DATA REPORT

FOR

QUANTIFYING POLLUTION IMPACTS FROM PUERTO RICO DUMP

ON CORAL REEF FISHERIES IN TANAPAG HARBOR, SAIPAN

PREPARED BY

RIDOLFI INC.

AND

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE,
CORAL REEF CONSERVATION PROGRAM,
PACIFIC SERVICES CENTER, AND
OFFICE OF RESPONSE AND RESTORATION

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EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) conducted an investigation of marine resources in Tanapag Harbor in August 2005. The purpose of the investigation was to evaluate whether contaminants that may have migrated from the former Puerto Rico Dump have impacted either sediments or marine organisms adjacent to the facility. NOAA collected marine fish, invertebrates, and sediment from areas adjacent to the dump and from a more distant reference area as part of the study. The samples were submitted to a laboratory and analyzed for polychlorinated biphenyls (PCBs), organochlorine pesticides, and metals. Results will help determine if these contaminants have migrated from the Puerto Rico Dump into the neighboring marine ecosystem and support future management decisions for the site, including identification of additional investigation needs.

The Puerto Rico Dump covers approximately 20 acres adjacent to Tanapag Harbor in Saipan, which is the capital of the U.S. Commonwealth of the Northern Mariana Islands (CNMI) in the North Pacific Ocean. The dump received military, industrial, and domestic solid wastes between World War II and 2003, and has been recognized as a potential source of contaminants to the adjacent marine environment.

Biological tissue samples collected for this investigation included emperor fish (primarily *Lethrinus harak*) and sea cucumber (*Holothuria* spp.), based upon available resident species and those most likely to accumulate contaminants. Surface sediment samples were also collected in the same general vicinity as the biological samples. A total of 16 fish, 16 invertebrate, and five sediment samples were collected from areas of the harbor adjacent to the dump as well an off-site reference area not impacted by the dump, and analyzed for contaminants of concern. All investigation activities, including collection procedures and analytical methodology, were conducted according to the Sampling and Analysis Plan (SAP) (Ridolfi and NOAA 2005).

No PCBs were detected above the method reporting limit (MRL) in any biological tissue or sediment samples. Pesticides were detected in biological samples and limited sediment samples, although the majority of the detected values were very low, estimated values that were below the MRL. The most frequently detected pesticides in emperor fish were 4,4′-DDD and 4,4′-DDE, which were also detected in reference samples; the average site concentrations exceeded the average reference concentrations by factors of 4.8 and 1.5, respectively, although many of these detected values were below the MRL. In sea cucumber, the pesticides 4,4′-DDD, cis-nonachlor, endosulfan II, and lindane average site concentrations exceeded reference concentrations by factors of 1.3 to 4.2, although nearly all detected values were below the MRL. In sediment, 4,4′-DDD and 4,4′-DDT were detected in one site and one reference sample, respectively, both of which were below the MRL.

Comparison of pesticide results to screening levels, where available, found that one pesticide in fish exceeded the Critical Tissue Value (CTV) for fish tissue, but in only one sample and at an exceedance factor of 1.7; however, three pesticides (beta-BHC, gamma-BHC, and Mirex) in sea cucumber exceeded the CTV for macroinfauna and, thus, may be of potential concern in sea cucumber in the harbor. Sediment, however, did not appear to serve as a source of pesticides; the only two pesticides detected were found in one harbor sample (4,4′-DDD) and in one reference sample (4,4′-DDT), and at concentrations below the MRL.

Metals were ubiquitously detected in biological and sediment samples. In biological samples, all metals were detected in both site and reference samples. In emperor fish, average values of arsenic, barium, lead, mercury, and silver were higher in site samples than in reference samples at factors ranging from 1.3 to 4.9; the highest was silver, although most of these values were detected below the MRL. The average values of cadmium, chromium, and selenium were higher in the reference samples. In sea cucumber, average values of arsenic, barium, chromium, lead, mercury, selenium, and silver were higher in site samples than in reference samples at factors ranging from 1.8 to 5.3 (the highest was barium), while the average value of cadmium was higher in the reference samples.

In sediment, all metals were detected in site samples, and all metals except mercury and selenium were detected in reference samples. Average values of arsenic, barium, chromium, and lead were higher in site samples than in the reference sample at factors ranging from 1.2 to 3.1 (the highest was barium), while the average site values of cadmium and silver were less than the reference sample. Cadmium in fish and invertebrate tissue was also higher in reference samples.

Comparison of metals results to fish tissue screening levels, where available, found that arsenic and selenium in fish exceeded thresholds; since selenium was comparable to reference concentrations, arsenic is the only metal that may be of potential concern in emperor fish in the harbor (although, the average detected concentration in the harbor was only 2.3 times higher than reference). Comparison of metals results to macroinfauna tissue screening levels, where available, found that arsenic, chromium, and selenium exceeded thresholds and may be of potential concern in sea cucumber in the harbor (although, the average detected concentration in the harbor was only 2 to 3 times higher than reference). There were no screening values for barium (fish and macroinfauna). Lastly, comparison of metals results to marine sediment screening levels, where available, found that no concentrations exceeded the Effects Range Low (ERL) (not available for barium or selenium) and, thus, metals are likely not of potential concern in surface sediment in the harbor.

These results indicate no substantial impacts from contaminants on biological organisms or sediment, although there were exceedances of conservative screening values in fish and sea cucumbers as stated above. These findings, however, are based on a limited sample size and a limited area, and may not reflect potential dump-related impacts to other biotic and abiotic media or in other areas of Tanapag Harbor.

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CLP	Contract Laboratory Program (USEPA)
CNMI	Commonwealth of the Northern Mariana Islands
COC	chain-of-custody
CPRD	Coastal Protection and Restoration Division
CTV	Critical Tissue Value (screening level for tissue)
DDD	Dichloro-diphenyl-dichloroethane
DDE	Dichloro-diphenyl-dichloroethylene
DDT	Dichloro-diphenyl-trichloroethane
DEQ	Department of Environmental Quality
ERL	Effects Range-Low (screening level for sediment)
GPS	global positioning system
LCS	laboratory control sample
MDL	method detection limit
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRCC	National Research Council of Canada
ORR	Office of Response and Restoration
PCB	polychlorinated biphenyl
PSC	Pacific Services Center
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
SAP	sampling and analysis plan
TEL	threshold effects level
TOC	total organic carbon
TRV	toxicity reference value
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This data report presents the results of an investigation of marine fish, invertebrates, and sediment from Tanapag Harbor, Saipan, conducted by the National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service (NOS). In August 2005, the NOAA Pacific Services Center (PSC) and Office of Response and Restoration/Coastal Protection and Restoration Division (ORR/CPRD), with support from the Coral Reef Conservation Program, collected biological tissue and sediment samples for chemical analysis. Samples were collected from an area of Tanapag Harbor adjacent to the former Puerto Rico Dump. Leachate may have migrated from the dump to nearby sediments, threatening marine resources critical to Saipan's coral reef fisheries. Based on the history of contaminants at the dump, biological and sediment samples were analyzed for polychlorinated biphenyls (PCBs), organochlorine pesticides, and Resource Conservation and Recovery Act (RCRA) metals. Results will help determine if these contaminants have migrated from the Puerto Rico Dump into the neighboring marine ecosystem and will support future management decisions for the site. This data report, prepared by RIDOLFI Inc. (Ridolfi) and NOAA, provides and briefly discusses the analytical results.

1.1 Site Background

The Commonwealth of the Northern Mariana Islands (CNMI), a U.S. territory, is a 14-island archipelago in the North Pacific Ocean, about three-quarters of the way from Hawaii to the Philippines. The island of Saipan is the CNMI's capital. Saipan has a population of approximately 63,000. Tourism and the garment industry are the principal sources of revenue. The Puerto Rico Dump covers approximately 20 acres adjacent to Tanapag Harbor in Saipan (Figure 1-1). During World War II, a landing area was established in this area, and at the end of the war, metal scrap, unexploded ordnance, and other materials were disposed of at the landing area. In the 1950s, the dump received a portion of Saipan's municipal waste and then in the 1970s, it became Saipan's primary waste disposal site when trash burning and ocean dumping were outlawed. It was not designed as a dump for hazardous materials and has no lining.

Estimates of the fraction of waste coming from the garment industry ranged from 30 to 60 percent. The USEPA cited Saipan for Clean Water Act violations from the dump a number of times, and in 2003, a new sanitary landfill was opened at Marpi, in the northern interior of the island. Although the Puerto Rico Dump became inactive when the new landfill was opened in 2003, it has not yet been formally closed or capped. The federal and territorial governments are working toward closure and remediation decisions for the Puerto Rico dump (NOAA 2005). After receiving military, industrial, and domestic solid wastes for over 50 years, the dump is a potential source of contaminants migrating into the adjacent marine environment.

1.2 Purpose of the Investigation

The primary purpose of this investigation was to collect marine fish and invertebrate tissue and sediment samples from Tanapag Harbor adjacent to the Puerto Rico Dump, analyze these samples for contaminants of concern, and interpret the results. These results will help determine if the contaminants have migrated from the dump to nearby sensitive mangrove and coral reef ecosystems. This information will ultimately support management decisions for the site, including closure priorities and remediation needs to protect and conserve the local coral reef ecosystem and public health. Results may also identify further investigation needs, such as additional biological monitoring, human health assessments from fish consumption or recreational activities, or post-closure monitoring.

1.3 Previous Investigations

Groundwater and soil sampling has been conducted at the Puerto Rico Dump; however, minimal information is available regarding contaminant releases to the nearby harbor. Dr. Gary Denton from the University of Guam, in conjunction with CNMI Department of Environmental Quality (DEQ), analyzed surface sediments from Tanapag Lagoon (Denton et al. 2001). A site located beside the dump was moderately contaminated with cadmium, copper, lead, and mercury, and heavily contaminated with zinc. Another site, located 50 m northwest of the dump, was moderately contaminated with lead and heavily contaminated with tin. Denton et al. (2001) summarizes the findings of an earlier study (DEQ 1987). The earlier study reported greater concentrations of contaminants, by a factor of 2 to 10, near the dump. Denton has collected additional sediment and biota samples, including some near the dump as part of a larger sampling effort throughout the lagoon, but those analytical results are not yet available.

2.0 STUDY DESCRIPTION

This section describes the overall study design, including species selection and contaminants of concern, and provides details of sample collection methods and analytical data quality assurance.

2.1 Study Design

The investigation was designed to obtain marine fish, invertebrate, and sediment samples from several sampling stations for chemical analysis, as described below.

2.1.1 Sample Species and Locations

Biological tissue samples collected for this investigation included emperor fish (primarily *Lethrinus harak*) and sea cucumber (*Holothuria* spp.). Species were selected based upon a survey of site conditions (i.e., available resident species), with consideration for those most likely to accumulate contaminants. Sediment was also sampled to characterize its potential as a source of contamination to marine organisms.

Figure 2-1 shows sample locations. Table 2-1 lists the samples collected, location coordinates, fish sample characteristics, and analyses performed. For each media type, four sampling stations were selected in the harbor and one reference station was selected in an off-site area outside of the harbor and not impacted by the dump. The reference sampling area was located in an area with comparable habitat and fish species relative to the dump site, but considered clean and removed from any known source of chemical contamination (Figure 2-1).

Sediment samples (approximately top 6 inches) were collected in the same area as the biological samples to co-locate data as much as possible. In the harbor, sediment and sea cucumber samples were collected from the same coordinate stations (01 through 04). Field crew then returned to these coordinates to collect emperor fish samples. At station 03, the field crew was able to capture only one sample, while at station 04 they found no fish to collect. Therefore, two new stations (05 and 06) were identified nearby for emperor fish collection. Figure 2-1 shows the stations (where multiple samples were collected), plus one fish sample (PD-EF-01-03) that was collected substantially off-station because of unexpected boat movement during sampling.

2.1.2 Contaminants of Concern

The Puerto Rico Dump accepted various types of wastes during its operation, including hazardous wastes from both civilian and military sources. The dump was never officially designated a hazardous waste disposal facility, however, and does not have any containment barriers to prevent contaminants from migrating into the adjacent harbor. Potential dump-related contaminants that may have migrated into the harbor include p,p'-dichlorodiphenyltrichloroethane (DDT), PCBs, waste oils, solvents, and various metals. During this investigation of the adjacent marine environment, samples were analyzed for PCBs, organochlorine pesticides, and USEPA RCRA metals. Chemical analyses were performed by Columbia Analytical Services of Kelso, Washington.

2.2 Sample Collection Methods

Marine biological tissue and surface sediment samples were collected in Saipan between August 10 and 13, 2005. Samples were collected and processed according to the procedures outlined in the Sampling and Analysis Plan (SAP) (Ridolfi and NOAA 2005). Table 2-1 lists the sample names and analytical methods. Appendix A provides photographs of the sampling event.

2.2.1 Biological Tissue Samples

A total of 32 biological tissue samples were collected for this investigation, 16 of which were emperor fish (primarily *Lethrinus harak*) and 16 of which were sea cucumber (*Holothuria* spp.). Of the 16 emperor fish samples, 13 site samples were collected from the Tanapag Harbor adjacent to the Puerto Rico Dump and three reference samples were collected at an off-site area outside of the harbor. The emperor fish site samples consisted of three replicates collected from four stations (PD-EF-01, -02, -05, and -06), plus one sample from station PD-EF-03. The reference samples consisted of three replicates collected from one off-site station (RF-EF-01). The CNMI Division of Fish and Wildlife field crew collected the emperor fish, of same species and size class to the greatest degree possible, removed the otoliths (to be used in a different study to determine age and growth patterns), and scored samples on a gonadal index. Samples were then transferred to NOAA field crew for rinsing with distilled water, placed in pre-cleaned sample containers, and submitted to the laboratory for chemical analysis. Species were later identified as *L. harak* (all female) for all specimens, except for one specimen of *L. xanthochilus* (unidentified sex) collected at PD-EF-01-01.

