battelle, Entrix, Tetra-Tech- EMI, and Neptune and Co. The SWG team is responsible for providing the Navy with technical expertise and guidance in addressing sediment management issues.

Dr. Donald Gunster is the SWG Team Program Manager. He is responsible for overall coordination of the SWG team activities. He selects subcontractors and assigns program responsibilities. He prepares

monthly reports and program schedules, and coordinates program-level activities. Dr. Gunster is responsible for review and approval of all final deliverables. He communicates directly with the SWG Team Project Health and Safety Officer, SWG Team QA Program Manager, and the SWG Team HPS Human Health Evaluation Task Leader. He reports program status to, and implements the directives of, the Navy Program Manager. He is authorized to stop work for cause if data quality or staff safety are threatened.

Mr. Jon Eastep is the SWG Team Project Health and Safety Officer. He is responsible for reviewing the HPS Human Health Evaluation Health and Safety Plan, ensuring that the field personnel have received appropriate health and safety training for work at HPS, and that the training is documented. He may also conduct inspections during field operations. He reports issues and concerns directly to the SWG Team Program Manager and has the authority to stop work.

Ms. Rosanna Buhl is the SWG Team QA Program Manager. She is responsible for ensuring that the QA systems required by the Navy for laboratories performing work under the Installation Restoration Guidelines are adequately addressed in QA documents that describe project activities: the QAPP, the FSP, and Standard Operating Procedures (SOPs). She prepares the QAPP and must approve the final version. She ensure that project reviews are conducted frequently enough to ensure that the work is being conducted according to the QAPP, FSP, and SOPs, and that corrective action plans are implemented to address any deficiencies identified. She reports the results of these oversight activities to the SWG Team Program Manager, SWG Team VS Project Manager, and the SWG Team HPS Human Health Evaluation Task Leader. She is authorized to stop work for cause if data quality or staff safety is threatened. She is responsible for reviewing the FSP to ensure that all elements are addressed in adequate detail. She ensures that all SOPs cited in the FSP are approved and available, and that appropriate training is documented for team members. She verifies that adequate forms and labels are designed for the sampling and analysis effort. She reviews custody forms to verify that custody is maintained, and conducts field and laboratory inspections as appropriate to ensure that the FSP is implemented. She prepares reports of inspections and audits, and communicates findings to the SWG Team VS Project Manager and the SWG Team Program Manager.

Ms. Patricia White is the SWG Team VS Project Manager. She coordinates technical activities as a liaison between the SWG Team Program Manager and SWG Team HPS Human Health Evaluation Task Leader and the SWG Team Field Manager and SWG Team Database Manager. She is responsible for ensuring that communication of all decisions that impact field or laboratory activities are dispatched in real time. She is responsible for responding to QA reports and either implementing or requiring corrective action to address systematic problems. She communicates directly with SWG Team Managers to coordinate activities and enforce schedules and deadlines.

Ms. Nancy Bonnevie is the SWG Team HPS Human Health Evaluation Task Leader. She is responsible for overall preparation and coordination of the HPS Human Health Evaluation planning documents: the FSP and QAPP. Ms. Bonnevie directs preparation of the HPS Human Health Evaluation reports. She reports to and coordinates HPS Human Health Evaluation activities with the SWG Team Program Manager and the SWG Team VS Project Manager.

Ms. Nancy Kohn is the SWG Team Field Manager. She works with the SWG Team VS Project Manager to prepare the FSP. She is responsible for ensuring access to the naval facility, scheduling the sampling trip, arranging for equipment and vessels, and escorts, where required. She coordinates the field and laboratory components of the validation studies, and is responsible for ensuring that all technical logistics are identified and addressed. Ms. Kohn communicates directly with the SWG Team Laboratory Leaders, Database Manager and Statistical Analysis Leader and reports progress and issues to the SWG Team HPS Human Health Evaluation Task Leader and SWG Team VS Project Manager. In addition, she works with

the SWG Team Program Health and Safety Officer and the SWG Team QA Program Manager to ensure that field activities are conducted safely and in accordance with QA requirements.

Ms. Suzanne Deveney is the SWG Team Database Manager. She is responsible for ensuring that the database construction and output meet the needs of the SWG team for analysis and report preparation. She is responsible for overseeing accurate and complete loading of data to the database, sample tracking, and providing sample identification codes to the SWG field crew. Ms. Deveney provides database exports to the Navy contractor validation firm for data validation upon request. She communicates data format issues to the SWG team laboratory leaders and reports issues to the SWG Team Field Manager.

Ms. Carole Peven is the SWG Team Chemistry Laboratory Leader. She is responsible for ensuring that appropriate and comparable technical procedures for sample analysis are used by all laboratories and for providing technical expertise to the analytical laboratories. She is responsible for performing a management review of analytical data reports, and for overseeing coordination between the laboratories and the SWG Team Field Leader to ensure that holding times are met and that reporting schedules are not compromised. Ms. Peven ensures that the status of laboratory analyses and potential problems are reported to the SWG Team Field Manager.

Ms. Nancy Kohn is also the SWG Team Field Team Leader. She is responsible for coordinating field logistics, providing the FSP to the SWG Team field crew and conducting a kick-off meeting prior to sampling activities, and ensuring that the field team is adequately trained in field sampling procedures. She verifies that field equipment and instruments have been adequately maintained and tested, and that appropriate calibration and decontamination between sites and samples is conducted and documented. Ms. Kohn is responsible for ensuring that samples are collected, handled, preserved, and shipped as specified, and that documentation is detailed, accurate, and legally defensible. She is responsible for ensuring that samples are collected and handled under custody. She communicates directly with the SWG Team field crew and reports to the SWG Team VS Project Manager.

The SWG Team field sampling crew is responsible for conducting all field activities according to the QAPP and FSP and for communicating problems to the SWG Team Field Team Leader.

The analytical laboratories are responsible for conducting all analytical activities according to the Navy Installation Restoration Chemical Data Quality manual (IRCDQM, 1999)<sup>1</sup>, the QAPP, and the FSP. Laboratories are responsible for maintaining sample custody records throughout processing and analysis, conducting analysis according to specified SOPs, reviewing QC data and implementing corrective action, as appropriate, and contacting the SWG Team Chemistry Laboratory Leader to communicate any issues that could affect sample integrity, data quality, or schedule.

Each laboratory is responsible for appointing an independent QA Officer who will monitor the study, conduct laboratory inspections and data audits, and report findings to management. Ms. Rosanna Buhl and Ms. Deborah Coffey are the Laboratory QA Officers at Battelle's Duxbury Operations (BDO) and Battelle's Sequim Laboratory (BSL), respectively. The laboratory QA officers report issues that could affect data quality to the SWG Team Program Manager.

## **E.2.2 Problem Definition/Background**

The U.S. Navy Southwest Division Naval Facilities Engineering Command (SW DIV NAVFACENGCOM) is performing a human health evaluation for offshore sediments (Parcel F) at the HPS in San Francisco Bay to more clearly define the distribution of sediments that pose an unacceptable risk to the environment. The results of the HPS Human Health Evaluation will be integrated with the

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<sup>1</sup> The NQAR has instructed Battelle to follow the draft Navy Installation Restoration Quality Assurance Program that is described in IRCDQM, 1999.

results of the Validation Study (Battelle, et al., 2000) to identify areas that require consideration in the feasibility study (FS) of remedial alternatives for sediments at HPS. This QAPP addresses the HPS Human Health Evaluation.

HPS is situated on a peninsula southeast of San Francisco. Historical site activities at HPS resulted in the release of chemicals to the environment, including offshore sediments. Environmental restoration activities are being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The naval facility was closed under the Defense Base Realignment and Closure Act of 1990 (BRAC), and is in the process of conversion to non-military use.

A draft FS report was submitted to the agencies for review in April 1998 (TtEMI and LFR, 1998) which presented high-volume and low-volume Feasibility Study (FS) footprints based on two different decision flow processes, with the high-volume FS footprint based on a more conservative set of criteria. Based on agreements with the Agencies this evaluation focuses on the low-volume FS footprint as described in the Validation Study (Battelle, et al., 2000). Currently, the low volume FS footprint is based on ecological criteria. One of the primary objectives of the HPS Human Health Evaluation is to ensure that the final FS footprint is also based on human health considerations.

As a result of multiple chemical sources in San Francisco Bay, health concerns associated with fish consumption have been identified as a regional issue during the last decade. Currently available data (SFRWQCB et al. 1995; SFEI 1999) indicate that concentrations of six chemicals or groups of chemicals (i.e., PCBs, dioxins, mercury, dieldrin, DDT, chlordane) in fish collected from throughout the San Francisco Bay are high enough to pose a potential risk to recreational anglers (OEHHA, 1994). Based on these data, sport fish health advisories have been implemented for the Bay, along with an on-going monitoring program. However, although this is a regional issue, concerns have been raised by regulators regarding the relative risks of consuming fish caught from the vicinity of HPS compared to other locations within San Francisco Bay. Preliminary evaluations based on existing data (Appendix B) indicate that levels of chemicals in fish from the vicinity of HPS are similar to those collected elsewhere in the Bay, however, additional data are required. To achieve sufficient data for a statistical comparison, fish tissue will be collected and analyzed from HPS as well as designated locations throughout San Francisco Bay. These data will be collected to support a risk communication program only, and will not be considered when evaluating the boundaries of the FS footprint.

The HPS Human Health Evaluation work plan will address the following QAPP elements for HPS:

- A site conceptual model and statement of the problem(s) to be addressed;
- Identification of data needs;
- The proposed approach to issue resolution; and,
- The specific QA and QC requirements needed to achieve the site DQOs.

### **E.2.3 Project/Task Description**

The primary objective of the HPS Human Health Evaluation is to more clearly define the extent of sediments that require evaluation in an FS of remedial options. To achieve this objective, the HPS Human Health Evaluation will focus on areas referred to as the low-volume FS footprint as identified in the draft Parcel F FS report (TtEMI and LFR, 1998). Additionally, the HPS Human Health Evaluation will collect and evaluate fish tissue concentrations from the vicinity of HPS and from throughout San Francisco Bay for risk communication purposes.

The HPS Human Health Evaluation tasks include:

- Review of body burden data analyzed for the HPS validation study 28-day *Macoma nasuta* bioaccumulation test.
- Collection and analysis of fish from the vicinity of Hunters Point Shipyard and from each of three locations in San Francisco Bay;
- Chemical analysis of all tissue samples for polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, butyltin compounds, and trace metals;

Once data collection is complete then the assessment tasks will include

- Compilation of data;
- Comparison of body burden data analyzed for the HPS validation study 28-day *Macoma nasuta* bioaccumulation test to risk-based screening concentrations (RBSCs);
- Statistical comparison of HPS and San Francisco Bay fish tissue data; and,
- Preparation of a final report.

## **E.2.4 Quality Objectives and Criteria for Measurement Data**

### **E.2.4.1 Data Quality Objectives**

DQOs are defined using a systematic planning process that defines the quality objectives and the performance criteria. DQOs are a product of the sampling design. For the HPS Human Health Evaluation, the statistical design developed for the ecological evaluation will be used to generate *Macoma nasuta* tissue data. In addition, a statistical design consistent with EPA QA/G-4, Guidance for the Data Quality Objectives Process, was used to plan the fish study in support of risk communication objectives.

The DQO inputs and analyses are detailed in the work plan. The work plan summarizes the basic DQO outputs and presents the resulting design for the collection of fish that will achieve the specified DQOs. These DQOs are presented in Tables E-2 and E-3 and discussed in the work plan.

The work plan documents the ways in which the collected data will be summarized and used to make the decisions. It defines:

- objectives of the intended sampling and analysis;
- underlying design assumptions for each sample type and matrix;
- how each data type will be assessed;
- method that will be used to determine whether or not the data support the design assumptions; and,
- how the data will be used in interpretation.

The data generated during this study will be used to:

- Determine whether the FS footprint identified for evaluation in the FS based on ecological concerns is adequate based on human health concerns, as well.

- Determine whether fish tissue in the vicinity of HPS are statistically elevated over fish tissue collected elsewhere in the bay to assist in risk communication.

The consequences of making an incorrect decision are addressed in the work plan. Based on this analysis of consequences, the work plan defines the project quality objectives in quantitative terms (such as specific limits on decision errors), and explains why there is no basis for establishing quantitative criteria and qualitatively specifies what the project is trying to achieve.

Potential data quality concerns are identified in the work plan for each type of measurement to be made, based on the proposed use of the data and the foreseeable consequences of errors resulting from incorrect interpretation of the measurements. Potential data quality concerns include, but are not limited to the following:

- collecting an adequate of samples to support the decision (the number of samples could be inadequate, for example, if measurement or sampling variability exceeds expectations);
- choosing measurement techniques and methods that are selective, sensitive, and precise enough to allow target analyte concentrations to be distinguished from pre-specified threshold levels;
- limiting contamination of samples to insignificant levels; and
- maintaining the desired degree of data comparability to allow for statistically valid evaluation or pooling of the data.

The DQO planning process resulted in a FSP that meets the applicable quality criteria. In developing a statistical design, certain assumptions are made about the relative contribution of variability and error that is factored in to maximize the probability that the data collected will be adequate to support the decision to be made. Table E-4 summarizes the study objectives and the study design.

#### **E.2.4.2 Measurement Quality Objectives**

Measurement quality objectives for the analyses conducted for the HPS Human Health Evaluation can be expressed in terms of accuracy, precision, completeness, and sensitivity goals. Accuracy and precision are monitored through the analysis of quality control samples (Section E.3.5). Completeness is a calculated value. Sensitivity is monitored through instrument calibration (Section E.3.7) and the determination of method detection limits and reporting limits (Section E.2.4.2). Qualitative quality objectives are expressed in terms of comparability, and representativeness.

Acceptable quality control (QC) methods and results are based on the data quality objective process that identified the use of NOAA NS&T methods for this study.

**Accuracy** is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations.

**Precision** is defined as degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.

**Completeness** is the amount of data collected as compared to the amount needed to ensure that the uncertainty or error is within acceptable limits. The goal for data completeness is 100%. However, the project will not be compromised if 90% of the samples collected are analyzed with acceptable quality.

**Comparability** is a measure of the confidence with which one data set can be compared to another. This is a qualitative assessment and is addressed primarily in sampling design through use of comparable sampling procedures or, for monitoring programs, through accurate re-sampling of stations over time. In the laboratory, comparability is assured through the use of comparable analytical procedures and ensuring that project staff are trained in the proper application of the procedures. Within-study comparability will be assessed through analytical performance (quality control samples). Data generated for the HPS Human Health Evaluation will be used for risk assessment and are not intended to be comparable with past analyses that used different analytical techniques.

**Representativeness** is the degree to which data accurately and precisely represent a characteristic of a population. This is a qualitative assessment and is addressed primarily in the sample design, through the selection of sampling sites, and procedures that reflect the project goals and environment being sampled. It is ensured in the laboratory through (1) the proper handling, homogenizing, compositing, and storage of samples and (2) analysis within the specified holding times so that the material analyzed reflects the material collected as accurately as possible.

