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EXTENDED SITE INSPECTION REPORT FOR CAUSEWAY LANDFILL SITE 3 WITH TRANSMITTAL LETTER MCRD PARRIS ISLAND SC
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ABB ENVIRONMENTAL SERVICES INC

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EXTENDED SITE INSPECTION REPORT
CAUSEWAY LANDFILL

MARINE CORPS RECRUIT DEPOT
PARRIS ISLAND, SOUTH CAROLINA

CONTRACT TASK ORDER NO. 033
NAVY CLEAN - DISTRICT I
CONTRACT NO. N62467-89-D-0317

AUGUST 1993

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

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8/30/93

August 24, 1993

Ms. Kathy Williams
South Carolina Department of Health and Environmental Control
Solid and Hazardous Waste
2600 Bull Street
Columbia, South Carolina 29201

Subject: Final Extended Site Inspection (ESI) Report for the Marine Corps Recruit Depot (MCRD), Parris Island, South Carolina

Dear Ms. Williams:

The following Final Extended Site Inspection (ESI) Report, prepared by ABB Environmental Services, Inc. is submitted on behalf of the U.S. Navy at Southern Division, Naval Facilities Engineering Command and the Marine Corps Recruit Depot (MCRD) at Parris Island, South Carolina.

This Final ESI Report presents the results of an Extended Site Inspection conducted to evaluate whether the consumption of fish and shellfish caught by recreational fisherman in the vicinity of the Causeway Landfill at MCRD poses a risk to human health. Mr. Hansel can be reached at (803) 743-0615 should you have any questions.

Sincerely,

ABB ENVIRONMENTAL SERVICES, INC.

Tracy W. Stenner

Tracy W. Stenner
Task Order Manager

Enclosures (9 copies)

cc: W. Hansel

TWS/law

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EXTENDED SITE INSPECTION REPORT
CAUSEWAY LANDFILL

MARINE CORPS RECRUIT DEPOT
PARRIS ISLAND, SOUTH CAROLINA

Contract No. N62467-89-0-0317

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August 1993

FOREWORD

The Department of the Navy developed the Navy Installation Restoration (IR) program to identify, assess, and clean up or control environmental contamination from past hazardous waste disposal operations and hazardous material spills at Navy and Marine Corps installations. The Navy IR program is a component of the Defense Environmental Restoration Program, which is codified in Superfund Amendments and Reauthorization Act (SARA) Section 211.

The Navy IR program uses a six-phase approach to manage past disposal sites. Phase I, the Preliminary Assessment (PA), consists of collecting and reviewing all available evidence of contamination that may pose a potential threat to human health or the environment. Phase II, the Site Inspection (SI), augments data collected in the PA through sampling and field data to determine if further investigation is required. Phase III, the Remedial Investigation (RI), is a field effort to collect sufficient information to characterize sites for development and evaluation of remedial responses. Phase IV, the Feasibility Study (FS), involves selecting remedial alternatives based on cost, environmental effects, and engineering feasibility. Phase V, the Remedial Design (RD), includes design of remedial technologies selected in the FS. Phase VI, the Remedial Action (RA), implements the RD.

This report outlines the results of an Extended Site Inspection (ESI) at the Marine Corps Recruit Depot (MCRD), Parris Island, South Carolina. Questions regarding this report should be address to the Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) Engineer-in-Charge, Wayne Hansel, at (803) 743-0615.

EXECUTIVE SUMMARY

This Extended Site Inspection (ESI) was conducted to evaluate whether the consumption of fish and shellfish caught by recreational fishermen in the vicinity of the Causeway Landfill at the Marine Corps Recruit Depot (MCRD) Parris Island, South Carolina, poses a risk to human health. Fish and shellfish commonly harvested in the area were sampled and analyzed to determine if tissue levels exceeded action levels established by the U.S. Food and Drug Administration (USFDA).

The Causeway Landfill is approximately 0.8-mile long and connects Parris Island and Horse Island at MCRD. It is a 10-acre area about 10 feet high and 60 feet across with a 2-lane gravel road along the center. It was constructed from solid waste, other debris, fill dirt, and reportedly, hazardous wastes across the tidal marsh of the Broad River and Ribbon Creek and was the major MCRD disposal area between 1960 and 1972. In 1975, culverts and tidal locks were installed to improve circulation through the sides of the causeway. Fishing piers were also constructed on the pond side of the causeway and these are actively used by recreational fishermen, although the area is not used for shellfishing.