Of the 16 sea cucumber samples, 12 site samples were collected from the harbor adjacent to the dump and four reference samples were collected off-site. The sea cucumber site samples consisted of three replicates collected from four stations (PD-SC-01, -02, -03, and -04), and the reference samples consisted of four replicates collected at an off-site station (RF-SC-01). The NOAA field crew collected sea cucumbers of same size class to the greatest degree possible by hand via snorkeling. If a single organism did not meet the minimum weight requirement (60 grams), multiple organisms were collected to obtain adequate volume to combine into one composite sample. NOAA field crew rinsed the samples with distilled water, placed them in pre-cleaned sample containers, and submitted them to the laboratory for chemical analysis.

One emperor fish sample and one sea cucumber sample were designated in the field for matrix spike/matrix spike duplicate (MS/MSD) analyses, and identified as such on the chain-of-custody (COC) form. The MS/MSD samples were analyzed for the same parameters as the associated field samples.

2.2.2 Sediment Samples

A total of five surface sediment samples were collected for this investigation. Of these, four site samples were each collected from distinct sample stations in the harbor adjacent the dump (PD-SD-01, -02, -03, and -04), and one reference sample was collected at an off-site station (RF-SD-01). NOAA field crew collected the samples via snorkeling using a push core inserted by hand approximately 6 inches into the substrate. A separate pre-cleaned push core was used for each sediment sample. The samples were placed in pre-cleaned glass jars and submitted to the laboratory for chemical analysis.

2.2.3 Field Measurements and Documentation

Length and weight measurements of the emperor fish samples were recorded at the time of collection (Table 2-1), as were descriptions of the sediment samples, such as color and approximate grain size. No other sample characteristics, such as lesions or other abnormalities (fish and invertebrates), or chemical odors, sheens, or stains (sediment) were observed.

Horizontal coordinates for each sampling location were determined in the field at the time of sample collection using a Global Positioning System (GPS) unit (Table 2-1). Photographs were also taken during sample collection (Appendix A).

2.2.4 Sample Processing

All biological and sediment sample jars were labeled in the field using indelible black ink. Each sample was assigned a unique sample identification according to the following format: *Location-Media-Station-Replicate.* Location codes indicated site versus reference samples: “PD” for Puerto Rico Dump and “RF” for reference. Sample media codes indicated the type of media sampled: “EF” for emperor fish, “SC” for sea cucumber, and “SD” for sediment. Station numbers indicated the sampling station (01 through 06), and the replicate numbers indicated the particular sample collected from that station. Not all sample replicates are numbered consecutively for emperor fish because more samples were collected than necessary, and not all of these collected samples were adequate for submitting to the laboratory for chemical analysis.

The samples were processed according to the SAP, stored in a secure location, and shipped frozen in coolers with blue ice and bubble wrap (Ridolfi and NOAA 2005). Coolers were shipped by overnight courier directly to the laboratory, accompanied by the appropriate COC form.

2.3 Sample Analysis Methods

The whole body of the emperor fish (minus the otolith), the whole sea cucumber, and the surface sediment samples were analyzed for contaminants of concern by the methods listed in Table 2-1. Percent lipids (tissue), grain size, and TOC (sediment) were also measured by the laboratory.

2.4 Quality Assurance Summary

Laboratory data were reviewed upon receipt of the data package from the laboratory, and included the following elements:

- Completeness of the laboratory data package
- Chain of Custody documentation
- Method holding times
- Method/preparation blanks
- Surrogate compound performance for organic analyses
- MS/MSD and laboratory duplicate analyses
- Laboratory control samples
- Certified reference materials
- Field replicates

Analytical data quality was evaluated both by the laboratory and independently, as specified in the project SAP. The independent review of laboratory data packages was performed in-house by Ridolfi. The reviewed laboratory analytical data appear in Appendix B, and the data review report is included as Appendix C.

Laboratory results were either accepted as received (unqualified) or were qualified. No results were rejected. Unqualified results are considered valid with respect to the specified procedures and quality assurance/quality control (QA/QC) measures and may be used as intended. Qualified results (flagged J) are considered usable with the understanding that the associated values are estimates. The data review report (Appendix C) provides an explanation of the data qualifiers.

The principal measures associated with data quality are precision, accuracy, representativeness, completeness, and comparability. An evaluation of each of these measures determined that overall analytical performance and data quality are acceptable.

3.0 DATA SUMMARY

This section discusses the results of the chemical analysis of Tanapag Harbor biological tissue and sediment samples. Summaries are provided in Tables 3-1, 3-2, and 3-3 for emperor fish, sea cucumber, and sediment samples, respectively. These tables include the range and average of detected concentrations for both site samples and reference samples, as well as the ratio of site to reference average values. For sediment, the number of detected values that exceeded screening benchmark criteria are also provided. Complete analytical result tables are provided in Appendix B. Results are presented in micrograms per kilogram (μg/kg) for PCB and pesticide data, in milligrams per kilogram (mg/kg) for metals data, and in percent for other measurements such as lipids, TOC, and grain size. Compounds that were not detected are reported at the laboratory method reporting limit (MRL)[1].

3.1 Data Evaluation Method

This data report evaluated analytical results by comparing contaminant concentrations detected in the site samples to those in the reference samples. Basic statistics (minimum, maximum, and average values) were calculated and then the average detected concentrations were compared between the site and reference sampling areas when such detected compounds existed in both areas (referred to as the "Site:Ref Avg Detect Ratio" in Tables 3-1 to 3-3). Additionally, tissue results were compared to conservative ecological screening values to identify contaminants that may pose a threat to area resources and potentially warrant further investigation. Maximum detected fish and invertebrate concentrations were compared to Critical Tissue Values (CTV), developed using No Observed Adverse Effects Levels, resulting in a "Max Exceedance Factor" (Ogden, 2001) (Table 3-4). The use of these conservative ecological screening benchmarks provides a high degree of confidence that any contaminants that do not exceed screening benchmarks will not pose significant adverse ecological risk. Conversely, contaminants

[1] The MRL "is the minimum concentration of an analyte that can be routinely identified and quantified above the method detection limit (MDL) by a laboratory" (USEPA and DOD, 2005).

exceeding conservative benchmarks may indicate the need for more detailed evaluations, but do not necessarily indicate a definitive problem. Similarly, maximum sediment results were compared to sediment quality guidelines, which predict the potential for adverse biological effects and can be used to identify contaminants of concern or prioritize areas for further investigation. Sediment samples were screened against the Effects Range-Low (ERL) values to indicate concentrations at which adverse biological effects have rarely been observed in laboratory studies (Long et al. 1998) (Table 3-4).

3.2 Fish Tissue Concentrations

Sixteen emperor fish (*Lethrinus harak*) tissue samples were collected from five harbor site stations (13 samples) and a reference station (three samples) and analyzed for PCBs, organochlorine pesticides, and RCRA metals. Results are summarized in Table 3-1 and provided in Appendix B-1 in wet weight.

3.2.1 PCBs

Emperor fish samples were analyzed for seven different PCB Aroclor mixtures. No PCBs were detected above the MRL in either site or reference samples, and the MRLs were all below the screening level of 36 µg/kg.

3.2.2 Pesticides

Emperor fish samples were analyzed for 31 different pesticide compounds. Most pesticides were detected in at least one sample, although the majority of these values were the result of detecting very low concentrations that were estimated (“J” flagged) below the MRL (but above the method detection limit [MDL]). Of those pesticides detected in site samples, more than half were found in only one or two samples. The pesticides 4,4’-DDD, -DDE, and -DDT were detected most frequently (in seven to eleven site samples). Only four pesticides—4,4’-DDD, 4,4’-

DDE, chlorpyrifos, and gamma-chlordane—were detected in references samples that could be compared to site samples (Table 3-1).

For 4,4'-DDD, the average site concentration of 0.91 µg/kg exceeded the reference concentration of 0.19 µg/kg by a factor of 4.8, although both of these averages were less than the MRL of 1.0. For 4,4'-DDE, the average site concentration of 2.09 µg/kg exceeded the reference concentration of 1.41 µg/kg by a factor of 1.5. For chlorpyrifos, the average site concentration of 0.30 µg/kg was less than the reference concentration of 0.58 µg/kg. Gamma-chlordane was detected in a reference sample only. The remaining pesticides were either not detected above the MRL, or were detected at very low concentrations.

Comparison of pesticide results to fish tissue screening levels, where available, found that only one pesticide, endosulfan II, exceeded the appropriate CTV; however, this exceedance occurred in only one sample and at an exceedance factor of 1.7 (the average site concentration did not exceed the CTV). Thus, pesticides are likely not of concern in emperor fish in the harbor.

3.2.3 Metals

Emperor fish samples were analyzed for eight RCRA metals compounds, each of which was detected in at least one sample. Average values of arsenic, barium, lead, mercury, and silver were higher in site samples than in reference samples, while the average values of cadmium, chromium, and selenium were higher in the reference samples (Table 3-1).

Arsenic, barium, lead, mercury, and silver were detected in every site and reference sample (minus one site sample for silver). For arsenic, the average site concentration of 5.71 mg/kg exceeded the average reference concentration of 2.52 mg/kg by a factor of 2.3. For barium, the average site concentration of 0.547 mg/kg exceeded the average reference concentration of 0.417 by a factor of 1.3. For lead, the average site concentration of 0.106 mg/kg exceeded the average reference concentration of 0.058 by factor of 1.8. For mercury, the average site concentration of 0.038 mg/kg exceeded the average reference concentration of 0.013 by a factor of 2.9. For silver, the average site concentration of 0.0044 mg/kg exceeded the average reference concentration of 0.0009 by a factor of 4.9, although most silver values were detected at very low, estimated concentrations below the MRL.

Cadmium, chromium, and selenium were detected in most site and reference samples. For cadmium, all site sample values (average 0.007 mg/kg) were less than reference samples (average 0.021 mg/kg). For chromium, the average site concentration of 0.44 mg/kg was less than the average reference concentration of 0.51 mg/kg. For selenium, the average site concentration of 0.38 mg/kg was less than the average reference concentration of 0.43 mg/kg.

Comparison of metals results to fish tissue screening levels, where available, found that concentrations of two metals, arsenic and selenium, exceeded the appropriate CTV. Arsenic exceeded the limit of 0.52 mg/kg in every sample, including the reference site, with a maximum exceedance factor of 24. Selenium exceeded the limit of 0.12 mg/kg, also in every sample including reference, with a maximum exceedance factor of 4.7. However, as mentioned above, the average selenium concentration was slightly higher in the reference samples. Thus, the only metal that may be of potential concern in emperor fish in the harbor is arsenic, although it is only slightly higher in fish from the harbor compared to reference.

3.3 Sea Cucumber Tissue Concentrations

Sixteen sea cucumber (*Holothuria* spp.) tissue samples were collected from four harbor site stations (12 samples) and a reference station (four samples) and analyzed for PCBs, organochlorine pesticides, and RCRA metals. Results are summarized in Table 3-2 and provided in Appendix B-2 in wet weight.

3.3.1 PCBs

Sea cucumber samples were analyzed for seven different PCB Aroclor mixtures. No PCBs were detected above the MRL in either site or reference samples, and the MRLs were all below the screening level of 40 µg/kg.

3.3.2 Pesticides

Sea cucumber samples were analyzed for 31 different pesticide compounds. More than half of these pesticides were detected in at least one sample, although the majority of these values were the result of detecting very low concentrations that were estimated ("J" flagged) below the MRL (but above the MDL). Of those pesticides detected in site samples, more than half were found in only one or two samples. At total of eight pesticides were detected in both site and reference samples, 4,4'-DDD, cis-nonachlor, dieldrin, endosulfan II, endosulfan sulfate, endrin ketone, gamma-BHC (lindane), and trans-nonachlor, half of which had greater average concentrations in site samples than reference samples (Table 3-2).

For 4,4'-DDD, the average site concentration of 0.35 µg/kg exceeded the reference concentration of 0.14 µg/kg by a factor of 2.5. For cis-nonachlor, the average site concentration of 0.22 µg/kg exceeded the reference concentration of 0.17 µg/kg by a factor of 1.3. For endosulfan II, the average site concentration of 0.67 µg/kg exceeded the reference concentration of 0.16 µg/kg by a factor of 4.2. For lindane, the average site concentration of 0.52 µg/kg exceeded the reference concentration of 0.16 µg/kg by a factor of 3.3. All detected values (minus one endosulfan II value) used to calculate these averages were estimated at less than the MRL of 1.0.

For dieldrin, the average site concentration of 0.14 µg/kg was less than the reference concentration of 0.29 µg/kg. For endosulfan sulfate, the average site concentration of 0.17 µg/kg was less than the reference concentration of 0.18 µg/kg. For endrin ketone, the average site and reference concentrations were equal, at 0.31 µg/kg. For trans-nonachlor, the average site and reference concentrations were equal, at 0.11 µg/kg. The remaining pesticides were either not detected above the MRL, or else were detected at very low concentrations.

Comparison of pesticide results to macroinfauna tissue screening levels, where available, found that three pesticides, beta-BHC, gamma-BHC (Lindane), and Mirex, exceeded the appropriate CTV. All three site samples that detected beta-BHC exceeded the CTV of 0.28 µg/kg, with a maximum exceedance factor of 3.3. Both site samples that detected gamma-BHC exceeded the CTV of 0.22 µg/kg, with a maximum exceedance factor of 3.1. Only one of the two site samples that detected Mirex exceeded the CTV of 3 µg/kg, with a maximum exceedance factor of 1.5. Since these pesticides were either not detected in reference samples or, in the case of gamma-BHC, was detected at a concentration lower than those from the harbor, these pesticides (beta-BHC, gamma-BHC, and Mirex) may be of potential concern in sea cucumber in the harbor.