**Sensitivity** is the capability of a test method or instrument to discriminate between measurement responses representing different levels (*e.g.*, concentrations) of a variable of interest. Sensitivity is addressed primarily through the selection of appropriate analytical methods, equipment, and instrumentation. The methods selected for the HPS Human Health Evaluation were chosen to provide the sensitivity required for the end-use of the data. This is a quantitative assessment and is monitored through the instrument calibrations and calibration verification samples and the analysis of procedural blanks with every analytical batch.

**Method Detection Limits (MDLs)** for organic compounds in tissues are determined annually according to 40 CFR Part 136 Appendix B by spiking clean, low-lipid tissue (*e.g.*, white meat fillet from a non-bottom-feeding fish species) with all parameters of interest and processing them according to the methods defined Section E.3.4. MDLs for GC/ECD analysis are determined on the primary column. Although it is not anticipated, if it becomes necessary to use data from the GC/ECD secondary column for quantification, then MDLs will be determined using the secondary column.

Because completely metal-free matrices for tissue do not exist, MDLs for metals in tissue samples are calculated from the MDLs generated by the fresh water MDL study, taking into account the anticipated sample dilution factors that would be used in actual tissue samples. MDLs for fresh water samples are determined annually according to 40 CFR Part 136 Appendix B by spiking deionized water with all metals of interest and processing them according to the methods defined in Section 3.4.

**Reporting Limits (RLs)** for organic compounds are empirical values based on instrument sensitivity and day-to-day operations. For organic compounds, the RL is calculated as

$$RL = (\text{Low Standard Concentration})(\text{Pre-injection volume})(\text{Dilution Factors})(1/\text{Sample Size})$$

For trace metals, the RL is calculated by multiplying the target analyte MDL by 3.18. The value 3.18 is based on the Student's-t value for 7 to 10 replicates, the number of replicates usually analyzed to generate the MDL. The NEDTS data qualifier "J" will be added to any reported values that are less than the RL.

## E.2.5 Special Training/Certification

### E.2.5.1 Training Requirements

Documented training is required for each individual performing activities in support of environmental data collection or analysis. Each laboratory technician and analyst must complete an initial demonstration

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of capability before processing or analyzing samples for this project. At least annually, technicians and analysts must demonstrate continued proficiency through one of the following procedures:

- Acceptable performance on another initial demonstration of capability;
- Acceptable performance on a blind (single blind to the analyst) sample according to the appropriate SOP. (Note that sediment PE sample results will be applied to tissue analyses for all compounds of interest because tissue PE samples are not available);
- Acceptable performance of a blind performance evaluation sample using a similar test method (i.e., analysis using one GC/MS method is counted as training for other GC/MS methods as long as the methods are similar);
- At least four consecutive laboratory control samples with acceptable accuracy and precision results; or,
- Analysis of authentic samples that have been analyzed by another trained analyst with statistically identical results.

The applicable laboratory manager is responsible for determining specific training and certification needs, and for ensuring that any required training is documented.

Individuals developing and implementing this QAPP must receive, at a minimum, orientation to the project's purpose, scope, and methods of implementation. This orientation is the responsibility of the SWG Team Program Manager or designee. Field and data management personnel must have documented experience or direct training in the procedures that they will be performing for this project, including any applicable SOPs. If these personnel do not have this experience or training then they must work under the direct supervision of trained personnel.

#### **E.2.5.2 Special Training**

Special training and certification required for the HPS Human Health Evaluation include the following:

- Any field team members involved with sample collection or handling must receive certification of training in hazardous waste handling and emergency response (HAZWOPER – 29 CFR 1910.120) is required for any team members. This is a 40-hour course.
- The VS Project Manager must complete an additional 8-hour supervisor training course (HAZWOPER – 29 CFR 1910.120).
- Vessel operators will be experienced and have demonstrable experience in small boat handling under the conditions expected at the site.

The SWG Team Field Manager is responsible for identifying worker certification needs for the field unit and ensuring that all team members are adequately trained. A field orientation must be conducted to establish guidelines for field observations between crews to ensure repeatability within the limits of this qualitative approach. This orientation is the responsibility of the SWG Team Field Manager.

#### **E.2.5.3 Navy Certification**

Only laboratories that the Navy has evaluated and approved within the previous 18 months for the laboratory analyses that will be performed may conduct work for the HPS Human Health Evaluation. Battelle's laboratories in Duxbury, Massachusetts (BDO) and Sequim, Washington (BSL) will be performing non-standard methods (NOAA Status and Trends methods). Both laboratories have obtained Navy approval for work at HPS. The Navy contractor must be notified in writing and grant prior approval whenever a subcontractor is contracted by Battelle to perform work on these projects. Use of a

subcontractor is not anticipated for this project. SOPs BDO HPS 001 and MSL-I-028 describe the implementation of specific procedures required for sample analysis to meet NAVFAC requirements.

#### **E.2.5.4 State of California Environmental Laboratory Approval Program**

Laboratory certification through the State of California Environmental Laboratory Approval Program (ELAP) is required for any certifiable methods. ELAP does not certify the NOAA Status and Trends methods required for the contaminants of potential concern (COPCs) analysis for this program; therefore certification is not required for these measurements.

### **E.2.6 Documentation and Records**

#### **E.2.6.1 Document Control**

It is critical that project personnel have the most recent versions of the QAPP, FSP, and SOPs. Version control is maintained by defining the version number and date on each of these documents. A distribution list is maintained for each controlled document. When a new version is approved, it is distributed and the old versions must be marked as “Obsolete.” To maintain control of these documents, *no internal copies of approved documents may be created*. Requests for the QAPP and FSP should be submitted to the SWG Team Program Manager who is responsible for control of these documents; requests for SOPs should be submitted to the QA Officer (who is responsible for control of SOP versions) at the authoring laboratory at the addresses listed in Section E.3.3. Field and laboratory logbooks are controlled documents and must be permanently bound and pre-numbered, dated, and distinctly labeled. All field records and documentation must comply with the documentation requirements defined in Sections E.2.6.2 and E.2.6.5.

#### **E.2.6.2 Field Documentation and Forms**

The field team members will maintain bound, paginated field logbooks to provide a daily record of field activities, observations, and measurements during sampling. All information pertinent to sampling will be recorded in the logbooks on activity-specific data forms. Field data and observations will be recorded in real-time in the bound field logs.

Activity-specific forms will be used to document field measurements. The data forms will either be bound into the logbook or affixed to the logbook pages. The FSP defines the specific records and data that must be maintained for each field activity to ensure that samples and data are traceable and defensible. All field records and documentation must comply with the documentation requirements defined in Section E.2.6.5

#### **E.2.6.3 Notification of Sample Receipt**

NFESC 1996 required that each analytical laboratory which performs chemical analysis must provide the Navy QA Representative (NQAR) with notification of sample receipt by the 5<sup>th</sup> day of the following month. However, IRCDQM (1999) deletes this requirement. Therefore sample notification will not be implemented for this evaluation.

#### **E.2.6.4 Laboratory Documentation**

Documentation of all activities is critical for tracking data and evaluating the success of any activity. Laboratory documentation requirements are defined in laboratory SOPs. Required documentation includes, but is not limited to, the following:

- Calibration and maintenance records for all instruments and equipment involved in the collection of environmental data.

- Preparation of calibration standards, spiking solutions, and dosing solutions such that each unique preparation can be tracked to the original (neat) material.
- Lot numbers for all standards, stock solutions, reagents, and solvents.
- All sample processing or preparation for testing such that it is traceable to sample receipt records.
- All sample analyses and results of analyses. All rejected data are accompanied by explanations of the failure and the corrective action.
- All data reduction formulas such that reported data is uniquely traceable to raw data.

#### **E.2.6.5 Documentation Standards**

Each organization performing activities in support of environmental data collection must have SOPs for all methods and procedures related to the collection, processing, analysis, reporting, and tracking of environmental data. SOPs must describe how analytical procedures are implemented at a specific facility and must be readily available in a QA manual (however named). SOPs are controlled documents and, as such, must be approved by management and dated. The laboratory must maintain a master list of SOPs in accordance with Navy Installation Restoration Data Quality Manual requirements. All SOPs that are used for environmental data collection activities used for HPS Human Health Evaluation activities must be reviewed annually and updated as needed. The FSP must define procedures by reference to the SOP number or another appropriate citation and include the SOP as an attachment.

All data generated during the course of this project must be able to withstand challenges to their validity, accuracy, and legibility. To meet this objective, data are recorded in standardized formats and in accordance with prescribed procedures. The documentation of all environmental data collection activities must meet the following minimum requirements. Other specific documentation requirements are discussed throughout this QAPP and the associated SOPs:

- Data must be entered directly, promptly, and legibly. All reported data must be uniquely traceable to the raw data. All data reduction formulas must be documented.
- Handwritten data must be recorded in ink. All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample ID and station or location ID (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry. The reason for the change must be documented, and the change must be initialed and dated by the person making the change.
- The use of pencil, correction fluid, and erasable pen is prohibited.

Any changes to the QAPP or FSP (*e.g.*, QA procedures, analytical procedures, sampling locations and frequencies, etc), that are anticipated up to 12 hours prior to the intended field or laboratory activities must be documented in writing. These anticipated changes must be submitted for review and approved by the SW DIV QA Officer, SWG Team Program Manager, and SWG Team QA Program Manager prior to implementation of the changes.

Any changes that are not anticipated (*i.e.*, deviations from the QAPP, FSP, or SOPs) must be documented in writing, approved by the SWG team leader, and communicated appropriately within 4 hours of the deviation. Documentation and communication include an assessment by the appropriate SWG team leader of the impact that the deviation has on data quality and the corrective action. Minor deviations (*e.g.*, those that would not impact the study objectives, design, or data quality) will be reported to and approved by the appropriate SWG team leader, the SWG Team Human Health Task Leader, and the SWG Team VS Project Manager. Major deviations (*e.g.*, those that could impact the study objectives, design, or data quality) will additionally be reported to the SWG Team Program Manager, the SWG Team QA Program Manager, the Navy Project Manager, and the Navy QA Officer. A discussion of major deviations and potential impact on the project objectives will be included in the final report.

Raw data are defined as any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (and verified accurate by signature) then the exact copy or exact transcript may be substituted (NELAC Chapter 1 Glossary June 2000).

#### **E.2.6.6 Contents of Data Packages**

The analytical laboratories that are performing chemistry (BDO and BSL) will provide the prime contractor with full data packages, which contain all information required for validation. (Section E.5.0 discusses data validation requirements). All data packages must contain any of the following elements which are applicable to the analysis because the data will be entered into the SWG database and therefore must be validated:

- Title page
- Table of contents
- Data package narrative (contents defined in Navy Installation Restoration Data Quality Manual) and this QAPP
- Copies of SOPs for all analyses not performed in accordance with strict EPA methods
- Final data report tables (see Section E.2.6.8 for contents)
- Analytical records:
  - Instrument tuning (GC/MS methods)
  - Degradation control (pesticide analyses)
  - Retention times (GC methods)
  - Calibration data
  - Calibration verifications
  - Surrogate recoveries (GC/MS and GC methods)
  - Internal standard response and retention times
  - All QC data required by the analytical method (blanks, LCS/LCSD, MS/MSD, duplicates)

- Required supporting information:
  - Entire package of sample custody documentation, including sample receipt form
  - Sample processing and spiking records
  - Copies of standard preparation logs for each standard used in sample preparation and instrument calibration
  - Run logs (see Navy Installation Restoration Data Quality Manual for specific requirements)
  - Raw data associated with field and QC data
  - Chromatograms
  - Instrument calibration records and calibration results
  - Results of all QC samples required by the QAPP; matrix spike solution compounds in concentration units
  - Sources of control limits for surrogates and LCS
  - Source of LCS
- Summary of internal standard retention times and response
- Description of manual integration procedures
- List of current method detection limits (MDLs) for the preparation and analysis methods used for sample processing

The summary data packages for analytical chemistry must contain all information included on CLP forms I–X (organic compounds) and forms I–XIV (inorganic compounds) but need not be reported in the CLP-prescribed format.

#### **E.2.6.7 Electronic Data Deliverable**

All data collected for the SWG will be submitted to the SWG Team Database Manager. Standard data reporting formats have been designed and described in project-specific SOPs such that data will be submitted in a uniform manner that meets the SWG's database requirements. This process is described in Section E.3.10. Because the SWG database will be used to facilitate analytical data validation, laboratories will be required to include QC data in the data submission. Project-specific SOPs will be provided to the labs that are submitting data after the database format and contents have been finalized. The electronic submission should include QC results. The QC codes are defined in BDO HPS SOP 004. All EDDs must conform to Navy Environmental Data Transfer Standards (NEDTS) by being ASCII ii- or ASCII iii-compatible.

#### **E.2.6.8 Reports**

The following types of reports are anticipated for the HPS Human Health Evaluation:

- Monthly progress reports will define progress during the previous month, the schedule of activities for the following month, problems encountered, and unresolved issues. The SWG Team Program Manager is responsible for preparing these reports.
- Field report describing field survey activities will be due within 3 weeks of the survey. It includes
  - a chronology of events,
  - a table of field statistics (date/time and coordinates of each trawl, trawl length and direction, weather conditions, tide phase, and observations),

- a sample table (trawl number, number of each fish species collected, sample IDs, sample observations, maximum total length and whole body weight of each fish, and
- a summary of problems encountered, deviations, and corrective actions.

The SWG Team Field Manager is responsible for the preparation of this report.

- Monthly QA reports will describe the status and results of internal and external audits, proficiency testing, QC problems, corrective actions, status of certification approvals, staff training activities, and new QA initiatives. The SWG Team QA Program Manager is responsible for preparing these reports.
- Data reports, consisting of a QC narrative and summary data tables, will be generated once the internal data review process is satisfactorily completed. The data management team is responsible for preparing these reports. Data reports must include the following:
  - Complete field sample identification
  - Sample identification numbers assigned by the laboratory
  - Date of sample collection
  - Date sample is received by the laboratory
  - Date of sample analysis
  - Sample matrix
  - Analytical SOP number and base EPA method (if applicable)
  - Results (with clearly defined concentration units) for each targeted analyte
  - Electronic file identification codes (when applicable, identify instrument data files)
  - Data qualifying flags
  - Dilution factor(s)
  - Limits of detection
  - Date of report
  - Review date and signature of the laboratory manager
- A data QC summary report will be submitted to the Navy Program Manager after review and approval by the QA Program Manager. Section E.4.2.2 describes the contents of these reports.
- A HPS Human Health Evaluation Report will be prepared as the final product of the human health evaluation. The report will
  - describe the results of the field sampling efforts
  - present recommendations for the areas within Parcel F that will require further evaluation during the Feasibility Study.

The report will be provided in draft, draft final, and final versions. The schedule of due dates and reviews will be mutually agreed upon with the Navy Program Manager and EPA.

### **E.2.6.9 Storage and Disposal**

All electronic and hardcopy raw data, data packages, and final data will be retained by the laboratory for a minimum of 10 years after final data submittal. If raw data will be stored on tape or CD then the magnetic tape storage device or other similar storage device must be capable of recording data for long-term, off-line storage. All contaminants of potential concern (COPC) raw data will be retained on writeable CDs or magnetic tape. Records may, at the Navy's discretion, be transferred to a naval facility for longer-term storage. Sample archival and disposal is discussed in Section E.3.3.4.