Previous investigations at the Causeway Landfill indicated that although leaching of contaminants from the causeway was likely, surface water and sediment samples analyzed for priority pollutants, (volatile organic compounds, acid and base-neutral extractable organics including polychlorinated biphenyls (PCBs) and pesticides, total metals, and extraction procedure (EP) toxicity metals) suggested that no further study was necessary because no significant contamination was found in either medium. However, based on requests from the U.S. Environmental Protection Agency (USEPA) and the South Carolina Department of Health and Environmental Control (SCDHEC), the current study was undertaken to determine if tissue contaminant levels exceeded USFDA action levels thereby indicating a risk to human health.

The KEMRON Environmental Services, Inc. (KEMRON), 1990 workplan was modified slightly for this study to apply appropriate sample matrices that would allow the data to be readily compared with available regional and State data. The number of samples proposed was also increased to provide additional data so that a specific comparison of results from the pond and tidal creek sides of the causeway could be completed. During the period November 20 to 25, 1991, fish and shellfish were collected on both sides of the Causeway Landfill and shipped to the laboratory for analysis. Striped mullet, summer flounder, blue crab, hard clams, and American oyster were sampled providing tissue samples for a wide range of trophic levels and feeding guilds. The results of the laboratory analysis of these tissue samples indicated that the observed levels of tissue contaminants were well below USFDA action levels, although these are only available for a few selected chemicals. However, a review of the applicability of these USFDA action levels determined that they are designed to protect the public from fish shipped in commercial commerce and reflect a balance between adverse risk from fish consumption and economic impacts on fisheries that may result from an advisory or closure. These action levels may not be adequately protective for the recreational fishermen at the Parris Island Causeway Landfill.

ACKNOWLEDGMENTS

ABB Environmental Services, Inc. (ABB-ES), would like to acknowledge the support provided by the Morale, Welfare, and Recreation Department at the Marine Corps Recruit Depot. The Marina Manager, Mr. Pete Dawson, provided substantial assistance with sampling efforts and logistic support that contributed significantly to the efficiency and effectiveness of this study as well as to the safety of the sampling team. Mr. Dawson's extensive knowledge of local fisheries and environmental conditions was invaluable and we sincerely appreciate his assistance. ABB-ES would also like to thank Mr. Gary Duke at MCRD for his assistance with scheduling.

The South Carolina Department of Health and Environmental Control and the National Oceanic and Atmospheric Administration also provided valuable comparative data from their respective monitoring programs. We would also like to thank the many people at the SOUTHNAVFACENGCOM who cooperated to make the successful completion of this study possible.

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Parris Island, South Carolina

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action Navy
CTO	Contract Task Order
CVAA	Cold vapor atomic absorption
DBOFB	Dibromo-octafluorobiphenyl
DCM	Methylene chloride
DDD	dichlorophenyl dichloroethane
DDE	dichlorophenyl dichloroethylene
DDT	dichlorophenyl trichloroethane
DOD	Department of Defense
EIC	Engineer-in-Charge
EMAP	Environmental Monitoring and Assessment Program
EP	Extraction procedure
ESI	Extended Site Inspection
g	gram
GC/ECD	Gas chromatography and electron-capture detection
GS/MS	Gas chromatography with mass spectrometry
HPLC	High-performance liquid chromatography
IAS	Initial Assessment Study
IR	Installation Restoration
KD	Kuderna-Danish
KEMRON	KEMRON Environmental Services, Inc.
m	meter
MCRD	Marine Corps Recruit Depot
MDL	Method detection limit
$\mu\ell$	microliter
$\mu g/g$	micrograms per gram
$\mu g/kg$	micrograms per kilogram
NACIP	Naval Assessment and Control of Installation Pollutants
NEESA	Naval Energy and Environmental Support Activity
ng/g	nanograms per gram
NOAA	National Oceanic and Atmospheric Administration
NST	National Status and Trends

GLOSSARY (Continued)