3.3.3 Metals

Sea cucumber samples were analyzed for eight RCRA metals compounds, each of which was detected in every site and reference sample. Average values of arsenic, barium, chromium, lead, mercury, selenium, and silver were higher in site samples than in reference samples, while the average value of cadmium was higher in the reference samples (Table 3-2).

Arsenic, barium, chromium, lead, mercury, selenium, and silver were detected in every site and reference sample. For arsenic, the average site concentration of 4.27 mg/kg exceeded the average reference concentration of 2.13 mg/kg by a factor of 2.0. For barium, the average site concentration of 4.17 mg/kg exceeded the average reference concentration of 0.783 mg/kg by a factor of 5.3. For chromium, the average site concentration of 8.09 mg/kg exceeded the average reference concentration of 3.61 mg/kg by a factor of 2.2. For lead, the average site concentration of 0.48 mg/kg exceeded the average reference concentration of 0.144 mg/kg by a factor of 3.3. For mercury, the average site concentration of 0.009 mg/kg exceeded the average reference concentration of 0.005 mg/kg by a factor of 1.8. For selenium, the average site concentration of 0.72 mg/kg exceeded the average reference concentration of 0.23 mg/kg by a factor of 3.1. For silver, the average site concentration of 0.0068 mg/kg exceeded the average reference concentration of 0.0023 mg/kg by a factor of 3.0, although many silver values were detected at very low, estimated concentrations below the MRL.

For cadmium, detected in all site and reference samples, the average site concentration of 0.011 mg/kg was less than the average reference concentration of 0.020 mg/kg.

Comparison of metals results to macroinfauna tissue screening levels, where available, found that concentrations of three metals, arsenic, chromium, and selenium, exceeded the appropriate CTV. Arsenic exceeded the limit of 1.03 mg/kg in every sample, including the reference site, with a maximum exceedance factor of 7.9. Chromium exceeded the limit of 1 mg/kg in all but one (reference) sample, with a maximum exceedance factor of 29.6. Selenium exceeded the limit of 0.022 mg/kg, in all site samples and half of the reference samples, with a maximum exceedance factor of 49. Although these metals (arsenic, chromium, and selenium) were also detected in reference samples, with some concentrations above the CTV, the concentrations in site samples were higher than reference, and, thus, may be of potential concern in sea cucumber in the harbor.

3.4 Sediment Concentrations

Five marine surface sediment samples were collected from four harbor site stations (four samples) and a reference station (one sample) and analyzed for PCBs, organochlorine pesticides, and RCRA metals. Results are summarized in Table 3-3 and provided in Appendix B-3 and B-4 in dry weight.

3.4.1 Physical characteristics

All sediment samples were composed primarily of sand (including all coarse, medium, and fine sands), allowing for adequate comparability (Table 3-3, Appendix B-3). Total percent fines (sum of silt and clay) was also comparable between the site and reference areas. The percent fines for the site samples ranged from 3.5% to 10.1% (average of 7.8%), and the percent fines for the reference sample was 11.8%. The TOC content was measured at less than 10% in any given sample, with an average of 5.88% for site samples and 5.06% for the reference sample.

3.4.2 PCBs

Sediment samples were analyzed for seven different PCB Aroclor mixtures. No PCBs were detected above the MRL in either site or reference samples.

3.4.3 Pesticides

Sediment samples were analyzed for 31 different pesticide compounds. Only two pesticides were detected: 4,4′-DDD was detected in one site sample at 0.16 µg/kg, and 4,4′-DDT was detected in the one reference sample at 0.66 µg/kg, both of which were below the MRL of 0.67 µg/kg. No other pesticides were detected above the MRL in either site or reference samples.

3.4.4 Metals

Sediment samples were analyzed for eight RCRA metals compounds, all of which were detected in at least one sample. Average values of arsenic, barium, chromium, and lead were greater in site samples than in the reference sample, while cadmium and silver were less in the site samples than in the reference sample. Mercury and selenium were not detected in the reference sample (Table 3-3).

Arsenic, barium, chromium, and lead were detected in all site and reference samples. For arsenic, the average site concentration of 1.93 mg/kg exceeded the reference concentration of 1.61 mg/kg by a factor of 1.2. For barium, the average site concentration of 19.7 mg/kg exceeded the reference concentration of 6.31 mg/kg by a factor of 3.1. For chromium, the average site concentration of 7.82 mg/kg exceeded the reference concentration of 5.68 mg/kg by a factor of 1.4. For lead, the average site concentration of 2.96 mg/kg exceeded the reference concentration of 0.97 mg/kg by a factor of 3.0.

For cadmium, which was detected in all site and reference samples, the average site concentration of 0.408 mg/kg was less than the reference concentration of 0.697 mg/kg. For silver, which was detected in all site and reference samples, the site concentration of 0.019 mg/kg was less than the reference concentration of 0.08 mg/kg. All mercury and silver values, detected in site samples only, were very low, estimated concentrations below than the MRL.

Comparison of maximum sediment results to the ERL (not available for barium or selenium) found that no metals concentrations exceeded screening levels; thus, metals are likely not of concern in sediment in the harbor.

4.0 CONCLUSIONS

This data report summarizes the analytical results of marine biological tissue and surface sediment samples collected from Tanapag Harbor in Saipan, CNMI. Although this was a limited investigation, results will help determine if contaminants have migrated from the former Puerto Rico Dump to the adjacent harbor, threatening marine resources in this critical habitat area. Analytical data results of harbor site samples were compared to reference samples, which were collected from an off-site location outside of the harbor and not impacted by the dump.

No PCBs were detected above the MRL in any biological tissue or sediment samples. Pesticides were detected in biological samples and limited sediment samples, although the majority of the detected values were very low, estimated values that were below the MRL. The most frequently detected pesticides in emperor fish were 4,4′-DDD and 4,4′-DDE, which were also detected in reference samples; the average site concentrations exceeded the average reference concentrations by factors of 4.8 and 1.5, respectively, although many of these detected values were below the MRL. In sea cucumber, the pesticides 4,4′-DDD, cis-nonachlor, endosulfan II, and lindane average site concentrations exceeded reference concentrations by factors of 1.3 to 4.2, although nearly all detected values were below the MRL. In sediment, 4,4′-DDD and 4,4′-DDT were detected in one site and one reference sample, respectively, both of which were below the MRL.

Comparison of pesticide results to screening levels, where available, found that one pesticide in fish exceeded the CTV for fish tissue, but in only one sample and at an exceedance factor of only 1.7; however, three pesticides (beta-BHC, gamma-BHC, and Mirex) in sea cucumber exceeded the CTV for macroinfauna and, thus, may be of potential concern in sea cucumber in the harbor. Sediment, however, did not appear to serve as a source of pesticides; the only two pesticides detected were found in one harbor sample and in one reference sample, and at concentrations below the MRL.

Metals were ubiquitously detected in biological and sediment samples. In biological samples, all metals were detected in both site and reference samples. In emperor fish, average values of arsenic, barium, lead, mercury, and silver were higher in site samples than in reference samples, at factors ranging from 1.3 to 4.9; the highest was silver, although most of these values were detected below the MRL. The average values of cadmium, chromium, and selenium were higher in the reference samples. In sea cucumber, average values of arsenic, barium, chromium, lead, mercury, selenium, and silver were higher in site samples than in reference samples, at factors ranging from 1.8 to 5.3 (the highest was barium), while the average value of cadmium was higher in the reference samples.

In sediment, all metals were detected in site samples, and all metals except mercury and selenium were detected in reference samples. Average values of arsenic, barium, chromium, and lead were higher in site samples than in the reference sample at factors ranging from 1.2 to 3.1 (the highest was barium), while the average site values of cadmium and silver were less than the reference sample.

Comparison of metals results to fish tissue screening levels, where available, found that arsenic and selenium in fish exceeded thresholds; since selenium was comparable to reference concentrations, arsenic is the only metal that may be of potential concern in emperor fish in the harbor (although the average detected concentration in the harbor was only 2.3 times higher than reference). Comparison of metals results to macroinfauna tissue screening levels, where available, found that arsenic, chromium, and selenium exceeded thresholds and may be of potential concern in sea cucumber in the harbor (although the average detected concentration in the harbor was only 2 to 3 times higher than reference). There were no screening values for barium (fish and macroinfauna). Lastly, comparison of metals results to marine sediment screening levels, found that no concentrations exceeded the ERL (not available for barium or selenium). Additionally, when comparing sediment samples to suggested numerical guidelines for classifying contaminant levels in calcareous reef sediments of biogenic original, which the Tanapag sediment samples could be classified as, only one sample could be classified as moderately contaminated with cadmium; the remaining samples would be classified as lightly contaminated or clean relative to these guideline values (Denton et al. 1997).

These results indicate no substantial impacts from contaminants on biological organisms or sediment, although there were exceedances of conservative screening values in fish and sea cucumbers as stated above.. These findings, however, are based on a limited sample size and a limited area, and may not reflect potential dump-related impacts to other biotic and abiotic media or in other areas of Tanapag Harbor. For example, because sample locations were confined to areas readily accessible by snorkeling, only the southwestern portion of the Puerto Rico Dump site was sampled. Unfortunately depth, rip-rap, and a deteriorating pier made accessing the western and northwestern areas of the harbor by boat or snorkel gear difficult. Future investigation should target these deeper portions of the harbor because local residents were observed fishing off these locations. The sediment chemistry values for this study were comparable to those of Denton et. al. (2001) and considerably lower than the chemistry values from the DEQ (1987) study of sediments in the harbor. As noted by the Denton et al. (2001) study, one possible explanation for the apparent decrease in sediment chemistry values relative to the 1987 study is the potentially increased sedimentation rates within the harbor. It may be that the sediment cores taken for this study contained relatively clean material from recent dredging projects or fill cover eroded from the dump site. Deeper sample cores would be needed to determine whether sediment contaminant conditions were improving at the site or simply being covered over. Given the relatively instability of surface sediment conditions around the dump due to extreme weather conditions such as typhoons, this data gap should be explored further in future studies.

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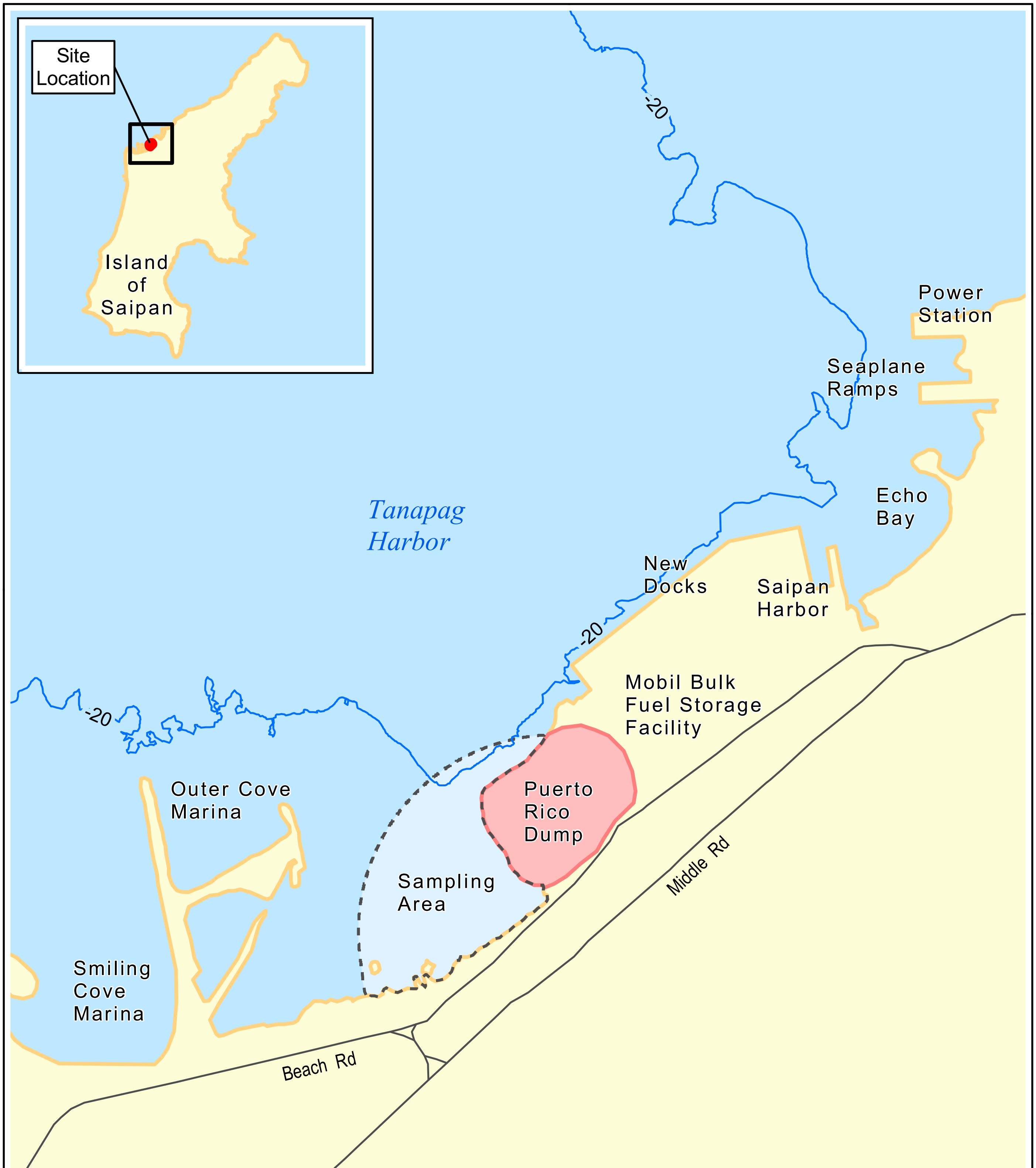
FIGURES