### **E.3.0 DATA GENERATION AND ACQUISITION**

This section describes the method requirements for all aspects of data measurement and acquisition for the following areas:

- Collection, handling, and analysis of samples
- Measured parameters obtained from other sources
- Quality control procedures and requirements
- Data management

The procedures described in this section are selected to ensure that data of the appropriate type and quality are collected in support of the HPS Human Health Evaluation. Therefore, it is critical that all significant quality assurance problems be reported to the QA Program Manager as soon as possible along with recommendations for corrective action.

#### **E.3.1 Sampling Process Design (Experimental Design)**

The HPS Human Health Evaluation sampling design is presented in Table E-4. Table E-5 lists the COPCs for the HPS Human Health Evaluation. Table E-6 defines critical vs. non-critical measurements. Table E-7 contains a list of all standard operating procedures that apply to this study.

##### **E.3.1.1 Station Locations**

Fish samples will be collected from the vicinity of Hunters Point Shipyard, and three ambient locations: San Francisco Pier, Berkley Pier, and San Mateo Bridge. Selection of the ambient locations was based their importance as recreational fishing locations within San Francisco Bay (RMP; SFEI, 1999), and because their geographical locations represent all areas of the Bay in the sampling program. San Pablo Bay will be used as a surrogate location if the weight of target fish collected from another ambient location is insufficient. The sampling locations are identified in the work plan. Sampling locations will be identified using a differentially-corrected global positioning system (dGPS). Site coordinates will be documented manually or using an automated differential receiver.

#### **E.3.2 Sampling Methods**

The tissue samples for the HPS Human Health Evaluation will be collected according to standard protocols described in *Contaminant Concentrations in Fish from San Francisco Bay* (SFEI 1999). These protocols are appropriate for the collection of tissue for measurement of chemical constituents. The selection of sampling methods will be determined by the sample type (i.e., species) as well as the characteristics of the sampling area (deep vs. shallow). The contaminant study conducted by the San Francisco Estuary Regional Monitoring Program (described in SFEI 1999) collected and analyzed seven fish species that are local recreational fishing targets. The target fish were shiner surfperch (*Cymatogaster aggregata*), white croaker (*Genyonemus lineatus*), California halibut (*Paralichthys californicus*), leopard sharks (*Triakis semifasciata*), white sturgeon (*Acipenser transmontanus*), striped bass (*Morone saxatilis*), and jacksmelt (*Atherinopsis californiensis*). The HPS Human Health Evaluation will primarily focus on three of these seven fish species (white croaker jacksmelt, and surfperch). The target fish species were selected based on the following three criteria:

- species previously evaluated by the RMP;
- species known to be caught and consumed by anglers in San Francisco Bay; and,

- species for which measured tissue concentrations exceed health-based guidelines based on the previous RMP data (SFRWQCB et al. 1995; SFEI 1999).

The following sampling protocols are relevant for the evaluation:

- Sampling coordinates will be measured at each station using a dGPS in order to accurately define the sample locations.
- Otter trawls (12-16 foot stretch nylon with a mesh size of approximately 1 inch at the cod end) will be used as the primary fish collection method.
- Other fishing techniques (e.g., hook and line, trammel or gill nets) will be used, if needed, to capture sufficient numbers of at least one of the target species at every location. Each fishing technique will be documented in the field logbook.
- Trawl speeds will be approximately 2-3 knots.
- For each location, sufficient fish of the same species and size class will be collected to achieve a whole body weight of either 2400 grams (HPS) or 800 grams (each ambient location). This will provide 100 grams of fillet per composite for analysis of the full COPC list. (It is estimated that the ratio of whole fish to fillet is 4:1).

The sampling design requires that six composite samples from the Hunters Point Shipyard area be compared with six ambient composites from the San Francisco Bay area. Three San Francisco Bay locations (San Francisco Pier, Berkley Pier, and San Mateo Bridge) will be sampled to represent ambient fish contaminants, with two composites prepared using fish collected at each location. Individuals of the three target species will be retained from each location until the minimum whole body weight is achieved for at least one species at all locations. One of the target species will then be selected based on availability and analyzed at all locations. Table E-8 illustrates the sampling design. The fish collected will be sorted by species and size class, a gross weight will be determined, and fish will then be wrapped in aluminum foil, and iced. Table E-9 summarizes the container type, required sample volumes, and preservation requirements for all sample analyses, as well as the maximum holding times to sample extraction and analysis, as necessary.

If sampling requirements cannot be met due to sampling or measurement system failure, field conditions or other factors that cannot be controlled, corrective action will be discussed with the HPS Human Health Evaluation QA Program Manager, the SWG Team Human Health Task Leader, and Field Team Leader. A corrective action will be agreed upon based on the critical/non-critical nature of the parameter, it will be documented in the field log, and the action will be communicated to the sampling team. In general, if critical measurements or samples cannot be collected, then sampling will be re-scheduled. If a non-critical measurement or sample cannot be collected, then the deviation will be documented. The HPS Human Health Evaluation QA Program Manager will review corrective actions to assess their effectiveness. The documentation and communication of any deviations from the QAPP or FSP is discussed in Section E.2.6.5.

### **E.3.3 Sample Handling and Custody**

Sample handling and custody requirements for samples collected for the HPS Human Health Evaluation will follow the requirements of the QAPP. All field procedures, including any decontamination of equipment, are detailed in the FSP.

### **E.3.3.1 Sample Processing**

Field sampling activities are the responsibility of BSL with assistance from other SWG Team members, as needed. Field personnel will wear pre-washed fabric gloves while handling fish. Gloves should be changed between samples. Gloves must be washed in hot water without detergent prior to use. The boat will be positioned upwind when the trawl is brought aboard and the fish sorted and packaged, to eliminate the potential for contamination by exhaust gases. At each station, fish will be sized by species (only fish within the target size range will be retained – see Table E-8), wrapped in pre-ashed aluminum foil, labeled, placed in a Ziploc® plastic bag, iced, and frozen as soon as possible. Labeling requirements are defined in Section E.3.3.2.

Iced samples will either be shipped within 24 hours or held in a refrigerated truck and shipped in batches. If samples are not shipped within 24 hours then fresh ice will be added to the cooler and the temperature of the refrigeration unit must be monitored and documented daily. Whole body fish samples will be shipped directly from the field to Mr. Michael Meara (BDO) at the following address:

Mr. Michael Meara (Custodian)  
Battelle Duxbury Operations  
397 Washington Street  
Duxbury, MA 02332  
(781) 952-5270

Attention: Carole Peven

All fish processing will be performed at Battelle Duxbury Operations. Fish will be thawed in the laboratory prior to processing. Each fish will be measured to ensure that the individual is within the target range. A fish board with an attached meter stick will be used to measure the maximum total length of each fish to the nearest 0.5 centimeter (cm). The whole body weight of each fish will be determined using a top-loading balance. Fish will be weighed to the nearest 0.1 gram (g). Both length and weight data will be recorded as part of the laboratory processing records.

A titanium knife will be used for filleting; fish fillets will be analyzed with skin. For each composite, equal portions of fillet from each fish will be combined to achieve a total of 100 grams of tissue. (300 grams will be required for the composite used as the matrix spike/spike duplicate). Samples will be homogenized using a Tekmar tissuemizer and then aliquotted for the analysis of organic compounds and trace metals. Aliquots for the analysis of organic compounds remain in the custody of Mr. Michael Meara. Trace metals aliquots are shipped to

Ms.Carolynn Suslick  
Battelle Marine Sciences Laboratory  
1529 Sequim Bay Road  
Sequim, WA 98382  
(360) 681-3604

Attention: Elizabeth Barrows

### **E.3.3.2 Sample Custody**

Sample custody records are the administrative records associated with the physical possession and/or storage history of each individual sample from the purchase and preparation of each sample container and sampling apparatus to the final analytical result and sample disposal. SOPs 6-010 and MSL-A-002 define field and laboratory custody procedures.

Water proof sample labels will be completed using waterproof ink and inserted in each Ziploc® bag with the sample. Sample labels provide sufficient detail to uniquely identify fish from each trawl and allow tracking to field activities. Sample labels must include a unique sample identification number, the trawl number, sampling area, collection date, species ID, container number and total number of containers (e.g., 1 of 2; 2 of 2), and sample collector’s name. An example is provided below.

|                      |       |                          |       |
|----------------------|-------|--------------------------|-------|
| <b>Sample ID</b>     | _____ | <b>Trawl No.</b>         | _____ |
| <b>Sampling Area</b> | _____ |                          |       |
| <b>Species ID</b>    | _____ |                          |       |
| <b>Container</b>     | _____ | <b>of</b>                | _____ |
| <b>Date</b>          | _____ | <b>Name of Collector</b> | _____ |

Sample custody will be documented throughout the life of the sample. Samples should not be left unattended unless properly secured. Each laboratory must have a formal, documented system designed to provide sufficient information to reconstruct the history of each sample, including preparation of sampling containers, sample collection and shipment, receipt, distribution, analysis, storage or disposal, and data reporting within the laboratory. Laboratory documentation must provide a record of custody for each sample (versus a sample batch) throughout processing, analysis, and disposal to a waste manifest.

Samples are considered to be in a person's custody if:

- The samples are in a person's actual possession;
- The samples are in a person's view after being in that person's possession;
- The samples were in a person's possession and then were locked or sealed up to prevent tampering; or,
- The samples are in a secure area.

The custody record will also be used as a record of the samples collected and analyses requested. Occasionally, multiple coolers of samples will be sent in one shipment to the laboratory. Each cooler will contain a separate custody record for the samples in that cooler. In addition, the outside of the cooler will be marked to indicate the cooler number and the number of coolers in the shipment (e.g., 1 of 2, 2 of 2). All coolers must be shipped under the same bill of lading.

**E.3.3.3 Sample Receipt**

Immediately upon receipt by a laboratory, the condition of samples must be assessed and documented. The contents of the shipping container must be checked against the information on the custody form for anomalies. If any discrepancies are noted, and if laboratory or project-specific criteria are not met, the laboratory must contact the SWG Team Field Manager for resolution of the problem. The discrepancy, its resolution, and the identity of the person contacted must be documented in the project file. The following conditions may cause sample data to be un-usable and must be communicated to the laboratory team leader:

- The integrity of the samples is compromised (e.g., leaks, cracks, grossly contaminated container exteriors or shipping cooler interiors, obvious odors, etc.);
- The identity of the container cannot be verified;

- The proper preservation of the container cannot be established,
- Incomplete sample custody forms (*e.g.*, the sample collector is not documented or the custody forms are not signed and dated by the person who relinquished the samples);
- The sample collector did not relinquish the samples; or
- Required sample temperatures were not maintained during transport.

The custodian must verify that sample conditions, amounts, and containers met the requirements for the samples (Table E-9). A unique sample identifier must be assigned to each sample container received at the laboratory, including multiple containers of the same sample.

#### **E.3.3.4 Sample Handling**

Sample holding conditions and holding times are defined in Table E-9. Holding times are to be calculated from the time of sample collection. Documentation must be sufficient to track sample holding, processing, and analysis times to ensure that the requirements of Table E-9 are met. Documentation of sample collection must include both date and time of day.

The following sample handling requirements must be met for all samples:

- Samples must be held in a controlled area with limited access
- Deviations from the defined storage requirements must be documented and reported with the data *even if alternative holding times are requested by the client* (not anticipated for this study).

Once the fish species for analysis has been determined, the other field samples (whole fish) will be incinerated as waste at BSL at the end of the survey. Any fish composites, carcasses, and homogenized samples that are not used for extraction/digestion will be held for six months after delivery of final data. Sample extracts and digestates will be held for one month. Fish tissue and sample containers will be discarded as solid waste. Sample extracts will be discarded as solvent waste. Sample digestates will be buffered and discarded as liquid waste. Records of waste disposal in a solid, solvent, or liquid waste stream must be sufficient to provide tracking from collection, through laboratory receipt, to sample disposal in a waste drum that is directly traceable to a disposal manifest.

### **E.3.4 Analytical Methods**

Sampling station characterization will consist of the critical and non-critical measurements and observations defined in Table E-6.

#### **E.3.4.1 Field Analyses**

Field analyses performed during the Hunters Point Shipyard Human Health Evaluation will be limited to those that directly support station or sample characterization.

- Sampling coordinates (latitude and longitude) will be determined using dGPS procedures that are defined Section 4.1.9 of Ward, et al. (1994). Coordinates will be recorded in California state plan (Zone III, NAD 83). If fish are collected in trawls then the start and stop tow coordinates and times will be determined.
- Fish will be identified to species using a taxonomically accurate identification key (*e.g.* Miller and Lea, 1972), by an experienced biologist familiar with fish species found in the San Francisco Bay area.

- Trawl time will be determined using a digital clock, determined as the difference between the trawl start time and trawl end time, recorded to the nearest minute.
- Trawl length will be estimated based on the boat speed and trawl duration.
- The low and high tide times will be recorded on the Field Log Forms. The tide phase will be determined by correcting for local tide differences and reported in relation to the high or low tide (e.g., 2 hours after high tide).

### **E.3.4.2 Laboratory Analyses**

#### ***E.3.4.2.1 Contaminants of Potential Concern (COPC)***

A specific list of COPCs, with the Risk Based Screening Concentrations (RBSC), and the laboratory reporting limits and detection limits, is provided in Table E-5. Laboratory procedures are defined in Table E-10. COPC analyses will be performed by BDO and BSL.

Each laboratory performing analyses for the HPS Human Health Evaluation must comply with the certification and training requirements defined in Section E.2.5. The analytical methods that will be used for the HPS Human Health Evaluation are low-level methods that are used routinely for generation of risk assessment data. For each analytical method performed by a laboratory, a demonstration of capability must be completed, method accuracy and precision defined, MDLs established, and a descriptive SOP prepared. MDLs must be determined annually for each method of interest by instrument, matrix, and compound of interest. MDLs for pesticide analysis are determined on the primary column. MDLs must also be determined on a confirmation column if data from confirmatory analyses will be reported. In these instances, the MDLs determined from confirmation column analysis must be less than those determined from the primary column. Quantification on confirmation columns is not, however, anticipated for this investigation. The quantitation limit (QL) is defined as 3.18 times the MDL.

Sample cleanup is a critical component of low-level organic compounds analyses; therefore, a variety of cleanup options may be employed to purify the sample extracts. Sample cleanup options are incorporated into the sample processing SOPs; all sample cleanup procedures will be documented. Sample cleanup procedures will be implemented on a batch-wide basis to ensure comparability of results and to assess cleanup effects on QC samples.

Laboratory analyses must be performed using instruments and columns that are capable of achieving the sensitivity and separation required by the work plan.

- Pesticide and PCB parameters are analyzed by GC/ECD, with a confirmatory column to qualitatively verify peak identification.
- Only Pesticide and PCB peaks confirmed on both columns will be considered “hits.”
- All GS/MS analyses will utilize the selected ion monitoring (SIM) method.
- With the exception of butyltin analysis, sample data will not be surrogate or blank-corrected. (The butyltin method specifies that target compounds be quantified vs. the surrogate internal standard to track loss during the derivatization process).