PAHs	Polynuclear aromatic hydrocarbons
PB	Procedural blank
PCBs	Polychlorinated biphenyls
ppb	pounds per billion
ppm	pounds per million
QA	Quality Assurance
QC	Quality Control
QRAC	Quantitative Risk Assessment Committee
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RIS	Recovery internal standard
SARA	Superfund Amendments and Reauthorization Act
SCDHEC	South Carolina Department of Health and Environmental Control
SOUTHNAVFAC-ENGCOM	Southern Division of Naval Facility Engineering Command
ΣDDT	Sum of DDT, DDD, and DDT compounds
ΣPAH	Sum of PAH compounds
ΣPCBs	Sum of PCB congeners
SIM	Selected ion monitoring
SIS	Surrogate internal standards
SOPs	Standard operating procedures
SRM	Standard reference material
TCMX	Tetrachloro-m-xylene
TCN	Tetrachloronaphthalene
USEPA	U.S. Environmental Protection Agency
USFDA	U.S. Food and Drug Administration
VOCs	Volatile organic chemicals

1.0 INTRODUCTION

1.1 BACKGROUND. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) program for evaluating and remediating problems related to releases and disposal of toxic and hazardous material at DOD facilities. The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR program for all Naval and Marine Corps facilities. The NACIP program was originally conducted in three phases: (1) Phase I, Initial Assessment Study (IAS), (2) Phase II, Confirmation Study (including a Verification Step and Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR program was modified in 1987 and 1988 to be consistent with CERCLA and SARA. The updated nomenclature for the Remedial Investigation/Feasibility Study (RI/FS) process is as follows:

- Preliminary Assessment and Site Inspection
- Remedial Investigation
- Feasibility Study
- Planning and Implementation of Remedial Design

In addition to these programs, military installations are subject to regulations promulgated by the 1976 Resource Conservation and Recovery Act (RCRA) and the 1986 Hazardous and Solid Wastes Act. Southern Division of Naval Facility Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for enforcement of the Navy IR program in the southeastern United States.

As a component of the IR program, two previous investigations were performed to assess potential threats to human health at the Causeway Landfill on the Marine Corps Recruit Depot (MCRD), Parris Island, South Carolina. These investigations included the 1985 IAS (Naval Energy and Environmental Support Activity [NEESA], 1986) and the 1990 Verification Study (NEESA, 1988). The history of the Causeway Landfill and environmental investigation is shown in Table 1-1. The IAS concluded that leaching of contaminants from the site into adjacent marsh areas was likely, due to tidal flushing of the filled materials (NEESA, 1986). The IAS was the functional equivalent of a CERCLA preliminary assessment. Subsequent surface water (eight samples) and sediment sampling (eight samples) along the causeway during the Verification Study in 1988 (now termed Site Inspection) suggested that no further study of the site was necessary because no significant contamination was detected in either medium. The sediment samples were analyzed for priority pollutants including volatile organic compounds (VOCs), acid and base-neutral extractable organics including polychlorinated biphenyls (PCBs) and pesticides, total metals, and extraction procedure (EP) toxicity metals. Surface water samples were analyzed for similar parameters. The results of these assays indicated that no priority pollutant VOCs were detected in either medium. In addition, heavy metal concentrations did not exceed U.S. Environmental Protection Agency (USEPA) ambient saltwater criteria or USEPA Drinking Water Standards. However, the USEPA and South Carolina Department of Health and Environmental Control (SCDHEC) asked that an additional study at the site be conducted. Because waters around the Causeway Landfill are used for recreational and/or subsistence fishing, an Extended Site Inspection (ESI) was recommended to determine if humans

Table 1-1
Site History

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Dates	Activity
1960 - 1966	Causeway Landfill was the major recipient of solid waste generated by MCRD.
1966 - 1968	Causeway Landfill was inactive
1969 - 1972	Causeway Landfill received all of the MCRD's solid waste as well as incidental hazardous wastes or materials.
1972	Completion of the Causeway Landfill across the marsh
1975	Culverts and locks installed at two locations to partially reconnect the impounded area pond with the estuary via tidal creeks.
1985	Initial Assessment Study (IAS)
1988	Verification Study including surface water and sediment sampling
1990	KEMRON prepared workplan for Extended Site Inspection (ESI)
1991	ABB-ES contracted under CLEAN CTO No. 33 to conduct ESI
November 1991	Field sampling of fish and shellfish from waters adjacent to the Causeway Landfill.

Notes: MCRD = Marine Corps Recruit Depot.
KEMRON = KEMRON Environmental Services, Inc.
ABB-ES = ABB Environmental Services, Inc.
CLEAN = Comprehensive Long-Term Environmental Action, Navy.
CTO = contract task order.

consuming fish and shellfish from the water surrounding the causeway are at risk. In 1990, KEMRON Environmental Services, Inc. (KEMRON), prepared a workplan for such a study.