N

0 500 1,000

Feet

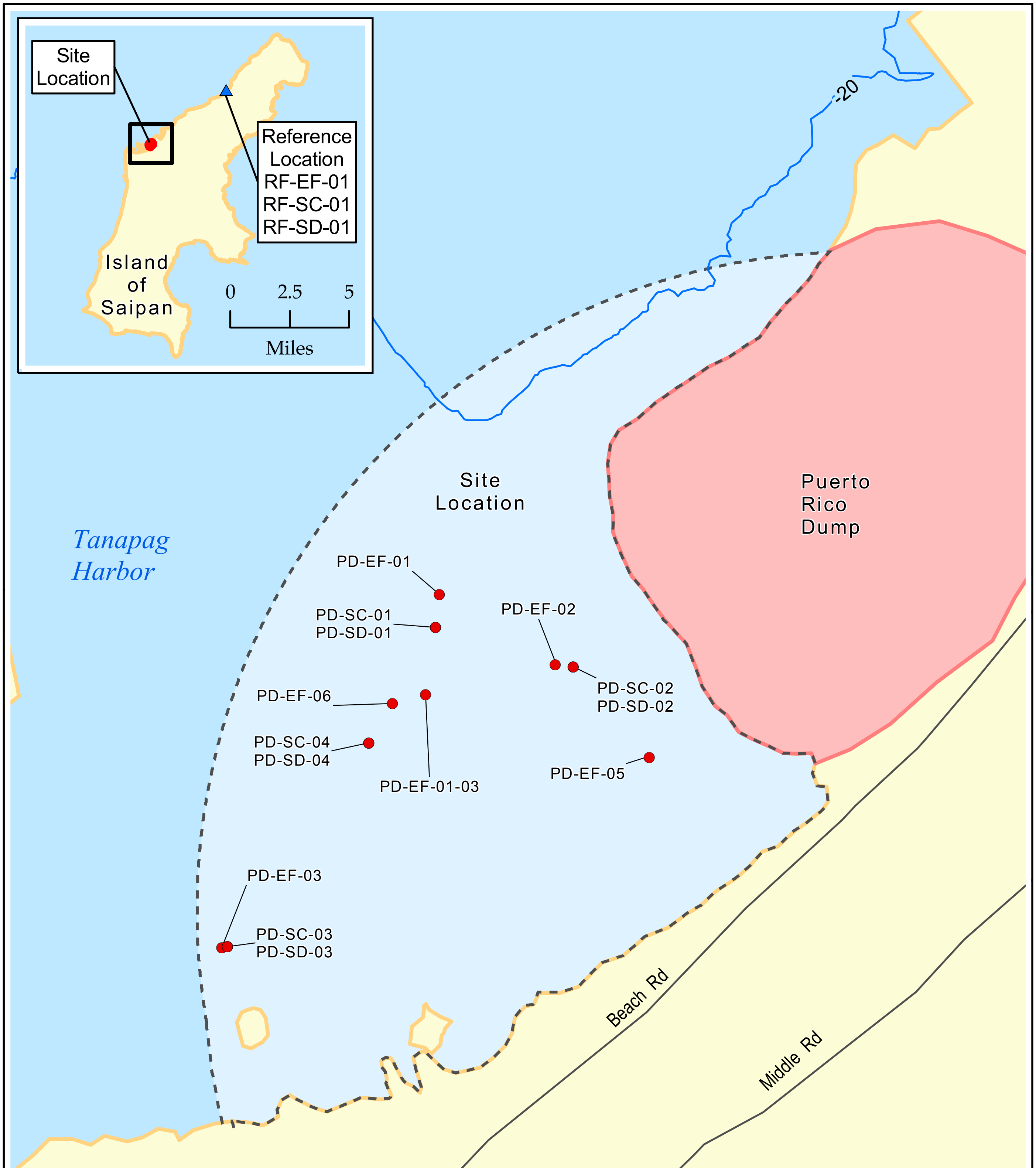
Legend

- Roads
- -20 ft Contour
- Sampling Area
- Puerto Rico Dump
- Saipan

Figure 1-1
Location of Tanapag Harbor and Puerto Rico Dump, Saipan

Quantifying Pollution Impacts from Puerto Rico Dump on Coral Reef Fisheries in Tanapag Harbor, Saipan

December 2005
NOAA/NOS/ORR
COASTAL PROTECTION
AND RESTORATION DIVISION



N

0 150 300

Feet

Legend

- Sampling Location
- Roads
- -20 ft Contour
- Sampling Area
- Puerto Rico Dump

Figure 2-1
Sample Locations

Quantifying Pollution Impacts from Puerto Rico Dump on Coral Reef Fisheries in Tanapag Harbor, Saipan

December 2005
NOAA/NOS/ORR
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TABLES

Table 2-1. Sample Identification, Location, and Analysis

SAMPLE NAME		LAB ID	COORDINATES		FISH METRICS					TISSUE AND SEDIMENT ANALYSIS						
			Latitude	Longitude	Species	Length	Weight	Gender	Gonadal Index	PCBs	Pesticides	Metals	Lipids	Solids	TOC	Grain Size
					Lethrinus spp.	cm	grams	Male, Female, Unknown	Mature, Immature, Unknown	USEPA 8082	USEPA 8081A	6010B /7000A /7471A	Bligh / Dyer	Freeze Dry	USEPA 415.1 /5310B	ASTM D-421/422
Emperor Fish Tissue																
Harbor Site	PD-EF-01-01	K0503231	15.22138059	145.7291633	*L. xanthochilus*	15.8	73.1	U	U	x	x	x	x	x	-	-
	PD-EF-01-02	K0503231	15.22138059	145.7291633	*L. harak*	23.6	275.2	F	M	x	x	x	x	x	-	-
	PD-EF-01-03	K0503231	15.22079587	145.7290828	*L. harak*	16.1	79.9	F	I	x	x	x	x	x	-	-
	PD-EF-02-02	K0503234	15.22095144	145.7298553	*L. harak*	16.8	99.4	F	I	x	x	x	x	x	-	-
	PD-EF-02-03	K0503234	15.22093534	145.729866	*L. harak*	19.4	148.9	F	I	x	x	x	x	x	-	-
	PD-EF-02-04	K0503234	15.2209729	145.7298607	*L. harak*	16.5	96.5	F	I	x	x	x	x	x	-	-
	PD-EF-03-01	K0503264	15.21931529	145.7278705	*L. harak*	17.6	103.1	F	I	x	x	x	x	x	-	-
	PD-EF-05-01	K0503264	15.22046864	145.7304829	*L. harak*	12.4	36.6	F	I	x	x	x	x	x	-	-
	PD-EF-05-02	K0503264	15.22045791	145.7304615	*L. harak*	13.4	50.5	F	I	x	x	x	x	x	-	-
	PD-EF-05-04	K0503264	15.22045255	145.7304025	*L. harak*	14	51	F	I	x	x	x	x	x	-	-
	PD-EF-06-02	K0503264	15.22072613	145.728895	*L. harak*	13.2	45.7	F	I	x	x	x	x	x	-	-
	PD-EF-06-03	K0503264	15.22072077	145.7289004	*L. harak*	19	136	F	I	x	x	x	x	x	-	-
	PD-EF-06-05	K0503264	15.22074223	145.7289004	*L. harak*	16.7	87.4	F	I	x	x	x	x	x	-	-
Reference	RF-EF-01-01	K0503231	15.25593281	145.7791543	*L. harak*	18	108.5	F	I	x	x	x	x	x	-	-
	RF-EF-01-02	K0503231	15.25593281	145.7791543	*L. harak*	17.6	108.4	F	I	x	x	x	x	x	-	-
	RF-EF-01-03	K0503231	15.25594354	145.7791597	*L. harak*	20.8	181.6	F	D	x	x	x	x	x	-	-
Sea Cucumber Tissue																
Harbor Site	PD-SC-01-01	K0503231	15.22118747	145.7291418	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-01-02	K0503231	15.22118747	145.7291418	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-01-03	K0503231	15.22118747	145.7291418	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-02-01	K0503234	15.22096217	145.729968	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-02-02	K0503234	15.22096217	145.729968	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-02-03	K0503234	15.22096217	145.729968	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-03-01	K0503264	15.21932065	145.7279027	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-03-02	K0503264	15.21932065	145.7279027	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-03-03	K0503264	15.21932065	145.7279027	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-04-01	K0503231	15.22051156	145.7287449	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-04-02	K0503231	15.22051156	145.7287449	-	-	-	-	-	x	x	x	x	x	-	-
	PD-SC-04-03	K0503231	15.22051156	145.7287449	-	-	-	-	-	x	x	x	x	x	-	-
Reference	RF-SC-01-01	K0503264	15.25536418	145.7793903	-	-	-	-	-	x	x	x	x	x	-	-
	RF-SC-01-02	K0503264	15.25536418	145.7793903	-	-	-	-	-	x	x	x	x	x	-	-
	RF-SC-01-03	K0503264	15.25536418	145.7793903	-	-	-	-	-	x	x	x	x	x	-	-
	RF-SC-01-04	K0503264	15.25536418	145.7793903	-	-	-	-	-	x	x	x	x	x	-	-
Surface Sediment																
Harbor Site	PD-SD-01	K0503231	15.22118747	145.7291418	-	-	-	-	-	x	x	x		x	x	x
	PD-SD-02	K0503234	15.22096217	145.729968	-	-	-	-	-	x	x	x		x	x	x
	PD-SD-03	K0503264	15.21932065	145.7279027	-	-	-	-	-	x	x	x		x	x	x
	PD-SD-04	K0503264	15.22051156	145.7287449	-	-	-	-	-	x	x	x		x	x	x
Reference	RF-SD-01	K0503231	15.25536418	145.7793903	-	-	-	-	-	x	x	x		x	x	x

Notes:
ASTM = American Society for Testing and Materials
D =
NA = not available
PCB = polychlorinated biphenyl
TOC = total organic carbon
USEPA = United States Environmental Protection Agency

Table 3-1. Emperor Fish Data Summary

SITE SAMPLES

Component (wet weight)	Screening Levels (SL) *	# Samples	# Detects	# Non-Detects	Min Detect Conc	Max Detect Conc	Avg Detect Conc	Min Non-Detect MRL	Max Non-Detect MRL	SL Max Exceedance Factor
Polychlorinated biphenyls (ug/kg)										
Aroclor 1016	36	13	0	13	-	-	-	10	10	-
Aroclor 1221	36	13	0	13	-	-	-	20	20	-
Aroclor 1232	36	13	0	13	-	-	-	10	10	-
Aroclor 1242	36	13	0	13	-	-	-	10	10	-
Aroclor 1248	36	13	0	13	-	-	-	10	10	-
Aroclor 1254	36	13	0	13	-	-	-	10	10	-
Aroclor 1260	36	13	0	13	-	-	-	10	19	-
Pesticides (ug/kg)										
2,4'-DDD	8	13	1	12	0.37	0.37	0.37	1	1	0.046
2,4'-DDE	42	13	1	12	0.28	0.28	0.28	1	1	0.007
2,4'-DDT	8	13	2	11	0.9	2.9	1.9	1	2.6	0.363
4,4'-DDD	8	13	11	2	0.15	3.6	0.91	1	1	0.450
4,4'-DDE	42	13	11	2	0.68	5.1	2.09	1	1.4	0.121
4,4'-DDT	9	13	7	6	0.48	3	1.09	1	1.7	0.333
Aldrin	157	13	4	9	0.19	0.44	0.29	1	1	0.003
alpha-BHC	1700	13	0	13	-	-	-	1	1	-
alpha-Chlordane	10	13	1	12	0.42	0.42	0.42	1	1	0.042
beta-BHC	486	13	4	9	0.76	3.7	1.86	1	2.3	0.0076
Chlordane	-	13	0	13	-	-	-	10	22	-
Chlorpyrifos	-	13	2	11	0.27	0.32	0.30	1	1.2	-
cis-Nonachlor	10	13	1	12	0.99	0.99	0.99	1	1	0.099
delta-BHC	486	13	1	12	0.78	0.78	0.78	1	1	0.0016
Dieldrin	360	13	2	11	0.14	0.21	0.18	1	1	0.001
Endosulfan I	0.7	13	1	12	0.59	0.59	0.59	1	1.5	0.843
Endosulfan II	0.7	13	4	9	0.1	1.2	0.42	1	1	**1.714**
Endosulfan Sulfate	0.7	13	1	12	0.17	0.17	0.17	1	1	0.243
Endrin	19	13	2	11	0.14	0.15	0.15	1	1	0.008
Endrin Aldehyde	19	13	2	11	0.35	1.3	0.83	1	1.1	0.068
Endrin Ketone	19	13	3	10	0.3	0.37	0.33	1	1.7	0.019
gamma-BHC (Lindane)	537	13	1	12	0.17	0.17	0.17	1	1	0.0003
gamma-Chlordane	10	13	0	13	-	-	-	1	1	-
Heptachlor	10	13	3	10	0.15	0.26	0.20	1	1.4	0.026
Heptachlor Epoxide	10	13	0	13	-	-	-	1	1.8	-
Isodrin	-	13	2	11	0.28	0.35	0.32	1	1	-
Methoxychlor	60	13	1	12	0.32	0.32	0.32	1	2.2	0.005
Mirex	420	13	4	9	0.62	1.5	0.93	1	1	0.004
Oxychlordane	10	13	0	13	-	-	-	1	1	-
Toxaphene	200	13	0	13	-	-	-	50	96	-
trans-Nonachlor	10	13	4	9	0.14	0.66	0.403	1	1	0.066
Metals (mg/kg)										
Arsenic	0.52	13	13	0	1.26	12.7	5.71	-	-	**24.42**
Barium	-	13	13	0	0.222	0.835	0.547	-	-	-
Cadmium	0.036	13	13	0	0.004	0.014	0.007	-	-	0.39
Chromium	2.3	13	11	2	0.09	1.09	0.44	0.13	0.14	0.47
Lead	0.34	13	13	0	0.037	0.246	0.106	-	-	0.72
Mercury	0.14	13	13	0	0.02	0.079	0.038	-	-	0.56
Selenium	0.12	13	13	0	0.17	0.56	0.38	-	-	**4.67**
Silver	0.06	13	12	1	0.0017	0.0093	0.0044	0.0116	0.0116	0.16
Conventionals (%)										
Lipids, Total	-	13	13	0	1	4.1	2.3	-	-	-
Solids, Total	-	13	13	0	12.4	31.2	27.1	-	-	-