Manual integrations are also a key element of low-level organic compounds analyses and are implemented routinely for low-level GC and GC/MS data to separate data system baseline integration features from peaks that can be distinguished at greater than 5:1 signal:noise ratio. Manual integration

- will not be used preferentially for QC samples and must not be used to satisfy QC criteria requirements.
- must be identified, and must be signed and dated by the analyst.
- must be justified in the final data report and all manually integrated data must be flagged.

The method of analysis for low-level trace metals will depend on the concentrations of trace metals detected in the field samples. Analyses will proceed from ICP-MS and ICP-AES to GFAA. Mercury samples will be analyzed by CVAA. The reported analysis will be based on the method that achieves a clear detectable signal, or the method that achieves the minimum RBSC.

The laboratory-derived MDLs and all but one reporting limit are lower than the minimum RBSCs for all COPCs (Table E-5). The reporting limit for Arsenic (As) is greater than the minimum RBSC. Attempts will be made to achieve the minimum RBSC for As by increasing the sample size and decreasing the digestate volume to lower the effective reporting limit (RL). The work plan describes the data assessment procedures that will be implemented if the reporting limit cannot be reduced to less than the minimum RBSC. It also describes the assessment procedures for compounds that are detected below the RL (Section 2.1).

#### ***E.3.4.2.2 Percent Lipids and Percent Moisture***

Tissue lipid concentrations will be determined using the methods of Lauenstein and Cantillo (1993a) as total extractable lipids, using dichloromethane as the extraction solvent.

Percent moisture will be determined for both trace metals and organic compound aliquots. The percent moisture of the trace metals aliquot will be determined by freeze-drying; the percent moisture of the aliquot for organic compound analysis will be determined by oven-drying at approximately 100°C for at least 24 hours or until steady state.

#### ***E.3.4.2.3 General Requirements***

A laboratory batch is defined as a group of  $\leq 20$  field samples of a similar matrix that is processed as a unit with the same reagents and solvents, simultaneously with the required QC samples, and analyzed in the same method sequence. A procedural blank must be analyzed in each analytical sequence. For the purposes of this study, all fish are considered a “similar” matrix.

Analytical failures must be assessed and corrected. In most cases an analytical failure will stop the flow of work until it is reviewed, the root cause is identified, and corrective action is implemented. Most analytical failures are associated with QC results or instrument performance. Corrective action for these areas is addressed in Sections E.3.5 and E.4.1. Any deviations from the approved methods must be documented and discussed in the report narrative.

Spent samples, residual tissue, and solvent waste will be discarded in the appropriate waste stream according to SOPs and the sample custody requirements defined in Section E.3.3.

### **E.3.5 Quality Control Requirements**

This section defines the quality control (QC) program for the HPS Human Health Evaluation. Appropriate field and laboratory QC procedures are designated in order to assess data quality through the measures of accuracy and precision. If data fall outside the specified accuracy or precision criteria defined for a procedure or measurement, or if problems affecting comparability are identified, the field or laboratory team leader must contact the SWG Team QA Program Manager and the SWG Team Human Health Task Leader to discuss options available for rectifying the out-of-control situation. The Navy QA

Officer and SWG Team QA Program Manager will have final authority on decisions made to address problems.

### **E.3.5.1 Field Sampling**

No field quality control samples are required to support the HPS Human Health Evaluation. Equipment blanks for tissue samples will not be collected because no sample processing will be performed in the field and the potential contamination from the sampling nets is of little concern. Sample duplicates are not appropriate because each fish collected at a station is a unique sample that will be composited for analysis. Temperature blanks are not initiated in the field for frozen samples because the frozen state of the samples is readily ascertained without a surrogate blank.

### **E.3.5.2 Analytical Laboratory**

#### ***E.3.5.2.1 Quality Control Samples***

The study design and QC samples are intended to assess the major components of total study error, which facilitates the final evaluation of whether environmental data are of sufficient quality to support the related decisions. The QC sample requirements are designed to provide measurement error information that can be used to initiate corrective actions with the goal of limiting the total measurement error.

QC samples and frequency applicable to analytical chemistry laboratories are detailed in Table E-11. Table E-12 defines the required accuracy and precision for QC samples, along with corrective actions that must be implemented if QC criteria are not met. These requirements are based on the DQOs and associated assumptions made during the study design process. Table E-13 provides formulas for the calculation of QC sample assessment statistics. SOP 7-029 and the BSL QA Management Plan define the calculation of QC statistics at BDO and BSL.

All QC sample failures and associated corrective actions will be documented. If data must be reported with failing QC results, then data qualifiers will be assigned to the QC sample data. Table E-14 defines data qualifiers.

### **E.3.5.3 Control Charts**

Laboratory control charts for analytical chemistry procedures are established and maintained using the percent recovery results of the LCS. The control chart average, warning ( $2\sigma$ ), and control limits ( $3\sigma$ ) must be based on at least 20 individual percent recovery values generated within a calendar year vs. a “true value” calculation. Control charts for organic compounds are maintained for each compound of interest and method (*i.e.*, the same SOP); the laboratory control sample will be used as the indicator. Control charts for representative trace metals will be prepared using a standard reference material. Criteria for monitoring control charts, for detecting warning or control limits, and for verifying that results fall within the acceptable limits are specified in the control chart SOPs or specific analytical procedures. Control criteria are defined in Table E-12.

## **E.3.6 Instrumentation/Equipment Testing, Inspection, and Maintenance**

### **E.3.6.1 Field Equipment**

Battelle and its subcontractors provide field equipment, instruments, the boat(s), dGPS, and other supplies for the field-sampling program.

Maintenance requirements for field instruments are provided in Table E-15. The dGPS used to determine station coordinates will be inspected and tested prior to use in the field. The dGPS manual or SOP must

be available in the field. Any problems with the operation of these units must be documented, along with corrective action and the results of performance verification.

### **E.3.6.2 Laboratory Equipment**

All analytical instruments and equipment are to be maintained according to SOPs and the manufacturers' instructions. Equipment and instrument and maintenance and frequency are defined in SOPs and are summarized in Tables E-16 and E-17. All routine maintenance and non-routine repairs are to be documented in a bound logbook. The information recorded should include analyst initials, date maintenance was performed, a description of the maintenance activity, and (if the maintenance was performed in response to a specific instrument performance problem) the result of re-testing to demonstrate that the instrument performance had been returned to acceptable standards prior to re-use. The return to analytical control is demonstrated by successful calibration.

A fish board will be used to measure the maximum total length (nose to tail) of each fish used in preparation of the composite. The fish board will be wiped clean with MilliQ water as needed between each measurement.

A top-loading balance will be used to measure the whole body weight of each fish. Fish will be wiped of extraneous material and blotted dry prior to weighing. The balance will be wiped clean with methanol as needed between measurements.

## **E.3.7 Instrument/Equipment Calibration and Frequency**

Laboratory and field equipment will be calibrated in accordance with EPA guidance or the manufacturers' recommendations. Field equipment refers to articles used for on-site monitoring and testing, whereas laboratory equipment refers to articles used in the laboratory in support of data collection (*e.g.*, refrigerators). Laboratory instruments are units used for sample analysis (*e.g.*, GC/MS). Calibration procedures and frequencies are provided in this section.

### **E.3.7.1 Field Equipment**

Table E-18 lists the calibration procedures for the field equipment. The manufacturer calibrates all field equipment. The calibration of each GPS unit is checked by the field team prior to each day of sampling using a reference location identified by the Field Team Leader. The location of the reference point will be documented in the field log.

The GPS is self-calibrated. The integrity of the unit is assured by conducting a comparison measurement of a known position at a specific location versus the position location that is acquired by the GPS unit. If the GPS fails to attain a reading that is within 100 meters of the actual position, then the manual should be consulted for sources of error and the reference position verified. All GPS units have a design positional accuracy of 15 meters. The GPS satellites are owned and controlled by the U.S. Department of Defense (DOD), which has the ability to degrade the accuracy of the GPS signal available to non-military users for purposes of national defense. During periods of selective availability (SA), the accuracy of the GPS may vary by  $\pm 100$  meters.

Calibration information will be recorded in the field logbook. In addition, a label specifying the scheduled date of the next calibration will be attached to the field equipment. If this identification is not feasible, then calibration records for the equipment will be readily available for reference.

Should any of the field equipment become inoperable, it will be removed from service and tagged to indicate that repair, recalibration, or replacement is needed. The field team leaders will be notified so that

prompt service or substitute equipment can be obtained. Backup systems will be available for each instrument in use and will be calibrated prior to use in the field.

### **E.3.7.2 Laboratory Equipment**

Laboratory equipment and instrument calibration procedures and schedules will be completed in accordance with the laboratory's SOPs (Table E-10). These requirements are summarized in Tables E-19 and E-20. Certified calibration standards used for instrument calibration will be obtained from commercial vendors for both inorganic and organic compounds and analytes. Where possible, standards will be traceable to NIST. Stock solutions for spiking solutions, surrogate compounds, and other inorganic compound mixes will be made from reagent-grade chemicals or as specified in the SOPs. Stock standards may also be used to make intermediate standards from which calibration standards are prepared. All analytical stock solutions will be prepared using Class-A volumetric ware. Documentation relating to the receipt, mixing, and use of standards is to be recorded in the laboratory logbooks. Specific handling and documentation requirements for the use of standards are provided in laboratory SOPs. All new calibration or spiking solutions are to be analyzed against a previously accepted standard to verify that the concentrations of each parameter are within 10% of the verified stock.

Prior to analysis, a calibration curve must be verified through the analysis of a check solution prepared from a source (or at least a lot) independent of that used for the initial calibration curve. GC/MS calibration check solutions must include all targeted analytes. GC/MS instruments must include a passing tune every 12 hours. Other GC analyses must be bracketed by passing calibration verification samples.

The fish board requires no calibration. The top loading balance will be calibrated at the beginning of each sampling day.

### **E.3.8 Inspection/Acceptance of Supplies and Consumables**

Prior to use, supplies and consumables will be inspected and tested to ensure that they conform to the required level of quality. Any defective material will be replaced before the sampling event or before analysis begins. Each laboratory must maintain an inventory of all chemicals, reagents, purchased standards solutions, and solvents.

Pre-cleaned containers will be used as containers for fish tissues. In the field, fish will be wrapped in pre-ashed aluminum foil. A cleaning lot number will be established in the laboratory and recorded on the sample collection form. In the laboratory, the fish tissue fillets will be placed in certified, clean (I-Chem or equivalent) glass jars and homogenized. Aliquots for trace metals will be placed in certified, clean (SPEC) jars. Prior to use, the containers will be inspected. Any defective material will be replaced before homogenization and aliquotting begins. The laboratory sample custodian will retain certificates of analysis provided with the containers. Appropriate materials, bubble wrap, plastic bags, tape, and supplies will be available for packing samples to avoid breakage during transport.

### **E.3.9 Non-direct Measurements**

The bioaccumulation data for *Macoma nasuta* that will be collected as part of the HPS Validation Study will be used for body burden comparisons. The use of additional literature or database sources of non-measured data is not anticipated.

### **E.3.10 Data Management**

Data generated in support of the HPS Human Health Evaluation will be tracked and reviewed by the appropriate SWG Team Leader. After review and validation of the field and laboratory data reports, the data will be entered into the SWG regional database system in place at Battelle. The database is the

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repository for both field and laboratory data and will be used to prepare reports and graphics. Description of the data-tracking process, which will be implemented to assess the quality of the database, will be described in BDO HPS SOP 002. The data management process for the validation studies has been designed to minimize loss and human error. Data flow will be automated to the extent practical.

Data management (*e.g.*, paper flow; data tracking, data entry, etc.) and data assessment (*e.g.*, verification, validation, and DQA) activities require adequate QC procedures to ensure that the SOPs will be followed and result in records and reports that are accurate and appropriate. QC procedures include peer review of each step and management review of a certain percentage of the data. Each laboratory must document its data management procedures in a SOP. Data verification and review is described in Section E.5.0.

### **E.3.10.1 Field Data**

Preprinted labels (Section E.3.2.2) that include a unique sample identification number and prompt for required sample-specific information will be provided to the field team. A separate label is inserted into each sample bag with the foil-wrapped fish and the sample ID recorded on the field log. This provides a unique link between the field records and each sample.

Sample collection information is initially hand recorded in bound, pre-paginated logbooks, then keyed into SampTrack for the Web (STW). Data entry into the electronic format follows the sampling efforts. The Field Team Leader accesses the password-protected STW and enters the relevant sample collection information. Sample collection information is validated and checked for adherence to the proper database format. For example, the sample ID, study ID, station ID, and sample media are selected from dropdown boxes listing the valid values. Dates and station coordinates are validated against a range of acceptable values. Once the user submits the electronic data and it is validated by the database, the sample collection information for that sample is immediately incorporated into the SWG production database. Accordingly, this information will also immediately appear in relevant data views on STW so that the entire group may track the progress of field operations.

In addition to sample collection information, which describes where and how samples were collected, the field team may also record other information associated with the collection of a sample. These data will be submitted as an electronic deliverable (BDO HPS SOP 002) or entered directly into STW.

### **E.3.10.2 Laboratory Data**

Data management at the laboratory begins with the receipt of samples. Samples are logged in and assigned unique identification numbers that are used to identify samples throughout storage, processing, analysis, and reporting. A combination of hand-recorded and electronically captured data is generated. Hand-recorded data include sample processing and spiking procedures. Hand-recorded data are transcribed to spreadsheets using established formats. (The raw data are maintained in the project files and the transcribed data are 100% verified). Electronically captured data include sample weights and instrument outputs. GC/MS and GC data are captured using Hewlett Packard EnviroQuant and X-chrome data systems, or equivalent. Once the analyst verifies peak identification and integration, data are exported to Excel spreadsheets for final reduction. A similar procedure is used for trace metals data.

### **E.3.10.3 Electronic Data Deliverables**

All critical data collected for the HPS Human Health Evaluation will be entered into the SWG Regional database. All laboratories generating data that will be entered into the database are required to submit data to the SWG Team Database Manager in an electronic format called an electronic data deliverable (EDD). The EDD for analytical laboratories is detailed in BDO HPS SOP 003-01. The EDD is an ASCII ii or iii file or a spreadsheet of the laboratory data in a very specific format. The EDD file is validated for format and content and imported into the SWG regional Oracle database. If an EDD is not correctly

structured, as described in SOPs, the laboratory will be required to resubmit the data file in the correct format in a timely manner. All EDDs will conform to the requirements of the NEDTS and SWDIV EWI #6. Section E.2.6.7 discusses the Electronic Data Deliverable.

Electronic data files are named uniquely and systematically, enabling tracking and retrieval. All instruments use the same software versions. Electronic data reside on specified servers, not individual PCs. Raw and final data files are saved to CDs in read-only format and are stored in locked cabinets.

## **E.4.0 ASSESSMENTS/OVERSIGHT**

This section presents the internal and external checks (assessments) that will be used to assure that

- Elements of this QAPP have been correctly implemented as prescribed for all investigations conducted under the work plan;
- The quality of the data generated is adequate and satisfies the DQOs identified in QAPPs; and,
- Corrective actions, when needed, are implemented in a timely manner and their effectiveness is confirmed.

Assessment activities will include inspection, peer review, data audits, and data quality assessment.