ABB Environmental Services, Inc. (ABB-ES), was contracted under the Comprehensive Long-term Environmental Action, Navy (CLEAN) contract (contract number N62467-89-D-0317, Contract Task Order Number 33 [CTO No. 033]) to conduct an ESI at the Causeway Landfill by (1) sampling selected biota, (2) analyzing tissue samples, and (3) preparing an ESI report summarizing the data and evaluating any potential risk to public health from the consumption of fish and shellfish by comparing detected concentrations with the U.S. Food and Drug Administration (USFDA) action levels.

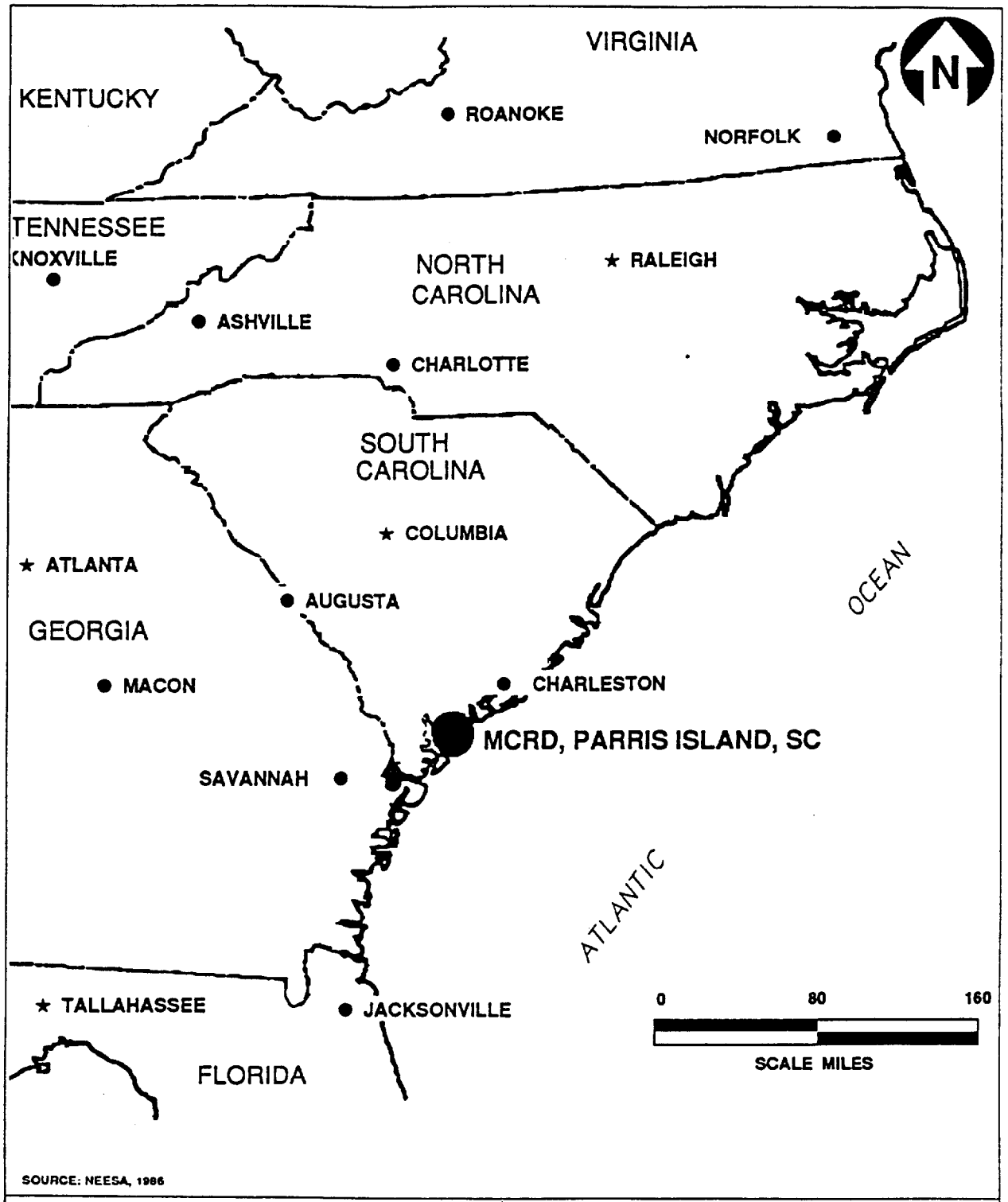
1.2 SITE DESCRIPTION. MCRD Parris Island is located 1 mile south of the city limits of Port Royal and about 3 miles south of the City of Beaufort, in the southeastern corner of South Carolina (Figure 1-1). The MCRD consists of 8,047 acres, of which 3,274 acres are dry land, 4,344 acres are salt marsh, and 429 acres are saltwater creeks and ponds (NEESA, 1986).