REFERENCE SAMPLES

Component	Screening Levels (SL) *	# Samples	# Detects	# Non-Detects	Min Detect Conc	Max Detect Conc	Avg Detect Conc	Min Non-Detect MRL	Max Non-Detect MRL	SL Max Exceedance Factor	Site:Ref Avg Detect Ratio
Polychlorinated biphenyls (ug/kg)											
Aroclor 1016	36	3	0	3	-	-	-	10	10	-	-
Aroclor 1221	36	3	0	3	-	-	-	20	20	-	-
Aroclor 1232	36	3	0	3	-	-	-	10	10	-	-
Aroclor 1242	36	3	0	3	-	-	-	10	10	-	-
Aroclor 1248	36	3	0	3	-	-	-	10	10	-	-
Aroclor 1254	36	3	0	3	-	-	-	10	10	-	-
Aroclor 1260	36	3	0	3	-	-	-	10	10	-	-
Pesticides (ug/kg)											
2,4'-DDD	8	3	0	3	-	-	-	1	1	-	-
2,4'-DDE	42	3	0	3	-	-	-	1	1	-	-
2,4'-DDT	8	3	0	3	-	-	-	1	1	-	-
4,4'-DDD	8	3	1	2	0.19	0.19	0.19	1	1	0.024	**4.8**
4,4'-DDE	42	3	3	0	0.84	1.9	1.41	-	-	0.045	**1.5**
4,4'-DDT	9	3	0	3	-	-	-	1	1	-	-
Aldrin	157	3	0	3	-	-	-	1	1	-	-
alpha-BHC	1700	3	0	3	-	-	-	1	1	-	-
alpha-Chlordane	10	3	0	3	-	-	-	1	1	-	-
beta-BHC	486	3	0	3	-	-	-	1	1	-	-
Chlordane	-	3	0	3	-	-	-	10	10	-	-
Chlorpyrifos	-	3	1	2	0.58	0.58	0.58	1	1	-	0.5
cis-Nonachlor	10	3	0	3	-	-	-	1	1	-	-
delta-BHC	486	3	0	3	-	-	-	1	1	-	-
Dieldrin	360	3	0	3	-	-	-	1	1	-	-
Endosulfan I	0.7	3	0	3	-	-	-	1	1	-	-
Endosulfan II	0.7	3	0	3	-	-	-	1	1	-	-
Endosulfan Sulfate	0.7	3	0	3	-	-	-	1	1	-	-
Endrin	19	3	0	3	-	-	-	1	1	-	-
Endrin Aldehyde	19	3	0	3	-	-	-	1	1	-	-
Endrin Ketone	19	3	0	3	-	-	-	1	1	-	-
gamma-BHC (Lindane)	537	3	0	3	-	-	-	1	1	-	-
gamma-Chlordane	10	3	1	2	0.19	0.19	0.19	1	1	0.019	-
Heptachlor	10	3	0	3	-	-	-	1	1	-	-
Heptachlor Epoxide	10	3	0	3	-	-	-	1	1	-	-
Isodrin	-	3	0	3	-	-	-	1	1	-	-
Methoxychlor	60	3	0	3	-	-	-	1	1	-	-
Mirex	420	3	0	3	-	-	-	1	1	-	-
Oxychlordane	10	3	0	3	-	-	-	1	1	-	-
Toxaphene	200	3	0	3	-	-	-	50	50	-	-
trans-Nonachlor	10	3	0	3	-	-	-	1	1	-	-
Metals (mg/kg)											
Arsenic	0.52	3	3	0	1.77	3.27	2.52	-	-	**6.29**	**2.3**
Barium	-	3	3	0	0.18	0.551	0.417	-	-	-	**1.3**
Cadmium	0.036	3	3	0	0.015	0.028	0.021	-	-	0.78	0.3
Chromium	2.3	3	3	0	0.5	0.54	0.51	-	-	0.23	0.9
Lead	0.34	3	3	0	0.044	0.065	0.058	-	-	0.19	**1.8**
Mercury	0.14	3	3	0	0.01	0.02	0.01	-	-	0.14	**2.9**
Selenium	0.12	3	3	0	0.4	0.47	0.43	-	-	**3.92**	0.9
Silver	0.06	3	3	0	0.0006	0.0012	0.0009	-	-	0.02	**4.9**
Conventionals (%)											
Lipids, Total	-	3	3	0	0.72	2.3	1.61	-	-	-	**1.4**
Solids, Total	-	3	3	0	27	30.3	28.9	-	-	-	0.9

Notes:

* Screening levels are "critical tissue values" based on No Observed Adverse Effects Levels (NOAEL) for residues in fish tissue (Ogden, 2001)

MRL = method reporting limit

Bold values show a Screening Level Maximum Exceedance Factor or Average Site:Reference ratio greater than 1

Table 3-2. Sea Cucumber Data Summary

Component (wet weight)	Screening Levels (SL)	SITE SAMPLES # Samples	# Detects	# Non-Detects	Min Detect Conc	Max Detect Conc	Avg Detect Conc	Min Non-Detect MRL	Max Non-Detect MRL	SL Max Exceedance Factor
Polychlorinated biphenyls (ug/kg)										
Aroclor 1016	40	12	0	12	-	-	-	10	10	-
Aroclor 1221	40	12	0	12	-	-	-	20	20	-
Aroclor 1232	40	12	0	12	-	-	-	10	10	-
Aroclor 1242	40	12	0	12	-	-	-	10	10	-
Aroclor 1248	40	12	0	12	-	-	-	10	10	-
Aroclor 1254	40	12	0	12	-	-	-	10	10	-
Aroclor 1260	40	12	0	12	-	-	-	10	10	-
Pesticides (ug/kg)										
2,4'-DDD	46.6	12	0	12	-	-	-	1	1	-
2,4'-DDE	46.6	12	0	12	-	-	-	1	1	-
2,4'-DDT	46.6	12	0	12	-	-	-	1	1	-
4,4'-DDD	46.6	12	3	9	0.16	0.45	0.35	1	1	0.010
4,4'-DDE	46.6	12	0	12	-	-	-	1	5.8	-
4,4'-DDT	46.6	12	2	10	0.18	0.32	0.25	1	1	0.007
Aldrin	480	12	4	8	0.13	0.26	0.18	1	1	0.001
alpha-BHC	2000	12	0	12	-	-	-	1	1	-
alpha-Chlordane	710	12	0	12	-	-	-	1	1	-
beta-BHC	0.28	12	3	9	0.41	0.93	0.66	1	1	**3.321**
Chlordane	--	12	1	11	1.2	1.2	1.2	10	10	-
Chlorpyrifos	--	12	0	12	-	-	-	1	1	-
cis-Nonachlor	710	12	3	9	0.2	0.24	0.22	1	1	0.0003
delta-BHC	0.28	12	0	12	-	-	-	1	1	-
Dieldrin	10	12	3	9	0.086	0.21	0.14	1	1	0.021
Endosulfan I	70	12	1	11	0.27	0.27	0.27	1	1	0.004
Endosulfan II	70	12	3	9	0.12	1.3	0.67	1	1	0.019
Endosulfan Sulfate	70	12	1	11	0.17	0.17	0.17	1	1	0.002
Endrin	5	12	0	12	-	-	-	1	1	-
Endrin Aldehyde	5	12	0	12	-	-	-	1	1	-
Endrin Ketone	5	12	3	9	0.26	0.34	0.31	1	1	0.068
gamma-BHC (Lindane)	0.22	12	2	10	0.35	0.69	0.52	1	1	**3.136**
gamma-Chlordane	710	12	0	12	-	-	-	1	1	-
Heptachlor	10	12	0	12	-	-	-	1	1	-
Heptachlor Epoxide	54	12	0	12	-	-	-	1	1	-
Isodrin	--	12	0	12	-	-	-	1	1	-
Methoxychlor	100	12	0	12	-	-	-	1	1	-
Mirex	3	12	2	10	2.5	4.4	3.45	1	1.9	**1.467**
Oxychlordane	710	12	0	12	-	-	-	1	1	-
Toxaphene	8.3	12	0	12	-	-	-	50	50	-
trans-Nonachlor	710	12	1	11	0.11	0.11	0.11	1	1	0.0002
Metals (mg/kg)										
Arsenic	1.03	12	12	0	2.28	8.1	4.27	-	-	**7.86**
Barium	--	12	12	0	1.02	7.9	4.17	-	-	-
Cadmium	0.08	12	12	0	0.006	0.021	0.011	-	-	0.26
Chromium	1	12	12	0	1.41	29.6	8.09	-	-	**29.60**
Lead	4	12	12	0	0.26	0.808	0.48	-	-	0.20
Mercury	0.859	12	12	0	0.004	0.021	0.009	-	-	0.02
Selenium	0.022	12	12	0	0.39	1.07	0.72	-	-	**48.64**
Silver	0.22	12	12	0	0.0032	0.0125	0.0068	-	-	0.06
Conventionals (%)										
Lipids, Total	-	12	12	0	0.092	0.32	0.19	-	-	-
Solids, Total	-	12	12	0	13.1	25.3	19.4	-	-	-

Component	Screening Levels (SL)	REFERENCE SAMPLES # Samples	# Detects	# Non-Detects	Min Detect Conc	Max Detect Conc	Avg Detect Conc	Min Non-Detect MRL	Max Non-Detect MRL	SL Max Exceedance Factor	Site:Ref Avg Detect Ratio
Polychlorinated biphenyls (ug/kg)											
Aroclor 1016	40	4	0	4	-	-	-	10	10	-	-
Aroclor 1221	40	4	0	4	-	-	-	20	20	-	-
Aroclor 1232	40	4	0	4	-	-	-	10	10	-	-
Aroclor 1242	40	4	0	4	-	-	-	10	10	-	-
Aroclor 1248	40	4	0	4	-	-	-	10	10	-	-
Aroclor 1254	40	4	0	4	-	-	-	10	10	-	-
Aroclor 1260	40	4	0	4	-	-	-	10	10	-	-
Pesticides (ug/kg)											
2,4'-DDD	46.6	4	4	0	0.36	1.7	0.86	-	-	0.036	-
2,4'-DDE	46.6	4	1	3	1.5	1.5	1.5	1	1	0.032	-
2,4'-DDT	46.6	4	0	4	-	-	-	1	1	-	-
4,4'-DDD	46.6	4	1	3	0.14	0.14	0.14	1	1	0.003	**2.5**
4,4'-DDE	46.6	4	2	2	1.2	1.4	1.3	1	1	0.030	-
4,4'-DDT	46.6	4	0	4	-	-	-	1	1	-	-
Aldrin	480	4	0	4	-	-	-	1	1	-	-
alpha-BHC	2000	4	0	4	-	-	-	1	1	-	-
alpha-Chlordane	710	4	0	4	-	-	-	1	1	-	-
beta-BHC	0.28	4	0	4	-	-	-	1	1	-	-
Chlordane	--	4	0	4	-	-	-	10	10	-	-
Chlorpyrifos	--	4	0	4	-	-	-	1	1	-	-
cis-Nonachlor	710	4	1	3	0.17	0.17	0.17	1	1	0.0002	**1.3**
delta-BHC	0.28	4	0	4	-	-	-	1	1	-	-
Dieldrin	10	4	1	3	0.29	0.29	0.29	1	1	0.029	0.5
Endosulfan I	70	4	0	4	-	-	-	1	1	-	-
Endosulfan II	70	4	2	2	0.11	0.2	0.16	1	1	0.003	**4.2**
Endosulfan Sulfate	70	4	1	3	0.18	0.18	0.18	1	1	0.003	0.9
Endrin	5	4	0	4	-	-	-	1	1	-	-
Endrin Aldehyde	5	4	0	4	-	-	-	1	1	-	-
Endrin Ketone	5	4	1	3	0.31	0.31	0.31	1	1	0.062	1.0
gamma-BHC (Lindane)	0.22	4	1	3	0.16	0.16	0.16	1	1	0.727	**3.3**
gamma-Chlordane	710	4	0	4	-	-	-	1	1	-	-
Heptachlor	10	4	0	4	-	-	-	1	1	-	-
Heptachlor Epoxide	54	4	0	4	-	-	-	1	1	-	-
Isodrin	--	4	0	4	-	-	-	1	1	-	-
Methoxychlor	100	4	1	3	0.24	0.24	0.24	1	1	0.002	-
Mirex	3	4	0	4	-	-	-	1	1	-	-
Oxychlordane	710	4	1	3	0.098	0.098	0.098	1	1	0.0001	-
Toxaphene	8.3	4	1	3	14	14	14	50	50	**1.687**	-
trans-Nonachlor	710	4	1	3	0.11	0.11	0.11	1	1	0.0002	1.0
Metals (mg/kg)											
Arsenic	1.03	4	4	0	1.69	2.53	2.13	-	-	**2.46**	**2.0**
Barium	--	4	4	0	0.706	0.825	0.783	-	-	-	**5.3**
Cadmium	0.08	4	4	0	0.01	0.027	0.020	-	-	0.34	0.5
Chromium	1	4	4	0	0.48	6.74	3.61	-	-	**6.74**	**2.2**
Lead	4	4	4	0	0.101	0.161	0.144	-	-	0.04	**3.3**
Mercury	0.859	4	4	0	0.003	0.007	0.005	-	-	0.01	**1.8**
Selenium	0.022	4	4	0	0.17	0.32	0.23	-	-	**14.55**	**3.1**
Silver	0.22	4	4	0	0.0018	0.0027	0.0023	-	-	0.01	**3.0**
Conventionals (%)											
Lipids, Total	-	4	4	0	0.077	0.22	0.14	-	-	-	**1.3**
Solids, Total	-	4	4	0	13.4	18.7	15.8	-	-	-	**1.2**