### **E.4.1 Assessment and Response Actions**

The following subsections identify planned assessment and oversight activities to assure that the objectives identified above are attained for field and laboratory operations. The Navy QA Officer, SWG Team QA Program Manager, and/or the SWG Team Program Manager may also identify additional assessment activities to be performed during the course of the HPS Human Health Evaluation, based upon findings of the planned assessment activities described below. These individuals are authorized to stop work for cause if data quality or staff safety is threatened.

#### **E.4.1.1 Assessment Actions**

##### ***E.4.1.1.1 Assessment of Field Activities***

An audit evaluates the capability and performance of a measurement system or its components and identifies problems warranting correction. All auditors will be independent of the activities audited and will be selected by the Navy QA Officer or SWG Team QA Program Manager. Technical expertise and experience in auditing will be considered in selecting an auditor or audit team.

A field audit involves an on-site visit by the auditor or audit team. At least one field audit will be conducted for the HPS Human Health Evaluation survey. The SWG Team QA Program Manager will conduct the field audit. The auditor or audit team will develop an individual audit plan to provide a basis for the field audit. Field audits may include reviews of work plan adherence; availability and implementation of approved field procedures; calibration and operation of equipment; activity performance and records; quality assessment data; custody procedures; packaging, storage, and shipping of samples; training status; health and safety procedures; documentation of procedures and instructions; conformance to SOPs; and non-conformance documentation. Audits may also review compliance with applicable laws, regulations, policies, and procedures. The SWG Team QA Program Manager will be notified of project schedules so that the field activities may be selected for an audit.

The field audit will be conducted during field activities and will observe field activities to verify that correct protocols are being followed. If field activities do not comply with the procedures defined in the

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QAPP, FSP, and SOPs, the auditor will bring the non-compliant procedures to the attention of the field crew and recommend appropriate corrective actions. The auditor will verify completion of recommended corrective action. A corrective action request form and/or status report, describing the incident and closing the audit, will be completed.

After an audit is completed, the auditor or audit team will submit an audit report to the SWG Team QA Program Manager and a copy to the SW Team HPS Human Health Evaluation Task Leader. This report will also be included in the project summary report. These personnel will coordinate a management review of corrective action for any deficiencies that are noted.

#### ***E.4.1.1.2 Assessment of Laboratory Operations***

A laboratory performance audit has been conducted by the Navy at both analytical laboratories. The purpose of a performance audit is to assure that the laboratory is capable of producing data of known and acceptable quality. The laboratory audit included reviewing the laboratory's written procedures, evaluating the laboratory's historical performance, and verifying that the laboratory procedures comply with Navy QA requirements. The performance audit also includes analysis of blind performance evaluation samples provided by the Navy to measure the laboratory's performance. Navy certification of Battelle's Duxbury and Sequim Laboratories is complete.

Each laboratory must have an internal audit program to monitor the degree of adherence to their own policies, procedures, and standards. The internal audit program includes systems audits, performance evaluations, data audits, and spot assessments. Internal audits are conducted by the laboratory QA officer, who is independent of the area(s) being evaluated. The internal QA program at each laboratory must be defined in a QA manual. QA audit assessment procedures must be defined in SOPs.

The SWG Team Chemistry Laboratory Leader will communicate with each analytical laboratory on a regular basis while the HPS Human Health Evaluation samples are being analyzed. This will allow assessment of progress in meeting DQOs and MQOs, and the identification of any problems requiring corrective actions early in the investigative process. The SWG Team Chemistry Laboratory Leader will promptly report problems identified, corrective actions taken, and make recommendations as appropriate for additional corrective action to the SWG Team VS Project Manager. The SWG Team VS Project Manager will review the problem and provide for the swift implementation of any outstanding corrective actions. In addition, contact between the SWG Team QA Program Manager and the independent data validator (see Section E.5) could also result in the need for a laboratory audit. The SWG Team Chemistry Laboratory Leader will be responsible for working directly with the laboratory to assure the prompt resolution of any problems identified.

#### **E.4.1.2 Response Actions**

An effective QA program requires prompt and thorough correction of non-conformance conditions that can affect quality. Rapid and effective corrective action minimizes the possibility of questionable data or documentation.

Two types of corrective actions exist: immediate and long-term. Immediate corrective actions include correction of documentation deficiencies or errors, repair of inaccurate instrumentation, or correction of inadequate procedures. Often, the source of the problem is obvious and can be corrected at the time it is observed. Long-term corrective actions are designed to eliminate the sources of problems. Examples of long-term corrective actions are correction of systematic errors in sampling or analysis and correction of procedures producing questionable results. Corrections can be made through additional personnel training, instrument replacement, or procedural improvements. One or more corrections may be necessary.

QA problems and corrective actions will be documented to provide a complete record of QA activities and to help identify needed long-term corrective actions. Defined responsibilities are required for scheduling, conducting, documenting, and ensuring the effectiveness of the corrective action.

#### ***E.4.1.2.1 Field Procedures***

Field non-conformance conditions are defined as occurrences or measurements that are either unexpected or that do not meet established acceptance criteria and which will affect data quality if corrective action is not implemented. Some examples of non-conformance conditions include incorrect use of field equipment; improper sample collection, preservation, storage, or shipment procedures; incomplete field documentation, including custody records; incorrect decontamination procedures; incorrect collection of QC samples; and unsafe field practices.

Corrective action procedures will depend on the severity of the non-conformance condition. In cases in which immediate and complete corrective action is implemented by field personnel, the corrective action will be recorded in the field log notebook. Non-conformance conditions which have a substantial impact on data quality require completion of a corrective action request form (however named). This form may be filled out by an auditor or by an individual who suspects that any aspect of data integrity is being affected by a field non-conformance issue. Each form is limited to a single non-conformance issue; if additional problems are identified, multiple forms must be used for documentation.

Copies of the corrective action request form will be distributed, as appropriate, to the SWG Team Field Leader and/or the SWG Team Chemistry Laboratory Leader, the SWG Team QA Program Manager, and the project file. The SWG Team QA Program Manager will forward completed corrective action forms, as appropriate. The problem resolution will follow the steps listed below.

- Determine when and how the problem developed
- Assign responsibility for problem investigation and documentation
- Determine corrective actions to eliminate the problem
- Design a schedule for completion of the corrective action
- Assign responsibility for implementing the corrective action
- Document and verify that the corrective action has eliminated the problem

The report will also list completion dates for each phase of the corrective action procedure and the due date for the SWG Team QA Program Manager to review and check the effectiveness of the solution. If warranted, a follow-up audit will be conducted to check that the problem has not reappeared. The follow-up review is conducted to ensure that the solution has adequately and permanently corrected the problem. Either the Navy QA Officer or the SWG Team QA Program Manager can require field activities to be limited or discontinued until the corrective action is complete and the non-conformance issue has been eliminated.

#### ***E.4.1.2.2 Laboratory Procedures***

The internal laboratory corrective action procedures and a description of non-conformance situations requiring corrective action are contained in the laboratory QA plan and SOPs. At a minimum, corrective action and/or notification of the SWG Team Chemistry Laboratory Team Leader will be implemented when any of the following three conditions occurs: (1) control chart warning or control limits are exceeded, (2) method QC requirements are not met, and (3) sample holding times are exceeded. Non-conformance situations will be reported to the appropriate laboratory manager within two working days after they are identified. In addition, a corrective action report, signed by the laboratory manager and the

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laboratory QA Manager, will be provided to the SWG Team Chemistry Laboratory Leader and the SWG Team Human Health Task Leader. Corrective actions will be implemented where possible, as specified in laboratory SOPs. Where corrective action is not feasible, appropriate qualifiers will be added to data.

#### **E.4.2 Reports to Management**

When the HPS Human Health Evaluation is complete, a report will be produced that will include sampling and testing methodologies, types of data, statistical methods, evaluation of the data, and recommendations for further work, as necessary.

##### **E.4.2.1 Project Monthly Progress Report**

A summary report is prepared by the SWG Team Program Manager and the SWG Team QA Program Manager on a monthly basis and submitted to the Navy. This report will include the following:

- Status of the project
- Instrument, equipment, or procedural problems affecting QA and recommended solutions
- Objectives achieved during the reporting period;
- Objectives from the previous report that were not achieved;
- Work anticipated for the next month

##### **E.4.2.2 Quality Control Summary Report**

A data QC summary report will be prepared by Battelle and submitted to the Navy Program Manager with the final study report or annually, if the study is expanded to encompass analyses for more than one year. These reports will be reviewed and approved by the QA Program Manager and will describe, for each type of analysis,

- a summary of the QC procedures used to assess data accuracy, precision, and completeness;
- a detailed report of analytical data accuracy, precision, and completeness;
- the results of performance and systems audits; and
- the corrective actions that have occurred over the period of the report.

Particular emphasis will be placed on determining whether project quality criteria were met and whether data are of sufficient quality to support required decisions. The duration and location of storage for the complete data packages will also be defined in this report.

#### **E.5.0 DATA VALIDATION AND USABILITY**

This section of the QAPP provides a description of the data review activities that will occur after the data collection phase of the project is completed. The requirements and methods for data review, verification, and validation, as well as the process for reconciling data generated with the DQOs are described. Implementation of these methods will determine whether or not the data conform to the specified criteria, thus satisfying the project objectives.

### **E.5.1 Data Review, Validation, and Oversight**

Data review includes data verification, validation, and oversight, as well as reconciliation of the data quality with user requirements. The data verification process includes the initial review of the data packages to ensure that the analyses requested have been provided. Data validation is the process of reviewing data and accepting, qualifying, or rejecting data on the basis of sound criteria using established EPA guidelines. Final technical data review occurs after independent data validation has been completed. It provides an indication of overall trends in data quality and usability. These procedures are detailed below.

#### **E.5.1.1 Data Verification**

Data generated during field investigations will be assembled in packages by sample delivery group, processing batch, or analytical batch. The contents of a data package are defined in Section E.2.6.6. The data packages will contain supporting QC data for the associated field samples and will be subjected to full data validation conducted by the Navy's independent data validator (Section E.5.1.2).

Each analytical laboratory is responsible for reviewing each data package prior to release for validation. At a minimum, the following reviews must be performed:

- Peer review of the data by a qualified analyst;
- Review of the reported data and deviations by a technical supervisor or data coordinator; and,
- QA office review of 10% of the data.

Implementation of these procedures is defined in laboratory SOPs. These reviews must ensure the following:

- All data for project samples are reported accurately and completely;
- Sample analysis was conducted in accordance with required laboratory procedures and analytical methods specified in the QAPP and FSP;
- Criteria for data quality have been met or deviations are documented in the package narrative and data flags have been appropriately applied;
- Each data set is appropriately reviewed; and,
- All project requirements have been met.

#### **E.5.1.2 Data Validation**

“Data validation is a systematic process through which project data are compared to established criteria in order to provide assurance that the data are adequate for the intended use” (Navy IR Guide 1996). Data validation is conducted to assess the compliance of chemistry data with the DQOs defined in the QAPP. Data are assessed for completeness and compliance with the requirements of the analytical methods. Validation is conducted on each data package to determine the adequacy of the data meet the DQOs. Laboratory Data Consultants (Carlsbad, CA) is the data validation firm.

The data generated for the HPS Human Health Evaluation is being generated by BDO and BSL using low-level (NOAA Status and Trends) analytical methods that are appropriate for the assessment of ecological and human health risk. There are no formal validation guidelines for the validation of these methods. Non-CLP type analytical methods will be validated for compliance with the requirements of the respective methods. CLP-like validation protocols will be used for these methods. Thus, validation will emulate EPA 1994b, 1994c, and 1994d, although no specific validation criteria for data generated

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according to these methods exist in the literature. Therefore, while the EPA validation *guidelines* will be used in data validation, the method-specific criteria will be defined in the laboratory SOPs and the QAPP, in cases where the methods are not accepted by EPA. The data assessment criteria are defined in the QAPP, the FSP, and the laboratory analytical SOPs.

Hunters Point Shipyard is a NPL site. According to SW DIV Environmental Work Instruction #1 (Chemical Data Validation), these data should be validated using the validation strategy of 20% Level-IV and 80% Level-III.

- Level-III data validation assumes that reported data values are correct as reported. Data quality is assessed by verifying that the criteria defined in the QAPP for each compound class have been achieved (Table E-12).
- Level-IV data validation is based on the assessment of raw data packages, which include all data required for a full review and assessment of compound selection, integration, interference assessment, and re-quantification (*e.g.*, spectra and chromatograms). Supporting records are also included in the package (*e.g.*, calibration standard, instrument sequence files, and dilution factors).
- Level-IV data validation includes re-quantification of reported QC and field sample values using the raw data files. In addition, instrument performance, calibration methods, and calibration standards are reviewed to ensure that the detection limits and data values are accurate and appropriate.

These validation levels cannot be strictly applied to data generated using non-standard methods, and therefore the CLP-like validation strategy described above will be implemented.

#### ***E.5.1.2.1 Results of Data Validation***

During data validation, the laboratory performance is assessed against prescriptive requirements and subjective requirements. Evaluation of laboratory performance against prescription requirements is assessed through compliance with the method requirements and the acceptability of QC sample results that are independent of sample matrix (*e.g.*, instrument performance checks, calibration criteria). An assessment of the subjective requirements involves identification of potential matrix effects, and consists of an evaluation of the analytical results and the results of the testing blank, duplicate, and matrix spike samples. The validator then assesses how, if at all, the matrix effect impacted the usability of the data. Best professional judgment in any area not specifically addressed by EPA guidelines will be utilized as necessary and will be described in the usability assessment portion of the data validation report.

The data validation report will include a comprehensive narrative detailing all QC exceedances and explaining qualifications of data results. Data qualification “flags” will be applied by the laboratory for data that do not meet quality criteria. These data qualifiers are listed and defined in Table E-14. Additional qualifiers will be applied by the validator, as appropriate. The validation assessment parameters are listed in Table E-21.

### **E.5.2 Data Quality Assessment Reconciliation with Planning Objectives**

Data Quality Assessment (DQA) is a data analysis and interpretation process involving scientific and statistical evaluation of data sets to determine if they are sufficient to support specific decisions. To implement the DQA process, the analyst will work closely with a multidisciplinary team, potentially including the team leader, data manager, chemist, statistician, risk assessor, and earth scientists. The Navy will implement the DQA process as described in EPA guidance (EPA QA/G-9, 1998) to determine the adequacy of data to support a decision.

The HPS Human Health Evaluation will consider *Macoma nasuta* tissue data from bioaccumulation tests, and will generate fish tissue data from field collected fish to support an assessment of human health risk associated with shellfish ingestion, and to determine if fish in and around HPS are elevated in comparison to fish collected elsewhere in the bay. As discussed in the Validation Study (Battelle, et al., 2000), the statistical design for *Macoma* bioaccumulation tests was based primarily on sediment chemistry, using historical data to stratify the low volume FS footprint, and determine the variability expected in sediment chemistry within each stratum. An assumption is made that the sample sizes that are expected to provide adequate data for sediment chemistry, will be adequate for the evaluation of bioaccumulation in *Macoma*. The statistical sample sizes for fish collection were based on an analysis of the variability of available fish tissue data from San Francisco Bay (SFEI, 1999; SFRWQCB et al. 1995) fish data, and required DQOs as discussed in Section 3.2. The DQA will start by determining if critical design assumptions held true, and whether the sampling design provided data of adequate quality to support the stated decisions.