The Causeway Landfill, also referred to as Site 3, is located at the MCRD, Parris Island, South Carolina. The Causeway Landfill site is approximately 0.8-mile long and connects Parris Island and Horse Island (Figure 1-2). At its completion, the Causeway Landfill consisted of a 10-acre area approximately 10-feet high. A two-lane gravel road was constructed along the center of the Causeway. The Causeway was constructed of solid wastes and fill dirt across the tidal marsh of the Broad River and Ribbon Creek and was the major Depot disposal area between 1960 and 1972. Between 1969 and 1972, the site received all the MCRD's solid wastes. In addition to trash, other solids and reported hazardous wastes were potentially disposed at the Causeway via MCRD dumpsters and trash cans (Table 1-2). Wastes remaining uncovered during daily causeway construction activities were burned each night.

Upon completion of the causeway, the area between the causeway and Scout Island became a saltwater impoundment. To improve drainage and control of water height and flow from the pond to Broad River, culverts and locks were installed through the sides of the causeway in 1975. At the time of excavation and installation of the culvert, only typical domestic trash was encountered (NEESA, 1986).

1.3 PURPOSE. The results of the 1986 IAS conducted at the Causeway Landfill suggested that leaching of contaminants from the site into the adjacent marsh areas was likely because of tidal flushing of the filled materials (NEESA, 1986). Based on the results of the Verification Study, it was recommended that no further study of the site was necessary because no significant contamination (i.e., contaminants in surface water were below USEPA criteria) was detected in either surface water or sediment. However, USEPA and SCDHEC requested an additional study at the site to evaluate possible uptake and bioconcentration by aquatic biota subject to potential human consumption.

As part of the ESI, a field sampling program was conducted in November 1991 to collect aquatic biota from the marsh areas adjacent to the Causeway Landfill. Marine and estuarine animals were collected from four general locations at the Causeway including the waters adjacent to the two fishing piers (P1 and P2) on the pond side of the causeway, and the waters adjacent to the tide gates (TG1 and TG2) that are directly opposite each of the piers on the other side of the