Notes:

* Screening levels are "critical tissue values" based on No Observed Adverse Effects Levels (NOAEL) for residues in macroinfauna tissue (Ogden, 2001)

MRL = method reporting limit

Bold values show a Screening Level Maximum Exceedance Factor or Average Site:Reference ratio greater than 1

Table 3-3. Sediment Data Summary

Component (dry weight)	Screening Levels (SL)	SITE SAMPLES # Samples	# Detects	# Non-Detects	Min Detect Conc	Max Detect Conc	Avg Detect Conc	Min Non-Detect MRL	Max Non-Detect MRL	SL Max Exceedance Factor	Component	Screening Levels (SL)	REFERENCE SAMPLE # Samples	# Detects	# Non-Detects	Min/Max/Avg Detect Conc	Min/Max Non-Detect MRL	SL Max Exceedance Factor	Site:Ref Avg Detect Ratio
Polychlorinated biphenyls (ug/kg)											**Polychlorinated biphenyls (ug/kg)**								
Aroclor 1016	-	4	0	4	-	-	-	5	7.3	-	Aroclor 1016	-	1	0	1	-	6.9	-	-
Aroclor 1221	-	4	0	4	-	-	-	10	15	-	Aroclor 1221	-	1	0	1	-	14	-	-
Aroclor 1232	-	4	0	4	-	-	-	5	7.3	-	Aroclor 1232	-	1	0	1	-	6.9	-	-
Aroclor 1242	-	4	0	4	-	-	-	5	7.3	-	Aroclor 1242	-	1	0	1	-	6.9	-	-
Aroclor 1248	-	4	0	4	-	-	-	5	7.3	-	Aroclor 1248	-	1	0	1	-	6.9	-	-
Aroclor 1254	-	4	0	4	-	-	-	5	7.3	-	Aroclor 1254	-	1	0	1	-	6.9	-	-
Aroclor 1260	-	4	0	4	-	-	-	5	7.3	-	Aroclor 1260	-	1	0	1	-	6.9	-	-
Pesticides (ug/kg)											**Pesticides (ug/kg)**								
2,4'-DDD	-	1	0	1	-	-	-	1	1	-	2,4'-DDD	-	0	0	0	-	-	-	-
2,4'-DDE	-	1	0	1	-	-	-	1	1	-	2,4'-DDE	-	0	0	0	-	-	-	-
2,4'-DDT	-	1	0	1	-	-	-	1	1	-	2,4'-DDT	-	0	0	0	-	-	-	-
4,4'-DDD	-	4	1	3	0.16	0.16	0.16	0.67	0.74	-	4,4'-DDD	-	1	0	1	-	0.69	-	-
4,4'-DDE	-	4	0	4	-	-	-	0.67	1	-	4,4'-DDE	-	1	0	1	-	0.69	-	-
4,4'-DDT	-	4	0	4	-	-	-	0.67	1	-	4,4'-DDT	-	1	1	0	0.66	-	-	-
Aldrin	-	4	0	4	-	-	-	0.67	1	-	Aldrin	-	1	0	1	-	0.69	-	-
alpha-BHC	-	4	0	4	-	-	-	0.67	1	-	alpha-BHC	-	1	0	1	-	0.69	-	-
alpha-Chlordane	-	4	0	4	-	-	-	0.67	1	-	alpha-Chlordane	-	1	0	1	-	0.69	-	-
beta-BHC	-	4	0	4	-	-	-	0.67	1	-	beta-BHC	-	1	0	1	-	0.69	-	-
Chlordane	-	1	0	1	-	-	-	10	10	-	Chlordane	-	0	0	0	-	-	-	-
Chlorpyrifos	-	1	0	1	-	-	-	1	1	-	Chlorpyrifos	-	0	0	0	-	-	-	-
cis-Nonachlor	-	1	0	1	-	-	-	1	1	-	cis-Nonachlor	-	0	0	0	-	-	-	-
delta-BHC	-	4	0	4	-	-	-	0.67	1	-	delta-BHC	-	1	0	1	-	0.69	-	-
Dieldrin	-	4	0	4	-	-	-	0.67	1	-	Dieldrin	-	1	0	1	-	0.69	-	-
Endosulfan I	-	4	0	4	-	-	-	0.67	1	-	Endosulfan I	-	1	0	1	-	0.69	-	-
Endosulfan II	-	4	0	4	-	-	-	0.67	1	-	Endosulfan II	-	1	0	1	-	0.69	-	-
Endosulfan Sulfate	-	4	0	4	-	-	-	0.67	1	-	Endosulfan Sulfate	-	1	0	1	-	0.69	-	-
Endrin	-	4	0	4	-	-	-	0.67	1	-	Endrin	-	1	0	1	-	0.69	-	-
Endrin Aldehyde	-	4	0	4	-	-	-	0.67	1	-	Endrin Aldehyde	-	1	0	1	-	0.69	-	-
Endrin Ketone	-	4	0	4	-	-	-	0.67	1	-	Endrin Ketone	-	1	0	1	-	0.69	-	-
gamma-BHC (Lindane)	-	4	0	4	-	-	-	0.67	1	-	gamma-BHC (Lindane)	-	1	0	1	-	0.69	-	-
gamma-Chlordane	-	4	0	4	-	-	-	0.67	1	-	gamma-Chlordane	-	1	0	1	-	0.69	-	-
Heptachlor	-	4	0	4	-	-	-	0.67	1	-	Heptachlor	-	1	0	1	-	0.69	-	-
Heptachlor Epoxide	-	4	0	4	-	-	-	0.67	1	-	Heptachlor Epoxide	-	1	0	1	-	0.69	-	-
Isodrin	-	1	0	1	-	-	-	1	1	-	Isodrin	-	0	0	0	-	-	-	-
Methoxychlor	-	4	0	4	-	-	-	0.67	1	-	Methoxychlor	-	1	0	1	-	0.69	-	-
Mirex	-	1	0	1	-	-	-	1	1	-	Mirex	-	0	0	0	-	-	-	-
Oxychlordane	-	1	0	1	-	-	-	1	1	-	Oxychlordane	-	0	0	0	-	-	-	-
Toxaphene	-	4	0	4	-	-	-	34	50	-	Toxaphene	-	1	0	1	-	35	-	-
trans-Nonachlor	-	1	0	1	-	-	-	1	1	-	trans-Nonachlor	-	0	0	0	-	-	-	-
Metals (mg/kg)											**Metals (mg/kg)**								
Arsenic	8.2	4	4	0	1.55	2.66	1.93	-	-	0.32	Arsenic	8.2	1	1	0	1.61	-	0.20	**1.2**
Barium	--	4	4	0	6.71	30.7	19.7	-	-	--	Barium	48	1	1	0	6.31	-	0.13	**3.1**
Cadmium	1.2	4	4	0	0.073	0.822	0.408	-	-	0.69	Cadmium	1.2	1	1	0	0.697	-	0.58	0.6
Chromium	81	4	4	0	5.77	9.12	7.82	-	-	0.11	Chromium	81	1	1	0	5.68	-	0.07	**1.4**
Lead	46.7	4	4	0	1.37	4.33	2.96	-	-	0.09	Lead	46.7	1	1	0	0.97	-	0.02	**3.0**
Mercury	0.15	4	3	1	0.011	0.013	0.012	0.015	0.015	0.09	Mercury	0.15	1	0	1	-	0.019	-	-
Selenium	--	4	3	1	0.3	1.4	0.9	2.6	2.6	--	Selenium	1	1	0	1	-	2.9	-	-
Silver	1	4	4	0	0.013	0.026	0.019	-	-	0.03	Silver	1	1	1	0	0.08	-	0.08	0.2
Conventionals (%)											**Conventionals (%)**								
Total Organic Carbon	-	4	4	0	2.22	9	5.88	-	-	-	Total Organic Carbon	-	1	1	0	5.06	-	-	**1.2**
Solids, Total	-	4	4	0	66.7	74.9	69.7	-	-	-	Solids, Total	-	1	1	0	73.2	-	-	1.0

Notes:

* Screening levels are Effects Range-Low (ERL) levels for marine sediment (Long et al., 1995).

MRL = method reporting limit

Bold values show a Screening Level Maximum Exceedance Factor or Average Site:Reference ratio greater than 1

Table 3-4. NOAEL-based Critical Tissue Values (CTV) and Sediment Effects Range-Low (ERL) Values

Analyte	Fish CTVs (Wet weight) [1]			Macroinfauna CTVs (Wet weight) [1]			Sediment ERL (Dry weight) [2]	
	mg/kg (ppm)		ug/kg (ppb)	mg/kg (ppm)		ug/kg (ppb)	mg/kg (ppm)	ug/kg (ppb)
	Test CTV	CTV w/UF*	CTV w/UF*	Test CTV	CTV w/UF*	CTV w/UF*		
PCBs								
Aroclors (1260)*	0.36	0.036	**36**	0.04	0.04	40		
PESTICIDES								
2,4'-DDD	0.008	0.008	**8**	0.0466	0.0466	**46.6**		
2,4'-DDE	0.042	0.042	**42**	0.0466	0.0466	**46.6**		
2,4'-DDT	0.008	0.008	**8**	0.0466	0.0466	**46.6**		
4,4'-DDD	0.008	0.008	**8**	0.0466	0.0466	**46.6**		
4,4'-DDE	0.042	0.042	**42**	0.0466	0.0466	**46.6**	0.0022	**2.2**
4,4'-DDT	0.009	0.009	**9**	0.0466	0.0466	**46.6**		
Aldrin	0.157	0.157	**157**	0.48	0.48	**480**		
alpha-BHC*	170	1.7	**1700**	2	2	**2000**		
alpha-Chlordane	0.01	0.01	**10**	0.71	0.71	**710**		
beta-BHC*	48.6	0.486	**486**	0.028	0.00028	**0.28**		
Chlordane	--	--	**--**	--	--	**--**		
Chlorpyrifos	--	--	**--**	--	--	**--**		
cis-Nonachlor	0.01	0.01	**10**	0.71	0.71	**710**		
delta-BHC*	48.6	0.486	**486**	0.028	0.00028	**0.28**		
Dieldrin	0.36	0.36	**360**	0.01	0.01	**10**		
Endosulfan I*	0.07	0.0007	**0.7**	0.07	0.07	**70**		
Endosulfan II*	0.07	0.0007	**0.7**	0.07	0.07	**70**		
Endosulfan Sulfate*	0.07	0.0007	**0.7**	0.07	0.07	**70**		
Endrin*	0.019	0.019	**19**	0.05	0.005	**5**		
Endrin Aldehyde*	0.019	0.019	**19**	0.05	0.005	**5**		
Endrin Ketone*	0.019	0.019	**19**	0.05	0.005	**5**		
gamma-BHC (Lindane)*	0.537	0.537	**537**	0.022	0.00022	**0.22**		
gamma-Chlordane	0.01	0.01	**10**	0.71	0.71	**710**		
Heptachlor	0.01	0.01	**10**	0.01	0.01	**10**		
Heptachlor Epoxide	0.01	0.01	**10**	0.054	0.054	**54**		
Isodrin	--	--	**--**	--	--	**--**		
Methoxychlor	0.06	0.06	**60**	0.1	0.1	**100**		
Mirex*	0.42	0.42	**420**	0.03	0.003	**3**		
Oxychlordane	0.01	0.01	**10**	0.71	0.71	**710**		
Toxaphene*	0.2	0.2	**200**	0.83	0.0083	**8.3**		
trans-Nonachlor	0.01	0.01	**10**	0.71	0.71	**710**		
METALS								
Arsenic	0.52	**0.52**		1.03	**1.03**		8.2	
Barium	--	**--**		--	**--**		--	
Cadmium	0.036	**0.036**		0.08	**0.08**		1.2	
Chromium (Cr+6)	2.3	**2.3**		1	**1**		81	
Lead	0.34	**0.34**		4	**4**		46.7	
Mercury	0.14	**0.14**		0.859	**0.859**		0.15	
Selenium*	0.12	**0.12**		0.22	**0.022**		--	
Silver	0.06	**0.06**		0.22	**0.22**		1.0	

Notes

* Uncertainty Factor (UF) of 10 or 100 used to adjust Fish and/or Macroinfauna CTV; e.g., LC50 adjusted to NOAEL