Upon receipt of the laboratory analytical chemistry data, the data analyst will assemble the data set, including field information such as sample coordinates and descriptions and associated field measurements, and review any additional reports (e.g., data validation report). The DQA shall begin with exploratory data analysis, including a significant graphical component. Standard EDA tools, such as histograms, q-q plots, cumulative frequency distributions, and box plots will be used. Because the DQA process evaluates individual data points within the context of entire data sets, it will identify both “suspect” data (probable outliers to the actual data distribution) and critical observations that could affect decisions based on these data. As necessary, “suspect” data will be submitted for “focused validation” to determine whether the “suspect” data resulted from errors in the data generation process. “Suspect” and other unusual observations will be reviewed by experts on the natural environment and the measurement process to determine if there are scientific explanations and can data corrected or need to be rejected. If observations are not corrected or rejected by the above process and are therefore determined to represent variability inherent in the measurement process or the environment, these data shall be retained within the data set. Any changes made to the data set shall be fully documented.

The DQA process addresses the questions “Did we get what we asked for?” and “Did we ask for what we need?” The standards which will be used to evaluate the adequacy of the study findings from the actual data received are the original DQO specifications for the HPS survey design which will be reviewed for continued relevance to the HPS human health risk decisions being made. To assess the adequacy of this sampling design to support the study questions, the data analyst must work with other members of the project team to determine if the number type, and quality of samples, as specified in the FSP and as actually collected, were appropriate. This includes: determining if the number and location of samples required by the FSP were taken; determining if the appropriate media were sampled; judging the adequacy of the sample number and locations, given the updated understanding of the problem; and determining if the understanding of the problem changed since the FSP/QAPP was prepared because of observations made by the field team.

Provided that the sampling design was adequate to support the decision, the evaluation of data adequacy to support that decision may terminate after the initial exploratory analysis, and the site should move forward in the decision-making process. This determination will be made based on the observed bioaccumulation in *Macoma*, and observed fish tissue constituent levels, the variability of these measurements, and a determination of the uncertainty associated with the types of comparisons that are being made with the data. Ultimately, the adequacy of data will be a function of whether the *Macoma* data are adequate to support decisions regarding the low-volume FS footprint with respect to Human Health and whether the fish tissue data are adequate to observe differences between HPS and the rest of the Bay at the desired level of confidence.

The SWG will use the elements of the DQA process defined by EPA that are relevant to data use, or its equivalent, to assess data adequacy to support a statistically based decision. The first two steps of this

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formal DQA process, review of the sampling design and preliminary data review, are described above. The remaining three steps are summarized below:

- data analyst will work with the project team to ensure that the most appropriate statistical test will be used. Additional or alternate tests may be considered at this time.
- Underlying assumptions that must hold for the proposed statistical procedures will be evaluated for this data set. Also, the data analyst will consult with the appropriate scientists and site experts to ensure that the comparisons implied by the statistical test are appropriate.
- data analyst will use the site data to generate estimates of total study error based on the data collected and to perform the appropriate statistical tests at a significance level consistent with the decision-makers' desire to control decision errors.

If an adequate level of confidence was achieved at the chemical constituent concentrations actually observed, this observation supports the case that data are sufficient to support the proposed decision.

Results of DQA will be documented in adequate detail for the decision-maker and peer reviewers to evaluate the effect of these results on decision-making.

**Table E–1. Specific Planning Documents for the Hunters Point Shipyard Human Health Evaluation.**

| Document  | Purpose   |
|---|---|
| HPS Human Health Evaluation Work Plan                             | Defines the history of the facility, potential sources of contamination, chemicals of potential concern (COPC) decision process, sampling design, data quality objectives (DQOs), and site-specific issues. |
| HPS Human Health Evaluation Health and Safety Plan                | Defines the potential human health risks associated with public uses of the facility, sampling design, and DQOs.  |
| HPS Human Health Evaluation Quality Assurance Project Plan (QAPP) | Defines project requirements for specific measurements that are required to achieve these study DQOs.   |
| HPS Human Health Evaluation Field Sampling Plan (FSP)             | Defines study objectives, sampling design, facility specific sampling locations, methods, and data use.   |

**Table E–2. Data Quality Objectives for Determination of Feasibility Study Footprint.**

|   |
|---|
| <b>Step 1: State the Problem (See Section 3.1)</b>  |
| <b>Step 2: Identify the Decision</b> <ul style="list-style-type: none"><li>• Do COPCs in <i>Macoma nasuta</i> tissues exposed to sediments from HPS in 28 day bioaccumulation studies exceed risk-based screening levels?</li></ul>   |
| <b>Step 3: Identify Inputs to the Decision</b> <ol style="list-style-type: none"><li>1. Results of analyses of 28-day <i>Macoma nasuta</i> bioaccumulation studies for each sampling location within the low volume FS footprint at HPS</li><li>2. Results of the ecological validation study, identifying which portions of the low volume FS footprint pose an unacceptable ecological risk (and will be included in the proposed FS footprint).</li><li>3. Human health risk-based screening criteria (RBSCs) for shellfish tissue ingestion.</li></ol>  |
| <b>Step 4: Define the Study Boundaries</b> <ul style="list-style-type: none"><li>• Analytical chemistry data from <i>Macoma nasuta</i> bioaccumulation study results from the areas described in Table 3-4 (DQOs for the Bioaccumulation Test), in the September, 2000, HPS Validation Study Work Plan. <i>M. nasuta</i> will be exposed to the top 5 cm of sediment from stations in each of the five areas included in the low-volume FS footprint represented by the numbers I, III, VIII, IX and X. Samples will not be collected in shoreline or intertidal areas covered with riprap or disposal debris. Surface sediment from each sample station will be represented by a localized composite sample to allow collection of sufficient sediment volume to support all required evaluations.</li></ul> |
| <b>Step 5: Develop a Decision Rule</b> <ul style="list-style-type: none"><li>• If the concentration of any chemical in <i>M. nasuta</i> tissues exposed to sediments from a defined area of the low-volume FS footprint exceeds RBSCs, and the uncertainty in the exposure parameters is acceptable, then conclude that the area must be included in the human health FS footprint.</li></ul>   |
| <b>Step 6: Evaluate Decision Errors</b> <ul style="list-style-type: none"><li>• Risk decision errors are controlled according to RAGs (EPA, 1989)</li></ul>   |
| <b>Step 7: Optimize the Design for Obtaining Data (See Section 3.2)</b> <ul style="list-style-type: none"><li>• The <i>M. nasuta</i> bioaccumulation study design developed for the ecological portion of the HPS Validation Study is adequate to support the evaluation of human health risk. Each portion of the low-volume FS footprint is sampled utilizing a stratified systematic approach, with more samples taken in areas of higher sediment chemistry variability and concentrations.</li></ul>   |

Table E- 3. Data Quality Objectives for Risk Communication Evaluation.

|   |
|---|
| <b>Step 1: State the Problem (See Section 3.1)</b>  |
| <b>Step 2: Identify the Decision</b> <ul style="list-style-type: none"> <li>Do concentrations of chemicals in fish from the vicinity of HPS exceed those in fish from other (ambient) locations in San Francisco Bay?</li> </ul>  |
| <b>Step 3: Identify Inputs to the Decision</b> <ul style="list-style-type: none"> <li>Results of analysis of fillet tissues following the RMP protocol for fish collected at HPS and at ambient locations. This includes compositing equal weight, skin-on fillets to produce composite samples of at least 100 grams.</li> </ul>   |
| <b>Step 4: Define the Study Boundaries</b> <ul style="list-style-type: none"> <li>Fish will be collected at the offshore areas of HPS, and at the following RMP locations (SFEI 1999): San Francisco Waterfront, Berkeley, and South Bay Bridges. If sufficient fish tissue can not be sampled at any one of these selected RMP stations, then the San Pablo Bay station will be evaluated as a substitute.</li> </ul>  |
| <b>Step 5: Develop a Decision Rule</b> <ul style="list-style-type: none"> <li>If the mean concentration of chemicals in fish filets from HPS is significantly greater than the mean concentration of chemicals in fish collected from ambient locations, then determine what type of risk communication should take place to inform potential receptors.</li> </ul>   |
| <b>Step 6: Evaluate Decision Errors</b> <ul style="list-style-type: none"> <li>Probability of failing to determine that fish fillets in HPS are greater than ambient, when in "truth" they are elevated by 90% will be limited to 5%, and the probability of incorrectly determining they are the same to 5%. Failure to properly determine HPS fish are more contaminated would result in a failure to communicate increased risk due to fishing at this site. Improperly determining HPS fish are elevated over ambient fish would result in falsely alarming the public and the associated costs for risk communication. Both error types are of concern to the Navy.</li> </ul> |
| <b>Step 7: Optimize the Design for Obtaining Data (See Section 3.2)</b> <ul style="list-style-type: none"> <li>A minimum of 6 composite samples will be collected at HPS and from the three ambient locations (i.e., 2 composites from each ambient location). The development of this sample size estimate is based on the procedures discussed in Section 3.2.1.</li> </ul>   |

Table E-4. Sampling Design for the Hunters Point Shipyard Human Health Evaluation.

| Objective  | Measurement  | Assessment          |
|--|--|---------------------|
| Compare measured levels of chemicals in tissue from the <i>Macoma nasuta</i> bioaccumulation study being implemented as part of the HPS VS to risk-based screening concentrations (RBSCs) in support of validating the FS footprint. | Tissue chemistry<br><i>Macoma</i> bioaccumulation test<br>body burden data (from HPS validation study) | COPC concentrations |
| Collect and analyze fish tissue from the vicinity of HPS and other Regional Monitoring Program (SFEI, 1999) sample sites throughout San Francisco Bay for statistical comparison in support of risk communication.                   | Fish tissue chemistry  | COPC concentrations |

**Table E-5. COPCs and Risk Based Screening Concentrations for Hunters Point Shipyard Human Health Evaluation.**

Reporting Limits are compared to the minimum RBSC.

| Analytes                                    | Reporting Limit <sup>1</sup> | Tissue Method Detection Limit | RBSC Range |            |
|---|------------------------------|-------------------------------|------------|------------|
|   |                              |                               | Minimum    | Maximum    |
| <b>TRACE METALS (mg/kg wet weight)</b>      |                              |                               |            |            |
| Ag  | 0.019                        | 0.006                         | 19         | 1,000      |
| Sb  | 0.0048                       | 0.002                         | 1.6        | 80         |
| As  | 0.19 <sup>2</sup>            | 0.06                          | 0.06       | 60         |
| Cd  | 0.095                        | 0.03                          | 1.9        | 100        |
| Cr  | 0.19                         | 0.06                          | 12         | 600        |
| Cu  | 0.048                        | 0.015                         | 140        | 7400       |
| Pb  | 0.024                        | 0.008                         | NA         | NA         |
| Hg  | 0.00095                      | 0.00030                       | 1.2        | 60         |
| Ni  | 0.14                         | 0.045                         | 78         | 4,000      |
| Se  | 0.19                         | 0.06                          | 19         | 1,000      |
| Zn  | 0.19                         | 0.06                          | 1,200      | 60,000     |
| <b>ORGANIC COMPOUNDS (µg/Kg wet weight)</b> |                              |                               |            |            |
| Naphthalene                                 | 0.64                         | 0.42                          | 78,000     | 4,000,000  |
| 2-Methyl naphthalene                        | 0.64                         | 0.036                         | NA         | NA         |
| Acenaphthylene                              | 0.64                         | 0.020                         | NA         | NA         |
| Acenaphthene                                | 0.64                         | 0.022                         | 230,000    | 12,000,000 |
| Fluorene                                    | 0.64                         | 0.03                          | 160,000    | 8,000,000  |
| Phenanthrene                                | 0.64                         | 0.16                          | NA         | NA         |
| Anthracene                                  | 0.64                         | 0.016                         | 1,200,000  | 60,000,000 |
| Fluoranthene                                | 0.64                         | 0.21                          | 160,000    | 8,000,000  |
| Pyrene                                      | 0.64                         | 0.13                          | 120,000    | 6,000,000  |
| Benzo(a)anthracene                          | 0.64                         | 0.017                         | 120        | 21,000     |
| Chrysene                                    | 0.64                         | 0.02                          | 12,000     | 2,100,000  |
| Benzo(b)fluoranthene                        | 0.64                         | 0.017                         | 120        | 21,000     |
| Benzo(k)fluoranthene                        | 0.64                         | 0.02                          | 1,200      | 210,000    |
| Benzo(a)pyrene                              | 0.64                         | 0.02                          | 12         | 2,100      |
| Indeno(1,2,3-c,d)pyrene                     | 0.64                         | 0.009                         | 120        | 21,000     |
| Dibenz(a,h)anthracene                       | 0.64                         | 0.016                         | 12         | 2,100      |
| Benzo(g,h,i)perylene                        | 0.64                         | 0.012                         | NA         | NA         |
| 4,4'-DDD                                    | 0.52                         | 0.040                         | 380        | 65,000     |
| 2,4'-DDD <sup>3</sup>                       | 0.52                         | 0.027                         | 380        | 65,000     |
| 4,4'-DDE                                    | 0.52                         | 0.035                         | 270        | 46,000     |
| 2,4'-DDE <sup>3</sup>                       | 0.52                         | 0.091                         | 270        | 46,000     |
| 4,4'-DDT                                    | 0.52                         | 0.025                         | 270        | 100,000    |
| 2,4'-DDT <sup>3</sup>                       | 0.52                         | 0.033                         | 270        | 100,000    |
| a-Chlordane                                 | 0.52                         | 0.021                         | 260        | 100,000    |
| g-Chlordane                                 | 0.52                         | 0.18                          | 260        | 100,000    |
| Dieldrin                                    | 0.52                         | 0.025                         | 5.7        | 10,000     |
| Endrin                                      | 0.52                         | 0.017                         | 1,200      | 60,000     |
| Endosulfan II <sup>4</sup>                  | 0.52                         | 0.049                         | 23,000     | 1,200,000  |
| Heptachlor                                  | 0.52                         | 0.027                         | 20         | 10,000     |

**Table E-5. COPCs and Risk Based Screening Concentrations for Hunters Point Shipyard Human Health Evaluation (continued).**

| Analytes                                    | Reporting Limit <sup>1</sup> | Tissue Method Detection Limit | RBSC Range |         |
|---|------------------------------|-------------------------------|------------|---------|
|   |                              |                               | Minimum    | Maximum |
| <b>ORGANIC COMPOUNDS (µg/Kg wet weight)</b> |                              |                               |            |         |
| Total PCBs <sup>5</sup>                     | NA                           | NA                            | 45         | 7,800   |
| TBT   | 1.87                         | 1.443                         | NA         | NA      |
| DBT   | 1.73                         | 3.053                         | NA         | NA      |
| Total Butyltins <sup>6</sup>                | NA                           | NA                            | NA         | NA      |

<sup>1</sup>See Section E.2.4.2 for a full discussion of reporting limit calculations.

<sup>2</sup>See Section E.3.4.2.1 and Work Plan Section 2.1 for a discussion of how COPCs with reporting limits that are greater than the minimum RBSC will be treated.

<sup>3</sup>The RBSC values for 4,4'-DDX's are applied to 2,4'-DDX's.

<sup>4</sup>The RBSC values for Endosulfan II were calculated using the Oral Reference Dose and RBSC values for Endosulfan.

<sup>5</sup>Total PCB will be based on the sum of the 19 PCB congeners defined for the NOAA Status and Trends Program.

<sup>6</sup>Total butyltins is the sum of TTBT, TBT, DBT, and MBT. All four compounds will be measured but only TBT and DBT are COPCs.

**Table E–6. Critical and Non-Critical Measurements for the Hunters Point Shipyard Human Health Evaluation.**

| Critical  | Non-Critical  |
|---|---|
| <i>Field Measurement</i>  |   |
| <ul style="list-style-type: none"> <li>• Latitude (Start and end for tows)</li> <li>• Longitude (Start and end for tows)</li> <li>• Fish –common name and taxonomic identification</li> <li>• Fish – maximum total length</li> <li>• Fish – whole body weight</li> <li>• Number of each fish species per station</li> </ul> | <ul style="list-style-type: none"> <li>• Weather conditions</li> <li>• Sample observations</li> <li>• Trawl time</li> <li>• Trawl length and direction</li> <li>• Boat speed</li> <li>• Tide phase</li> </ul> |
| <i>Chemical Analysis</i>  |   |
| <ul style="list-style-type: none"> <li>• COPC Analysis in Tissues:               <ul style="list-style-type: none"> <li>Trace metals</li> <li>Butyltins</li> <li>PAHs</li> <li>Pesticides</li> <li>PCB congeners</li> <li>PCB Aroclors</li> </ul> </li> <li>• Tissue lipids</li> <li>• Percent moisture</li> </ul>          |   |

**Table E-7. Standard Operating Procedures.**

| <b>Battelle Duxbury Operations</b>             |  |
|--|--|
| <b>(3) Facilities And Equipment</b>            |  |
| 3-092  | Operation and Maintenance of Hewlett-Packard 5970B, 5972A, and 5973A Gas Chromatograph/ Mass Selective Detector (GC/MSD) using Hewlett-Packard Software              |
| 3-116  | Operation and Maintenance of Gas Chromatographs  |
| <b>(5) Laboratory and Field Procedures</b>     |  |
| 5-128  | Identification and Quantification of Polychlorinated Biphenyls (By Congener and Aroclor) and Chlorinated Pesticides by Gas Chromatography/Electron Capture Detection |
| 5-157  | Identification and Quantification of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Spectrometry   |
| 5-190  | Tissue and Sediment Extraction for Trace Level Semi-Volatile Organic Contaminants  |
| 5-196  | Measurement of Butyltin Species in Tissues and Sediment/Soil   |
| <b>(6) Documentation, Records, And Reports</b> |  |
| 6-010  | Sample Receipt, Custody and Handling   |
| <b>(7) Data Processing</b>                     |  |
| 7-029  | Preparation, Analysis, and Reporting Quality Control Data in the Chemistry Laboratory  |
| BDO HPS SOP 001                                | Performance of Analytical Chemistry Work According to the Requirements of the Naval Facilities Engineering Service Center  |
| BDO HPS SOP 002                                | Sample Tracking System   |
| BDO HPS SOP 003                                | EDD for Analytical Laboratories  |
| <b>Battelle Sequim Laboratory</b>              |  |
| <b>(A) Administrative</b>                      |  |
| MSL-A-002                                      | Sample Chain of Custody  |
| <b>(I) Inorganic chemistry</b>                 |  |
| MSL-I-016                                      | Total Mercury in Tissues and Sediment by CVAA  |
| MSL-I-022                                      | Determination of Elements in Aqueous and Digestate Samples by ICP/MS   |
| MSL-I-024                                      | Mixed Acid Tissue Digestion  |
| MSL-I-027                                      | Determination of Metals in Aqueous and Digestate Samples by ICP/AES  |
| MSL-I-028                                      | Navy Sample Analysis Plan  |
| MSL-I-029                                      | Determination of Metals in Aqueous and Digestate Samples by GFAA   |
| <b>(C) Conventional Organic Chemistry</b>      |  |
| MSL-C-003                                      | Percent Dry Weight and Homogenizing Dry Sediment, Soil, and Tissue   |

**Table E-8. Sampling Design for the Hunters Point Shipyard Human Health Evaluation.**

| Species          | Size Range (cm) | Whole Body Weight of Fish Required to Achieve 100 grams Fillet per Composite <sup>1,2</sup> |                                      |                                 |                                     |
|------------------|-----------------|---|--------------------------------------|---------------------------------|-------------------------------------|
|                  |                 | Hunters Point Shipyard (g) (6 composites)   | San Francisco Pier(g) (2 composites) | Berkley Pier (g) (2 composites) | San Mateo Bridge (g) (2 composites) |
| White croaker    | 20-30           | 2400  | 800                                  | 800                             | 800                                 |
| Shiner surfperch | 10-15           | 2400  | 800                                  | 800                             | 800                                 |
| Jacksmelt        | 21-30           | 2400  | 800                                  | 800                             | 800                                 |

<sup>1</sup>Assumes a ratio of whole body weight:fillet of 4:1. Therefore, 400 grams of whole fish are required in order to achieve 100 grams of fillet per composite.

<sup>2</sup>An additional 800 g of each species should be collected for one composite so that a laboratory matrix spike/spike duplicate can be prepared.

**Table E-9. Sample Containers, Sample Size, Preservative Requirements, and Holding Time for Analytical Samples.**

| Parameter   | Method Container <sup>1</sup> | Minimum Fillet Size  | No. of Containers | Sample Preservative | Holding Time <sup>2</sup> x/y |
|---|-------------------------------|----------------------|-------------------|---------------------|-------------------------------|
| <i>TISSUE - Organic Compound Analyses</i>                     |                               |                      |                   |                     |                               |
| Polycyclic aromatic hydrocarbons (PAHs)                       | G                             | 100 g                | 1                 | Frozen              | 1 year/40 days                |
| Organochlorine pesticides and Polychlorinated biphenyls (PCB) | G                             | (100 g) <sup>3</sup> | (1)               | Frozen              | 1 year/40 days                |
| Butyltins   | G                             | (100 g)              | (1)               | Frozen              | 1 year/40 days                |
| Lipids  | G                             | (30 g)               | (1)               | Frozen              | 1 year/40 days                |
| <i>TISSUE – Inorganic Compound Analyses</i>                   |                               |                      |                   |                     |                               |
| Metals  | PS                            | (20) g               | 1                 | Frozen              | 1 year                        |
| Hg  | PS                            | (20 g)               | (1)               | Frozen              | 1 year                        |

<sup>1</sup> Container Types: G = Amber glass with Teflon-lined lid; PS = Polystyrene

<sup>2</sup> "x" days/"y" days refers to the maximum number of days from sampling to extraction/the maximum number of days from extraction to analysis.

<sup>3</sup> One sample will be collected, processed, homogenizes and split at BDO for these analyses.

**Table E-10. Methods for Laboratory Analysis.**

| Parameter<br>(Units of Measure)                       | EPA Base Method   | Lab | Laboratory<br>SOP                   | Description <sup>1</sup> |
|---|---|-----|-------------------------------------|--------------------------|
| <i>Analysis of Tissue</i>                             |   |     |                                     |                          |
| Butyltins (ng/g)                                      | No EPA Method   | BDO | 5-196                               | T & C<br>GC/FPD          |
| Lipids (%)  | Lauenstein and Cantillo<br>(1993a) <sup>2</sup>         | BDO | 5-190                               | Gravimetric              |
| PAHs (ng/g)   | Lauenstein and Cantillo<br>(1993a) <sup>2</sup>         | BDO | 5-157                               | T&C<br>GC/MS SIM         |
| Pesticides<br>PCBs (Congeners and Aroclors)<br>(ng/g) | Lauenstein and Cantillo<br>(1993a) <sup>2</sup>         | BDO | 5-128                               | T&C<br>GC/ECD            |
| Metals (µg/g)   | EPA Method 200.9 <sup>2</sup> , and<br>EPA 7000 series  | BSL | MSL-I-029<br>MSL-I-024<br>MSL-C-003 | AD<br>GFAA               |
| Metals (µg/g)   | EPA 200.7 <sup>2</sup> , and<br>EPA 6010B; modified     | BSL | MSL-I-027<br>MSL-I-024<br>MSL-C-003 | AD<br>ICP-AES            |
| Metals (µg/g)   | Sediment and Tissue:<br>EPA 200.8 <sup>2</sup> and 6020 | BSL | MSL-I-022<br>MSL-I-024              | AD<br>ICP-MS             |
| Hg (µg/g)   | EPA 245.5 <sup>2</sup> modified                         | BSL | MSL-I-016                           | AD<br>CVAA               |

<sup>1</sup>Description:

- C = Centrifuge
- T = Tissuemizer
- AD = Acid digestion

Analytical instruments defined in glossary.

<sup>2</sup>Low-level NOAA Status and Trends methods are selected to achieve the required evaluation detection limits.

**Table E–11. Definitions, Requirements, and Frequency for Typical Quality Control Samples.**

| QC Sample  | Definition  | Frequency   |
|--|---|---|
| <i>LABORATORY QUALITY CONTROL</i>                                    |   |   |
| Method or Procedural Blank (MB)                                      | A combination of solvents, surrogates, and all reagents used during sample processing, processed concurrently with the field samples. Monitors purity of reagents and laboratory contamination. Matrices: Water (MilliQ); tissue (sodium sulfate)   | 1/sample batch <sup>1</sup><br>A processing batch MB must be analyzed with each sequence. |
| Laboratory Control Sample (LCS)                                      | A LCS sample is a matrix-specific sample that is prepared with each processing batch. It is spiked with the analytes of interest and processed identically to the field samples. Matrices are the same as those used for the procedural blank.  | 1/sample batch  |
| Matrix Spike (MS) <sup>2</sup>                                       | A field sample spiked with the analytes of interest at 10 X the MDL, processed concurrently with the field samples; monitors effectiveness of method on sample matrix; performed in duplicate for tissues and soils. An MS must be processed for each distinct matrix. (All fish species are considered the same matrix). | 1/sample batch  |
| Duplicate Sample (QADU) or Matrix Spike Duplicate (MSD) <sup>2</sup> | Second aliquot of a field sample processed and analyzed to monitor precision; each sample set should contain a duplicate. The duplicate may be a second matrix spike sample.  | 1/sample batch  |
| Recovery Internal Standards (RIS)                                    | All field and QC samples are spiked with recovery internal standards just prior to analysis; used to quantify surrogates to monitor extraction efficiency on a per sample basis.  | Each organic compounds and DRO sample   |
| Surrogate Internal Standards (SIS)                                   | All field and QC samples are spiked with a known amount of surrogates just prior to extraction; recoveries are calculated to quantify extraction efficiency.  | Each organic compounds and DRO sample   |
| Standard Reference Material (SRM)                                    | An external reference sample which contain a certified level of target analytes; serves as a monitor of accuracy. Extracted and analyzed with samples of a like matrix  | 1/batch   |
| Performance Evaluation (PE) or Performance Test (PT)                 | Blind sample of unknown composition that is analyzed as a routine sample. The PE is provided by either a government or commercial agency. Results are submitted to the supplier who determines whether the results fall within a statistically acceptable range.  | 2/year  |
| Independent Instrument Check (IC)                                    | Direct spike of target analytes into solvent where the spike source is independent of that used to prepare the calibration standards to assess instrument performance.  | 1/analytical run if an independent source is available                                    |
| Instrument (Solvent) Blank (IB)                                      | An injection of straight solvent to assess sample carry-over in GCs (not GC/MSs).   | 1/10 samples  |
| Reagent or Solvent Purity Checks                                     | All reagents are lot-checked prior to use.  | Per lot purchase  |

<sup>1</sup>A batch is defined as 20 field samples processed simultaneously and sharing the same QC samples.<sup>2</sup>Non-Navy samples may not be substituted to meet this requirement.

Table E–12. Data Quality Criteria.<sup>1,2</sup>

| QC Parameter   | Acceptance Criteria  | Corrective Action <sup>3</sup>   |
|--|--|--|
| <b>CHEMISTRY</b>   |  |  |
| <b>Accuracy</b>  |  |  |
| <ul style="list-style-type: none"> <li>• <i>Instrument Solvent Blank (GC)</i></li> <li>• <i>Method Blank (MB)</i></li> </ul> | MB <MDL<br>If MB>MDL and <minimum RBSC, then perform corrective action   | Review data and analysis for possible sources of contamination. Reanalyze and/or document corrective action.   |
|  | MB<MDL<br>If MB>MDL and > minimum RBSC; sample values > 10x MB, then perform corrective action   | Review data and analysis for possible sources of contamination. Reanalyze and/or document corrective action. Data must be flagged.   |
|  | MB<MDL<br>If MB>MDL and >RBSC; sample values ≤10x MB, then perform corrective action   | Perform corrective action as above and re-process (extract, digest) sample batch. If batch cannot be re-processed, notify client and flag data.  |
| <ul style="list-style-type: none"> <li>• <i>SRM</i></li> </ul>   | Organic compounds: Average PD ≤30%; ≤35% for each analyte.<br>Metals: ≤20% PD.<br>Determined vs. certified range. (analyte concentration must be 10xMDL to be used for DQC). | Review data to assess impact of matrix. Reanalyze sample and/or document corrective action. If other QC data are acceptable then flag associated data if sample is not reanalyzed.   |
| <ul style="list-style-type: none"> <li>• <i>Matrix Spike</i></li> </ul>  | Organic compounds: 40 - 120% recovery<br>Metals: 70 - 130% recovery  | Review data to assess impact of matrix. If other QC data are acceptable and no spiking error occurred, then flag associated data.<br><br>If QC data are not affected by matrix failure or spiking errors occurred, then re-process MS. If not possible, then notify client and flag associated data. |
| <ul style="list-style-type: none"> <li>• <i>Surrogate Spike (SIS)</i></li> </ul>   | Organic compounds: 40 - 120% recovery  | Review data. Discuss with Laboratory Leader (LL). Reanalyze, re-extract, and/or document corrective action and deviations.   |
| <ul style="list-style-type: none"> <li>• <i>Laboratory Control Sample (LCS)</i></li> </ul>                                   | Organic compounds: 40 - 120% recovery<br>Metals: 70 - 130% recovery  | Perform corrective action. Re-analyze and/or re-process sample batch. Batch data associated with failed LCS (LCS data outside control limits) cannot be reported.<br><br>If batch cannot be re-processed: notify client, flag data, discuss impact in report narrative.                              |
| <ul style="list-style-type: none"> <li>• <i>Instrument Check</i></li> </ul>  | Organic compounds: 85 - 115% recovery  | Perform corrective action. Re-analyze and/or re-process sample batch. Data outside control limits cannot be reported. <b>If batch cannot be re-processed, notify client, flag data, discuss impact in report narrative.</b>  |
| <ul style="list-style-type: none"> <li>• <b>Precision: Duplicates</b></li> </ul>   | Organic compounds (MSD): <30% RPD<br>Metals (laboratory duplicate): <30% RPD<br>Lipids: <30% RPD   | Review data to assess impact of matrix. If other QC data are acceptable, then flag associated data.<br><br>If QC data are not affected by matrix failure, then re-process duplicate. If not possible, then notify client and flag associated data.   |

<sup>1</sup>See abbreviation definitions

<sup>2</sup>Individual parameters included in the compound classes “Organic compounds” and “Metals” are defined in Table E-4.