1. Ogden, 2001

2. Long et al., 1995

APPENDIX A

Photographs

Photo 1. Surface Sediment Core Sample

Photo 2. Emperor Fish Sample

APPENDIX B

Laboratory Analytical Results

Appendix B-1. Emperor Fish Analytical Results

Compound	SITE SAMPLES													REFERENCE SAMPLES		
	PD-EF-01-01	PD-EF-01-02	PD-EF-01-03	PD-EF-02-02	PD-EF-02-03	PD-EF-02-04	PD-EF-03-01	PD-EF-05-01	PD-EF-05-02	PD-EF-05-04	PD-EF-06-02	PD-EF-06-03	PD-EF-06-05	RF-EF-01-01	RF-EF-01-02	RF-EF-01-03
Polychlorinated biphenyls (ug/kg)																
Aroclor 1016	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1221	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Aroclor 1232	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1242	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1248	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1254	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1260	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	19 U	14 U	10 U	10 U	10 U	10 U	10 U	10 U
Pesticides (ug/kg)																
2,4'-DDD	1 U	1 U	1 U	1 U	1 U	**0.37 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2,4'-DDE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.28 J**	1 U	1 U	1 U	1 U	1 U	1 U
2,4'-DDT	**2.9 J**	2.6 U	**0.9 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4,4'-DDD	1 U	**0.37 J**	**1 J**	**0.31 J**	**0.44 J**	**0.47 J**	**2.1**	1 U	**0.42 J**	**0.15 J**	**0.62 J**	**0.53 J**	**3.6**	**0.19 J**	1 U	1 U
4,4'-DDE	**1.6 J**	**4.3 J**	**0.9 J**	1 U	**0.81 J**	**1.1 J**	**3.3**	**0.92 J**	**3**	**1.3 J**	**0.68 J**	1.4 U	**5.1**	**1.9 J**	**0.84 J**	**1.5**
4,4'-DDT	**0.56 J**	**1.3**	**0.48 J**	1 U	1 U	**0.73 J**	**0.59 J**	**0.98 J**	**3**	1.7 U	1 U	1 U	1.3 U	1 U	1 U	1 U
Aldrin	1 U	**0.19 J**	1 U	**0.19 J**	**0.32 J**	1 U	1 U	1 U	1 U	**0.44 J**	1 U	1 U	1 U	1 U	1 U	1 U
alpha-BHC	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
alpha-Chlordane	1 U	**0.42 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
beta-BHC	**0.96 J**	1 U	1 U	**0.76 J**	1 U	2.3 U	1.9 U	2 U	1.7 U	**2 J**	1.4 U	**3.7**	1 U	1 U	1 U	1 U
Chlordane	14 U	22 U	10 U	10 U	11 U	15 U	10 U	10 U	10 U	10 U	10 U	10 U	16 U	10 U	10 U	10 U
Chlorpyrifos	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.32 J**	1 U	1 U	**0.27 J**	1.2 U	1 U	1 U	1 U	**0.58 J**
cis-Nonachlor	1 U	1 U	1 U	1 U	1 U	**0.99 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
delta-BHC	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.78 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dieldrin	1 U	1 U	1 U	**0.21 J**	**0.14 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Endosulfan I	1 U	1 U	**0.59 J**	1 U	1 U	1.5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Endosulfan II	1 U	1 U	**1.2**	1 U	1 U	1 U	**0.1 J**	**0.16 J**	1 U	1 U	1 U	1 U	**0.21 J**	1 U	1 U	1 U
Endosulfan Sulfate	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.17 J**	1 U	1 U	1 U	1 U
Endrin	1 U	1 U	1 U	**0.14 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.15 J**	1 U	1 U	1 U
Endrin Aldehyde	1 U	1 U	1 U	1 U	**0.35 J**	1 U	1 U	1 U	**1.3 J**	1 U	1.1 U	1 U	1 U	1 U	1 U	1 U
Endrin Ketone	1 U	1 U	1 U	1 U	1 U	1 U	**0.3 J**	1.6 U	1.7 U	1 U	**0.37 J**	**0.33 J**	1 U	1 U	1 U	1 U
gamma-BHC (Lindane)	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.17 J**	1 U	1 U	1 U	1 U	1 U	1 U
gamma-Chlordane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.19 J**
Heptachlor	1 U	1.4 U	1 U	1 U	1.1 U	1 U	**0.15 J**	**0.19 J**	**0.26 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Heptachlor Epoxide	1 U	1 U	1.8 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Isodrin	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.28 J**	**0.35 J**	1 U	1 U	1 U
Methoxychlor	1 U	1 U	1 U	1 U	1 U	1.1 U	2.1 U	2.2 U	1.3 U	1 U	1.1 U	**0.32 J**	1 U	1 U	1 U	1 U
Mirex	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.91 J**	**0.62 J**	**0.69 J**	**1.5 J**	1 U	1 U	1 U	1 U	1 U
Oxychlordane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toxaphene	50 U	50 U	50 U	50 U	50 U	50 U	96 U	50 U	50 U	50 U	64 U	50 U	60 U	50 U	50 U	50 U
trans-Nonachlor	1 U	**0.34 J**	**0.47 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.14 J**	**0.66 J**	1 U	1 U	1 U
Metals (mg/kg)																
Arsenic	**1.83**	**2.2**	**8.04**	**2.44**	**2.93**	**2.88**	**5.2**	**10.9**	**10.1**	**10.3**	**1.26**	**3.48**	**12.7**	**2.52**	**3.27**	**1.77**
Barium	**0.222**	**0.521**	**0.779**	**0.496**	**0.719**	**0.835**	**0.349**	**0.825**	**0.282**	**0.326**	**0.345**	**0.591**	**0.821**	**0.521**	**0.551**	**0.18**
Cadmium	**0.009**	**0.006 J**	**0.006**	**0.014**	**0.01**	**0.006 J**	**0.007**	**0.004 J**	**0.004 J**	**0.006 J**	**0.004 J**	**0.007 J**	**0.007 J**	**0.015**	**0.02**	**0.028**
Chromium	0.14 U	**0.99**	0.13 U	**0.18**	**0.14 J**	**0.43**	**1**	**1.09**	**0.16**	**0.15**	**0.09**	**0.26**	**0.31**	**0.5**	**0.54**	**0.5**
Lead	**0.068**	**0.124**	**0.069**	**0.088**	**0.103**	**0.127**	**0.075**	**0.246**	**0.097**	**0.115**	**0.037**	**0.087**	**0.146**	**0.065**	**0.044**	**0.065**
Mercury	**0.037**	**0.079**	**0.045**	**0.039**	**0.044**	**0.035**	**0.036**	**0.022**	**0.021**	**0.024**	**0.036**	**0.056**	**0.02**	**0.02**	**0.01**	**0.01**
Selenium	**0.41**	**0.35**	**0.46**	**0.37**	**0.34**	**0.31 J**	**0.4**	**0.4**	**0.47**	**0.43**	**0.17**	**0.32**	**0.56**	**0.43**	**0.47**	**0.4**
Silver	**0.0024 J**	**0.003 J**	**0.0023 J**	**0.0093**	**0.006**	**0.0082**	**0.0042 J**	**0.0021 J**	0.0116 U	**0.0017 J**	**0.0029 J**	**0.0055 J**	**0.0054 J**	**0.0012 J**	**0.0006 J**	**0.0008 J**
Conventionals (%)																
Lipids, Total	**1**	**3.9**	**1.4**	**2.3**	**3.8**	**2.8**	**2**	**1.2**	**2.6**	**1.6**	**1.5**	**4.1**	**1.7**	**1.8**	**0.72**	**2.3**
Solids, Total	**27**	**30.5**	**26.3**	**28.5**	**28.5**	**31.2**	**26.9**	**26.8**	**28.8**	**28.6**	**12.4**	**28.9**	**28**	**29.5**	**30.3**	**27**

Notes:

Bold values are detected.

Non-detected values are reported at the Method Reporting Limit (MRL).

Appendix B-2. Sea Cucumber Analytical Results

Compound	SITE SAMPLES												REFERENCE SAMPLES			
	PD-SC-01-01	PD-SC-01-02	PD-SC-01-03	PD-SC-02-01	PD-SC-02-02	PD-SC-02-03	PD-SC-03-01	PD-SC-03-02	PD-SC-03-03	PD-SC-04-01	PD-SC-04-02	PD-SC-04-03	RF-SC-01-01	RF-SC-01-02	RF-SC-01-03	RF-SC-01-04
Polychlorinated biphenyls (ug/kg)																
Aroclor 1016	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1221	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Aroclor 1232	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1242	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1248	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1254	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Aroclor 1260	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Pesticides (ug/kg)																
2,4'-DDD	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.44 J**	**0.36 J**	**1.7 J**	**0.93 J**
2,4'-DDE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**1.5**
2,4'-DDT	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4,4'-DDD	1 U	1 U	1 U	1 U	1 U	1 U	**0.45 J**	**0.16 J**	**0.44 J**	1 U	1 U	1 U	**0.14 J**	1 U	1 U	1 U
4,4'-DDE	2.4 U	2.1 U	1 U	4.3 U	5.8 U	2.6 U	1.1 U	1 U	1 U	1 U	1 U	1.7 U	**1.2 J**	**1.4 J**	1 U	1 U
4,4'-DDT	1 U	1 U	1 U	**0.32 J**	1 U	1 U	**0.18 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Aldrin	1 U	1 U	1 U	1 U	**0.26 J**	1 U	**0.18 J**	**0.15 J**	**0.13 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
alpha-BHC	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
alpha-Chlordane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
beta-BHC	1 U	**0.41 J**	1 U	**0.93 J**	1 U	**0.64 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlordane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	**1.2 J**	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chlorpyrifos	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-Nonachlor	1 U	1 U	1 U	1 U	1 U	1 U	**0.24 J**	**0.2 J**	**0.22 J**	1 U	1 U	1 U	1 U	1 U	1 U	**0.17 J**
delta-BHC	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dieldrin	**0.21 J**	**0.086 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.13 J**	1 U	1 U	**0.29 J**	1 U	1 U	1 U
Endosulfan I	1 U	1 U	1 U	1 U	1 U	**0.27 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Endosulfan II	**0.59 J**	1 U	1 U	1 U	**1.3 J**	1 U	1 U	**0.12 J**	1 U	1 U	1 U	1 U	**0.2 J**	1 U	**0.11 J**	1 U
Endosulfan Sulfate	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.17 J**	1 U	1 U	1 U	1 U	1 U	1 U	**0.18 J**	1 U
Endrin	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Endrin Aldehyde	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Endrin Ketone	1 U	1 U	1 U	1 U	1 U	1 U	**0.26 J**	**0.32 J**	**0.34 J**	1 U	1 U	1 U	1 U	1 U	1 U	**0.31 J**
gamma-BHC (Lindane)	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.35 J**	**0.69 J**	1 U	1 U	1 U	1 U	**0.16 J**	1 U	1 U
gamma-Chlordane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Heptachlor	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Heptachlor Epoxide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Isodrin	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methoxychlor	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.24 J**	1 U	1 U
Mirex	1 U	1.9 U	1 U	1.7 U	**4.4**	1.2 U	1 U	1 U	1 U	1 U	1.1 U	**2.5 J**	1 U	1 U	1 U	1 U
Oxychlordane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**0.098 J**	1 U	1 U	1 U
Toxaphene	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	**14 J**	50 U	50 U	50 U
trans-Nonachlor	1 U	1 U	1 U	1 U	1 U	1 U	**0.11 J**	1 U	1 U	1 U	1 U	1 U	1 U	**0.11 J**	1 U	1 U
Metals (mg/kg)																
Arsenic	**3.88**	**3.72**	**2.91**	**2.6**	**3.06**	**4.46**	**6.22**	**5.31**	**8.1**	**2.28**	**4.42**	**4.31**	**2.53**	**1.69**	**2.2**	**2.11**
Barium	**7.9**	**5.67**	**6.49**	**7.79**	**5.7**	**7.09**	**1.28**	**1.02**	**1.06**	**1.94**	**1.55**	**2.53**	**0.825**	**0.786**	**0.706**	**0.815**
Cadmium	**0.008**	**0.011**	**0.01**	**0.008**	**0.008**	**0.011**	**0.015**	**0.016**	**0.021**	**0.006**	**0.007**	**0.007**	**0.02**	**0.027**	**0.01**	**0.021**
Chromium	**11.1 J**	**10.8 J**	**7.35 J**	**2.84 J**	**3.32 J**	**8.15 J**	**2.89**	**9.43**	**29.6**	**7.46 J**	**2.76 J**	**1.41 J**	**6.74**	**2**	**0.48**	**5.21**
Lead	**0.478**	**0.376**	**0.447**	**0.712**	**0.599**	**0.808**	**0.519**	**0.402**	**0.53**	**0.296**	**0.26**	**0.336**	**0.161**	**0.158**	**0.101**	**0.157**
Mercury	**0.007**	**0.011**	**0.007**	**0.005**	**0.005**	**0.008**	**0.013**	**0.011**	**0.021**	**0.004 J**	**0.006**	**0.004**	**0.003 J**	**0.005**	**0.003 J**	**0.007**
Selenium	**0.79**	**0.82**	**0.71**	**0.45**	**0.53**	**1.07**	**0.86**	**0.77**	**1.01**	**0.39**	**0.64**	**0.62**	**0.21**	**0.17**	**0.23**	**0.32**
Silver	**0.0069**	**0.0056 J**	**0.0074 J**	**0.0125**	**0.0106**	**0.0087**	**0.0082**	**0.0045 J**	**0.0055**	**0.0038**	**0.0032**	**0.0048**	**0.0027 J**	**0.0024 J**	**0.0018 J**	**0.0022 J**
Conventionals (%)																
Lipids, Total	**0.15**	**0.21**	**0.11**	**0.22**	**0.1**	**0.3**	**0.32**	**0.2**	**0.3**	**0.092**	**0.13**	**0.14**	**0.077**	**0.1**	**0.18**	**0.22**
Solids, Total	**23.9**	**23.3**	**22.7**	**15.4**	**17.3**	**20.8**	**17.7**	**25.3**	**23.9**	**14.8**	**13.1**	**14.1**	**18.7**	**13.4**	**14.1**	**16.8**

Notes:

Bold values are detected.

Non-detected values are reported at the Method Reporting Limit (MRL).