Table E-13. Calculation of Quality Control Assessment Statistics.

|   |
|---|
| <p><b>Percent Recovery</b></p> <p>The percent recovery is a measurement of accuracy, where one value is compared with a known/certified value. The formula for calculating this value is:</p> $\text{Percent Recovery} = \frac{\text{amount detected}}{\text{amount expected}} \times 100$  |
| <p><b>Percent Difference</b></p> <p>The percent difference (PD) is a measurement of precision as an indication of how a measured value is difference from a "real" value. It is used when one value is known or certified, and the other is measured. The formula for calculating PD is:</p> $\text{Percent Difference} = \frac{X_2 - X_1}{X_1} \times 100$ <p>where: <math>X_1</math> = known value (e.g., SRM certified value)<br/> <math>X_2</math> = determined value (e.g., SRM concentration determined by analyst)</p>   |
| <p><b>Relative Percent Difference</b></p> <p>The relative percent difference (RPD) is a measurement of <i>precision</i>; it is a comparison of two similar samples (matrix spike/matrix spike duplicate pair, field sample duplicates). The formula for calculating RPD is:</p> $\text{RPD} = \left  \frac{2 \times (X_1 - X_2)}{(X_1 + X_2)} \right  \times 100$ <p>where: <math>X_1</math> is concentration or percent recovery in sample 1<br/> <math>X_2</math> is concentration or percent recovery in sample 2</p> <p><i>Note: Report the absolute value of the result -- the RPD is always positive.</i></p> |
| <p><b>Relative Standard Deviation</b></p> <p>The relative standard deviation (RSD) is a measurement of <i>precision</i>; it is a comparison of three or more similar samples (e.g., field sample triplicates, initial calibration, MDLs). The formula for calculating RSD is:</p> $\%RSD = \frac{\text{Standard Deviation of All Samples}}{\text{Average of All Samples}} \times 100$   |

**Table E-14. Navy Environmental Data Transfer Standard (NEDTS) Data Qualifiers.**

| <i>Method Qualifiers</i>          |  |
|-----------------------------------|--|
| A                                 | Method qualifier - Flame AA  |
| AV                                | Method qualifier - Automated cold vapor  |
| C                                 | Method qualifier - Manual spectrophotometric   |
| CV                                | Method qualifier- Manual cold vapor  |
| F                                 | Method qualifier - Furnace AA  |
| NR                                | Method qualifier - Analyte was not required  |
| P                                 | Method qualifier - ICP   |
| <i>Data Qualifiers</i>            |  |
| A                                 | Indicates that the TIC is a suspected aldol_condensation product   |
| B                                 | Analyte found in both sample and associated blank. The “B” will be reported on the result associated with the field samples, not the blank |
| C                                 | Presence confirmed by GC/MS (Pesticides only)  |
| D                                 | Dilution run. Initial run outside linear range of instrument   |
| E                                 | Estimate, result outside linear range of instrument. GC/MS only  |
| J                                 | Estimated value (value less than method reporting limit)   |
| R                                 | Rejected   |
| S                                 | Reported value determined by Method of Standard Additions (MSA)  |
| U                                 | The value was less than the IDL or the analyte was not detected  |
| W                                 | Post-digestion spike out of control limits   |
| X                                 | Indicates manual modification of result or EPA qualifier   |
| <i>Quality Control Qualifiers</i> |  |
| M                                 | Duplicate inject precision did not agree   |
| N                                 | Spiked sample recovery not within control limits   |
| *                                 | Duplicate analysis not within control limits   |
| +                                 | Correlation coefficient for the MSA is less than 0.995   |

**Table E–15. Maintenance Procedures for Field Equipment.**

| Equipment           | Activity | Frequency      |
|---------------------|----------|----------------|
| dGPS                | inspect  | Not applicable |
| Fish board          | clean    | As needed      |
| Top loading balance | clean    | As needed      |

**Table E–16. Maintenance Procedures for General Laboratory Equipment.**

| Equipment                     | Activity  | Frequency  |
|-------------------------------|---|--|
| Deionized water system        | Replace seals<br>Replace cartridges                                     | As needed for leaks and to maintain resistivity > 18 mOhms                   |
| MilliQ deionized water system | Replace seals<br>Replace cartridges                                     | Every 6 months or as needed for leaks and to maintain resistivity > 18 mOhms |
| Cahn balances                 | Clean   | As needed  |
| Electronic balances           | Clean   | As needed  |
| Freezers/refrigerators        | Clean<br>Defrost  | As needed  |
| Ovens                         | Clean   | As needed  |
| Glass thermometers            | Store in protective case  | Always except when in use  |
| Digital thermometer           | Avoid bending thermocouples   | Always   |
| Conductivity meter            | Remove batteries when inactive<br>Replace batteries<br>Clean electrodes | At least annually  |

**Table E–17. Maintenance Procedures for Analytical Instruments.**

| <b>Equipment</b>                                      | <b>Activity</b>  | <b>Frequency</b>   |
|---|--|--|
| <b><i>GC/MS Maintenance (SOP 3-092)</i></b>           |  |  |
| Rough pumps<br>Turbomolecular pump<br>Diffusion pumps | Routine service (service contract)<br><br>Check fluid levels       | Six months<br><br>Weekly   |
| Foreline traps<br>Helium gas traps                    | Inspect trap pellets for color change<br>Replace adsorbent pellets | Routinely<br><br>6-12 months, as needed  |
| Injection port septum                                 | Replace  | As needed to maintain EPC pressure   |
| Injection port liners                                 | Replace  | Approximately every 30-40 samples  |
| Precolumn   | Replace  | As needed to improve peak shape, resolution, or sensitivity                    |
| Calibration vial (PFTBA)                              | Refill   | 4 months or as needed  |
| Back grills of the GC/MS                              | Vacuum dust  | 6 months or as needed  |
| Ion source  | Clean  | As indicated when usage-dependent surface deposits degrade ion source function |
| <b><i>GC Maintenance (SOP 3-116)</i></b>              |  |  |
| Injection port  | Replace  | Weekly (~50 injections) or as needed   |
| Injection port liner                                  | Replace  | Weekly or as needed  |
| Injection port  | Clean  | Monthly or as needed   |
| Column  | Clip   | As needed to maintain performance  |
| Precolumn   | Replace  | As needed when chromatographic degradation is observed                         |
| Gas cylinders   | Replace  | When PSI is < 300  |
| Autosampler rinse vial                                | Fill   | Prior to analysis  |
| Autosampler syringe                                   | Replace/align  | As needed  |
| Ferrule   | Replace  | As needed for leaks  |
| Gas drying/purification traps                         | Replace  | Annually or as needed  |
| Column, detector                                      | Bakeout  | As needed  |
| <b><i>ICP-AES Maintenance (MSL-I-027)</i></b>         |  |  |
| Pump tubing   | Check and replace  | Daily  |
| Diluent bottle  | Check and refill   | Daily  |
| Torch   | Check and clean or replace   | Weekly   |
| <b><i>ICP-MS Maintenance (MSL-I-022)</i></b>          |  |  |
| Argon supply  | Check and record; replace as needed                                | Daily  |
| Vacuum  | Check and record   | Daily  |
| Cooling chiller                                       | Check and record temperature                                       | Daily  |
| Nebulizer flow  | Check and adjust   | Daily or as needed   |
| Sensitivity and stability                             | Check and record   | Daily  |
| Auto sampler tubing                                   | Change   | As needed  |

Table E-17. Maintenance of Analytical Instruments (continued).

| Equipment  | Activity                                   | Frequency                               |
|--|--|---|
| Cones  | Clean or change                            | As needed                               |
| <i>GFAA Maintenance (MSL-I-029)</i>                              |  |   |
| Graphite furnace tube  | Check and replace (~500 burns)             | Daily and as needed                     |
| Contact cylinders  | Check and replace as needed (10,000 burns) | Daily and as needed                     |
| Windows  | Clean                                      | Whenever tubes are changed or as needed |
| Water recirculator fluid level                                   | Check and refill                           | Daily                                   |
| <i>CVAA Maintenance (MSL-I-016)</i>                              |  |   |
| Soda lime  | Check and change                           | Checked daily, changed weekly           |
| Reagents (SnCl <sub>2</sub> , 3% HNO <sub>3</sub> , rinse water) | Check and change                           | Checked daily, changed weekly           |
| Carbon trap  | Check and change                           | Checked daily, changed bimonthly        |
| Filters  | Check and change                           | Checked daily, changed bimonthly        |
| Sample injection syringe   | Check and change                           | Checked weekly, changed as needed       |
| Tubing   | Check and change                           | Checked weekly, changed as needed       |
| Connectors   | Check and change                           | Checked weekly, changed as needed       |
| Lamp   | Check and change                           | Checked weekly, changed as needed       |
| Autosampler arm  | Lubricate                                  | Bimonthly                               |

Table E-18. Calibration Procedures for Field Equipment.

| Measurement                 | Instrument                  | Calibration Procedure (Accuracy Requirement)                                 | Frequency             |
|-----------------------------|-----------------------------|--|-----------------------|
| Latitude/longitude          | Trimble GPS or equivalent   | Verify vs. benchmark ( $\pm 100$ m - See Section E.3.7.1)                    | Prior to the survey   |
|                             |                             | Check vs. position with historical data ( $\pm 100$ m - See Section E.3.7.1) | Daily                 |
| Fish – maximum total length | Fish board with Meter stick | 0.5 cm   | Initially             |
| Fish – whole body weight    | Top loading balance         | 1% certified weight  | Daily prior to survey |

**Table E–19. Calibration Procedures for Laboratory Support Equipment.**

| Equipment                     | Calibration Procedure  | Frequency  | Acceptance Criteria   |
|-------------------------------|--|--|---|
| MilliQ deionized water system | Check resistivity<br>Check conductivity<br>Check pH  | Each use<br>Semiannually<br>Semiannually   | <18 mOhms<br>0 $\mu$ s<br>pH 5.5 - 7.5  |
| Balances                      | Professional calibration<br><br>Verify calibration with $\geq 1$ NIST-traceable weight within the range. | Annually<br><br>Daily check with 2 bracketing NIST-traceable weight(s) prior to sample measurements. | Within Manufacturer's specifications at specified weight ranges<br><br>$\leq 1-2\%$ of certified standard weight              |
| Freezers/<br>refrigerators    | Measure temperature<br><br>Calibrate the thermometer   | Daily (routine storage)<br>3 weekly (archive units)<br>Annually                                      | Freezers: < -10 or 20°C<br>Refrigerators: 4 $\pm$ 2°C   |
| Ovens                         | Measure temperature<br>Calibrate thermometer   | Daily before and after use<br>Annually   | % dry weights: 105 $\pm$ 5°C<br>Reagents: 125 $\pm$ 5°C   |
| Thermometers<br>(glass)       | Check using NIST-traceable thermometer   | Annually   | A correction factor is applied to correct temperature vs. the NIST thermometer. No correction factor $\geq 3^\circ\text{C}$ . |
| Digital Thermometers          | Check using NIST-traceable immersion thermometer   | Quarterly at 2 temperatures  | A correction factor is applied to correct temperature vs. the NIST thermometer. No correction factor $\geq 3^\circ\text{C}$ . |

Table E–20. Calibration of Laboratory Instruments.

| Instrument           | Standard Sources   | Initial Calibration  |   |   | Calibration Verification            |   |                                |
|----------------------|--|--|---|---|-------------------------------------|---|--------------------------------|
|                      |  | No. Standard   | Criteria  | Frequency   | Standards and Conc. Range           | General Criteria  | Frequency                      |
| GC/ECD<br>SOP 5-128  | Supelco, Inc.<br>Accu-Standard, Inc.<br>Ultra Scientific<br>Chem Service, Inc. | ≥5 for pesticides and Aroclors 1016 and 1260<br>1 for other Aroclors | Quadratic<br>$r \geq 0.99$ (3-point)<br>$r \geq 0.995$ (5-point)<br>Average Response Factor<br><25% RSD in initial for each target compound | Initially and after failure of continuing calibration | 1<br>Mid-level calibration standard | ≤25% from true check standard concentration   | Every 10-12 samples (24 hours) |
| GC/MS<br>SOP 5-157   |  | ≥3   | Passing PFTBA tune<br>Average Response Factor<br><br>≤25% RSD for each analyte and average RSD for all analytes ≤ 15%                       | Initially and after failure of continuing calibration | 1<br>Mid-level calibration standard | ≤25% from initial calibration average RF for each analyte and average difference for all analytes ≤ 15% | Every 12 hours                 |
| GC/FPD<br>SOP 5-196  |  | ≥3   | Average Response Factor<br><br>≤20% RSD for each analyte  | Initially and after failure of continuing calibration | 1<br>Mid-level calibration standard | ≤20% from initial calibration average RF for each analyte   | Every 12 samples               |
| GFAA<br>MSL-I-029    | High Purity Standard   | ≥3 (plus blank)  | NA  | Initially and after failure of continuing calibration | 1 ICV<br>1 CCV                      | ≤15% from true standard concentration   | Every 10 samples               |
| ICP/AES<br>MSL-I-027 |  | ≥3 (plus blank)  | $r > 0.995$   | Initially and after failure of continuing calibration | 1 ICV<br>1 CCV                      | ≤15% from true value  | Every 10 samples               |
| ICP/MS<br>MSL-I-022  |  | ≥3 (plus blank)  | $r > 0.995$   | Initially and after failure of continuing calibration | 1 ICV<br>1 CCV                      | ≤15% from true value  | Every 10 samples               |
| CVAA<br>MSL-I-016    |  | ≥3 (plus blank)  | $r > 0.995$   | Initially and after failure of continuing calibration | 1 ICV<br>1 CCV                      | ≤15% from true value  |                                |

**Table E–21. Level III Data Validation Assessment Parameters.**

| <b>Criteria</b>                                 | <b>PAH<br/>(GC/MS)</b> | <b>Butyltin and<br/>DRO TPH<br/>(GC)</b> | <b>Pesticides/<br/>PCBs<br/>(GC)</b> | <b>Trace<br/>Metals</b> | <b>Wet<br/>Chemistry</b> |
|---|------------------------|--|--------------------------------------|-------------------------|--------------------------|
| Holding times                                   | X                      | X  | X                                    | X                       | X                        |
| Instrument tunes                                | X                      |  |                                      |                         |                          |
| Initial and continuing<br>calibrations          | X                      | X  | X                                    | X                       | X                        |
| Blanks  | X<br>(5X/10X rule)     | X<br>(5X/10X rule)                       | X                                    | X                       | X                        |
| LCS/<br>Laboratory set limits                   | X                      | X  |                                      | X                       | X                        |
| Surrogates                                      | X                      | X  | X                                    |                         |                          |
| MS/MSD  | X                      | X  | X                                    | X                       | X                        |
| Duplicates                                      |                        |  |                                      | X                       | X                        |
| Internal standard area<br>performance           | X                      |  |                                      |                         |                          |
| Target compound<br>retention times              |                        | X  | X                                    |                         |                          |
| Instrument performance                          |                        |  | X                                    |                         |                          |
| Interference with<br>compound<br>quantification |                        |  | X                                    |                         |                          |

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