Appendix B-3. Sediment Grain Size Results

Grain Size (%)	SITE SAMPLES				REFERENCE SAMPLE
	PD-SD-01	PD-SD-02	PD-SD-03	PD-SD-04	RF-SD-01
Gravel, Medium	1.37	1.97	1.78	2.39	1.97
Gravel, Fine	13.5	10.6	9.86	11.1	4.97
Sand, Very Coarse	24.3	26.6	33.8	23.3	15.6
Sand, Coarse	23	19.2	26.6	21.7	17
Sand, Medium	16.9	15.7	11	17	22
Sand, Fine	15.6	16.2	6.18	15.4	26.2
Sand, Very Fine	1.23	0.19	0.22	1.38	0.38
Silt	1.6	7.56	7.22	5.1	8.99
Clay	1.88	2.49	2.47	2.78	2.8
Total fines	*3.5*	*10.1*	*9.7*	*7.9*	*11.8*

Notes:

Total fines were calculated by summing silt and clay values.

Appendix B-4. Sediment Analytical Results

Compound	Screening Levels	SITE SAMPLES				REFERENCE SAMPLE
	NOAA ERL[1]	PD-SD-01	PD-SD-02	PD-SD-03	PD-SD-04	RF-SD-01
Polychlorinated biphenyls (ug/kg)						
Aroclor 1016	-	6.7 U	7.3 U	5 U	5 U	6.9 U
Aroclor 1221	-	14 U	15 U	10 U	10 U	14 U
Aroclor 1232	-	6.7 U	7.3 U	5 U	5 U	6.9 U
Aroclor 1242	-	6.7 U	7.3 U	5 U	5 U	6.9 U
Aroclor 1248	-	6.7 U	7.3 U	5 U	5 U	6.9 U
Aroclor 1254	-	6.7 U	7.3 U	5 U	5 U	6.9 U
Aroclor 1260	-	6.7 U	7.3 U	5 U	5 U	6.9 U
Pesticides (ug/kg)						
2,4'-DDD	-	-	-	-	1 U	-
2,4'-DDE	-	-	-	-	1 U	-
2,4'-DDT	-	-	-	-	1 U	-
4,4'-DDD	-	0.67 U	0.73 U	0.74 U	**0.16 J**	0.69 U
4,4'-DDE	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
4,4'-DDT	-	0.67 U	0.73 U	0.74 U	1 U	**0.66 J**
Aldrin	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
alpha-BHC	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
alpha-Chlordane	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
beta-BHC	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Chlordane	-	-	-	-	10 U	-
Chlorpyrifos	-	-	-	-	1 U	-
cis-Nonachlor	-	-	-	-	1 U	-
delta-BHC	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Dieldrin	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Endosulfan I	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Endosulfan II	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Endosulfan Sulfate	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Endrin	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Endrin Aldehyde	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Endrin Ketone	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
gamma-BHC (Lindane)	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
gamma-Chlordane	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Heptachlor	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Heptachlor Epoxide	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Isodrin	-	-	-	-	1 U	-
Methoxychlor	-	0.67 U	0.73 U	0.74 U	1 U	0.69 U
Mirex	-	-	-	-	1 U	-
Oxychlordane	-	-	-	-	1 U	-
Toxaphene	-	34 U	37 U	37 U	50 U	35 U
trans-Nonachlor	-	-	-	-	1 U	-
Metals (mg/kg)						
Arsenic	7.24	**1.55**	**2.66**	**1.91**	**1.58**	**1.61**
Barium [2]	20	**18.3**	**30.7**	**6.71**	**23**	**6.31**
Cadmium	0.676	**0.646**	**0.822**	**0.091 J**	**0.073 J**	**0.697**
Chromium	52.3	**5.77**	**9.12**	**8.86**	**7.53**	**5.68**
Lead	30.24	**1.37**	**4.33**	**2.87**	**3.25**	**0.97**
Mercury	0.13	0.015 U	**0.011 J**	**0.013 J**	**0.013 J**	0.019 U

APPENDIX C

Data Review and Quality Assurance Report

DATA REVIEW AND QUALITY ASSURANCE REPORT

This report summarizes the review of analytical results for tissue and sediment generated from field sampling in August 2005 in Tanapag Harbor, Saipan. This review is performed according to the requirements of the *Sampling and Analysis Plan for Quantifying Pollution Impacts from Puerto Rico Dump on Coral Reef Fisheries in Tanapag Harbor, Saipan* (Ridolfi and NOAA 2005). This review does not constitute a data validation. Calibration and other raw data were not reviewed.

The samples were analyzed by Columbia Analytical Services, Inc., of Kelso, Washington. The laboratory provided deliverables in the USEPA Contract Laboratory Program (CLP) style for all sample delivery groups. Laboratory data deliverables are complete. Qualified analytical results are presented in Appendix B. Methods and numbers of analyses are presented below:

Analytical Group	Method	Tissue	Sediment
Pesticides	EPA 8081A	32	5
PCBs	EPA 8082	32	5
RCRA Metals			
Arsenic	EPA 200.8	32	5
Barium	EPA 200.8	32	-
Cadmium	EPA 200.8	32	-
Chromium	EPA 6010B	32	-
	EPA 200.8	-	5
Lead	EPA 200.8	32	-
Mercury	EPA 7471A	32	5
Selenium	EPA 200.8	32	
	EPA 7740	32	3
Silver	EPA 200.8	-	2
TOC	ASTM D4129-98M	-	5
Particle Size	ASTM D422 Modified	-	5

The samples were handled and delivered to the laboratory according to chain-of-custody procedure. The laboratory received the sample coolers on 8/19/05 and 8/20/05 at temperatures ranging from 3.5° C to 6.6° C, which meets the recommended holding temperature (4° C ± 2° C). The laboratory noted the sample cooler associated with delivery group K0503264 was opened by U.S. Customs for inspection and the custody seals were not intact. The samples were frozen on arrival at the laboratory and held at -20º C before extraction or preparation.

Data qualifiers applied are defined below:

U: The analyte was analyzed for but was not detected above the reported sample quantitation limit (i.e., method reporting limit).

J: The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

POLYCHLORINATED BIPHENYLS ANALYSIS (PCBS) – USEPA Method 8082

Review Summary

Documentation, Custody, Holding Times	Acceptable
Method Blank	Acceptable (no analytes detected)
Surrogate Compound Performance	Acceptable
MS/MSD Analyses	Acceptable
Laboratory Control Sample	Acceptable
Field Replicates	None
Overall Assessment	Data quality sufficient for the intended use

Sample Holding Times: All samples were extracted within 25 days of collection and analyzed within 19 days of extraction, which is in accordance with regional guidance of one year for a holding time for frozen sample material.

Method Blank: One method blank was analyzed for each matrix, as specified, and no analyte responses are reported.

Surrogate Compound Performance: A surrogate compound was added to the project samples and laboratory QC samples prior to analysis to assess analytical performance. The surrogate compound is identified as decachlorobiphenyl. Surrogate performance is evaluated against laboratory-established limits for PCB analysis. Surrogate recoveries are within the specified limits for both samples, with the exception of tissue sample RF-EF-01-02 (23%R vs. lower limit of 37%R). No positive hits are reported for this sample and no action is taken.

Matrix Spike/Matrix Spike Duplicate Analyses: One or more MS/MSD analyses were performed per extraction batch. All matrix spike recoveries are within laboratory-specified control limits.

Laboratory Control Samples: One or more spiked blanks (LCS) were analyzed for pesticide target compounds per extraction batch. Performance is evaluated against laboratory-established limits. Recoveries are acceptable for all analyses.

Field Replicates: None

Overall Assessment: Overall analytical performance is considered acceptable, and data quality is sufficient for the intended use.

PESTICIDE ANALYSIS – USEPA Method 8081A

Review Summary

Documentation, Custody, Holding Times	Acceptable
Method Blank	Acceptable (no analytes detected)
Surrogate Compound Performance	Acceptable
MS/MSD Analyses	Acceptable
Laboratory Control Sample	Acceptable
Field Replicates	None
Overall Assessment	Data quality sufficient for the intended use

Sample Holding Times: All samples were extracted within 25 days of collection and analyzed within 31 days of extraction, which is in accordance with regional guidance of one year for a holding time for frozen sample material.

Method Blank: One or more method blanks were analyzed per analytical batch and no analyte responses are reported above method reporting limits.

Surrogate Compound Performance: Surrogate compounds were added to the project samples and laboratory QC samples prior to analysis to assess analytical performance. The surrogate compounds are identified as decachlorobiphenyl and tetrachlorometaxylene. Surrogate performance is evaluated against laboratory-established limits. Surrogate recoveries are within the specified limits for all analyses, with the exception TMX for the sediment sample PD-SD-01 (34%R vs. lower limit of 38%R). DCB recovery was acceptable for the sample; thus, no action was taken.

Matrix Spike/Matrix Spike Duplicate Analyses: One or more MS/MSD analyses were performed per extraction batch. All matrix spike recoveries are within laboratory specified control limits with the following exceptions:

Isodrin:	Sea cucumber tissue MS and MSD (PD-SC-03-01) 64%/58%R vs. 70%R lower limit – exception is minor, no positive hits, no action taken.
Isodrin:	Emperor fish tissue MS and MSD (RF-EF01-03) 67%/64%R vs. 70%R lower limit – exception is minor, no positive hits, no action taken.
Chlorpyrifos:	Sea cucumber tissue MS and MSD (PD-SC-03-02) 61%/62%R vs. 70%R lower limit – exception is minor, no positive hits, no action taken.
Chlorpyrifos:	Sea cucumber tissue MS and MSD (PD-SC-03-02) 55%/57%R vs. 70%R lower limit – exception is minor, no positive hits, no action taken.
Chlordane:	Sea cucumber tissue MSD (PD-SC-02-01) 69%R vs. 70%R lower limit – exception is minor, no positive hits, no action taken.

Laboratory Control Samples: One or more spiked blanks (LCS) were analyzed for pesticide target compounds per extraction batch. Performance is evaluated against laboratory-established limits. Recoveries are acceptable for all analyses.

Compound Identification: The "P" flag applied to results by the laboratory indicates that the RPD between the primary column result and the confirmation column result was >40%. These results have been qualified as "J."

Field Replicates: None

Overall Assessment: Overall analytical performance is considered acceptable and data quality is sufficient for the intended use.

RCRA METALS – USEPA METHODS 200.8, 6010B, 7471A, 7740

Review Summary

Documentation, Custody, Holding Times	Acceptable
Preparation Blank	Acceptable (no analytes detected)
MS Analyses	Acceptable as qualified
Duplicate Analyses	Acceptable as qualified
Laboratory Control Sample	Acceptable
Field Replicates	None
Overall Assessment	Data quality sufficient for the intended use

Sample Holding Times: All samples were analyzed within 64 days of collection, which is in accordance with regional guidance of one year for a holding time for frozen sample material. All sediment samples were analyzed for mercury within 28 days, per USEPA CLP guidance.

Preparation Blank: One or more preparation blanks were analyzed per preparation batch and no analyte responses are reported above method reporting limits.

Matrix Spike Analysis: One or more matrix spike analyses were performed per preparation batch. All matrix spike recoveries are acceptable (75–125%R) with the following exception:

- Chromium: Sea cucumber tissue (PD-SC-04-01) 44%R – nine associated results qualified as "J."

Laboratory Duplicate Analysis: One or more duplicate analyses were performed per analytical batch. Duplicate relative percent differences (RPDs) are within ±30% (laboratory criteria) with the following exception:

- Hg: Sediment (PD-SD-04) 49% RPD; associated batch duplicate is acceptable; only PD-SD-04 qualified as "J."

Laboratory Control Samples: For tissue, NRCC reference materials DOLT-2 and DORM-3 were analyzed per analytical batch. For sediment, ERA reference material #246 was analyzed per analytical batch. Recoveries are within advisory limits for all analyses with the exception of one lead result in one analysis of DOLT-3. Since the lead result for DORM-3 for this batch is acceptable, no associated results are qualified.

Field Replicates: None

Overall Assessment: Overall analytical performance is considered acceptable and data quality is sufficient for the intended use.

TOTAL ORGANIC CARBON – ASTM D4129-98M

Review Summary

Documentation, Custody, Holding Times	Acceptable
Preparation Blank	Acceptable (no analytes detected)
MS Analyses	Acceptable
Duplicate Analyses	Acceptable
Laboratory Control Sample	Acceptable
Field Replicates	None
Overall Assessment	Data quality sufficient for the intended use

Sample Holding Times: All sediment samples were analyzed within 32 days of collection, which is in accordance with regional guidance of one year for a holding time for frozen sample material.

Method Blank: One method blank was analyzed per analytical batch and no analyte responses are reported above method reporting limits.

Matrix Spike Analysis: One matrix spike analysis was performed per preparation batch. All matrix spike recoveries are within laboratory specified control limits (75–125%R) and are considered acceptable.

Laboratory Duplicate Analysis: One duplicate analysis was performed per analytical batch. Duplicate RPDs range from 3% to 6% and are considered acceptable

Laboratory Control Samples: One laboratory control sample was analyzed per preparation batch. All results are within laboratory-specified control limits (85–115%R) and are considered acceptable.

Field Replicates: None

Overall Assessment: Overall analytical performance is considered acceptable and data quality is sufficient for the intended use.

PARTICLE SIZE – ASTM D422 Modified

Review Summary

Documentation, Custody, Holding Times	Acceptable
Duplicate Analyses	Acceptable
Overall Recovery	Acceptable
Field Replicates	None
Overall Assessment	Data quality sufficient for the intended use

Laboratory Duplicate Analysis: One duplicate analysis was performed per analytical batch. Qualitative review of duplicate results shows good comparison between recoveries for individual size classes, including coarser fractions.

Overall Recovery: Overall recovery is greater than 99% by weight and is acceptable.

Field Replicates: None

Overall Assessment: Overall analytical performance is considered acceptable and data quality is sufficient for the intended use.