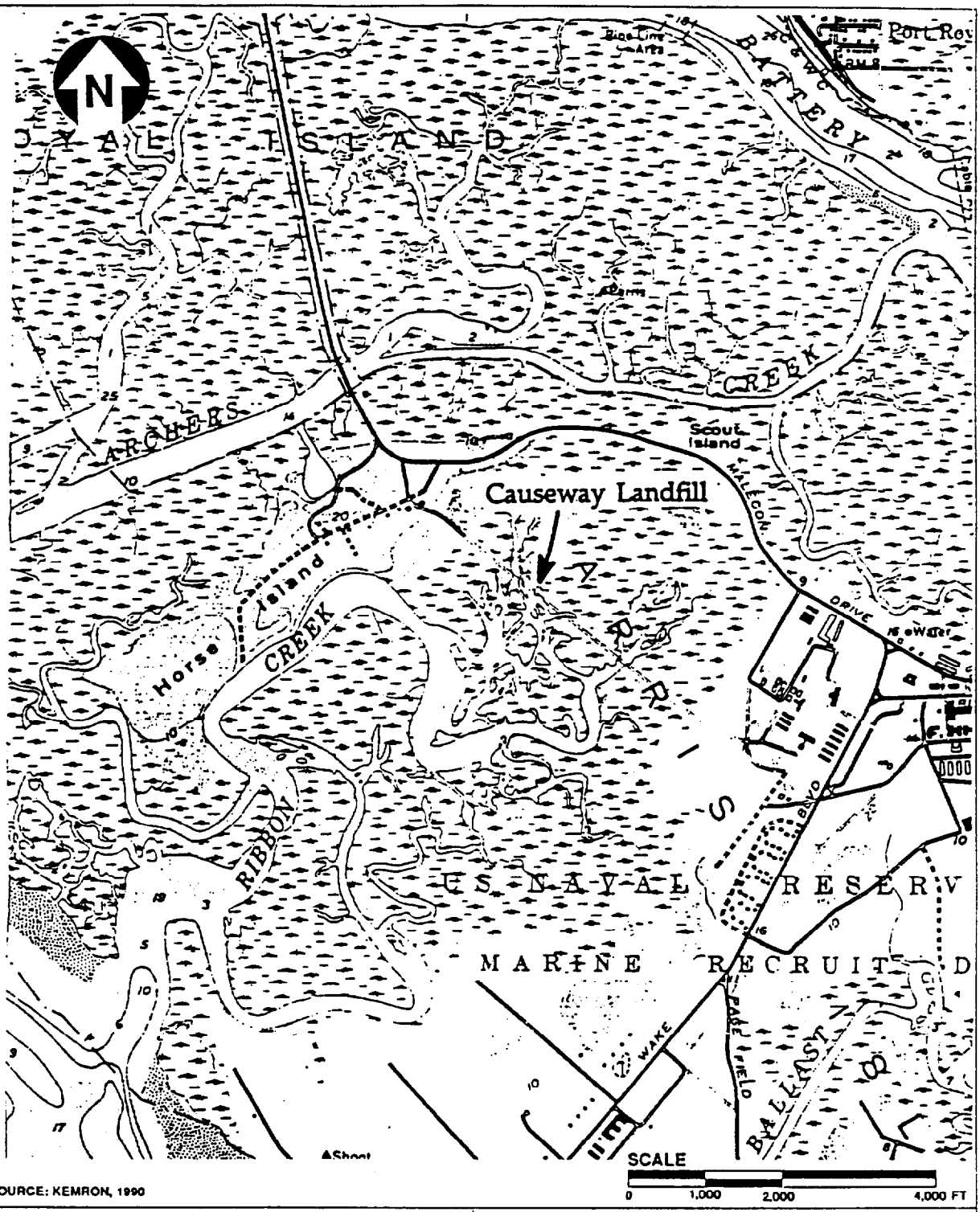
SOURCE: NEESA, 1986

FIGURE 1-1

GENERAL LOCATION OF THE MARINE CORPS RECRUIT DEPOT

EXTENDED SITE INSPECTION

MARINE CORPS RECRUIT DEPOT
CAUSEWAY LANDFILL,
PARRIS ISLAND,
SOUTH CAROLINA



SOURCE: KEMRON, 1990

FIGURE 1-2

SITE LOCATION

EXTENDED SITE INSPECTION

MARINE CORPS RECRUIT DEPOT
CAUSEWAY LANDFILL,
PARRIS ISLAND,
SOUTH CAROLINA

Table 1-2
Summary of Waste Deposited at Causeway Landfill (1960-1972)

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Waste Types	Estimated Totals	Source
Domestic trash	50,000 tons	Entire depot
Construction debris	Unknown	Unknown
Solid paint wastes[1]	28.2 tons	Paint shop
Empty pesticide containers	20,000	Pest control shop
Cleaning rags[2]	3 tons	Garages and shops
Spent absorbent	2 tons	Automobile hobby shops
Solvent sludge[3]	32 pounds	Automobile hobby shops
Perchloroethylene still bottoms	5,600 gallons	Dry cleaning plant
Mercury amalgam	2 tons	Dental clinic
Beryllium waste	3 pounds	Dental clinic
PCB-contaminated oil	15 pounds	Electrical shop

Source: NEESA, 1986.

[1] Solid paint wastes consist of used brushes, rollers, rags, cans, and spray booth scrapings and skimmings.
[2] Cleaning rags contaminated with oil, mineral spirits, and kerosene.
[3] Solvent consisted of equal amounts of aliphatic petroleum and chlorinated solvent compounds.

Note: PCB = polychlorinated biphenyls.

causeway (Figure 1-3). Upon completion of the field work, biological tissues were analyzed for inorganic compounds (mercury), organic polynuclear aromatic hydrocarbons (PAHs), PCBs, and pesticides. These analyses were selected based on the types of constituents potentially present at the site, (i.e., present in the causeway fill material), their persistence, and their tendency to biomagnify.

The purpose of this report is to present the results of the field sampling and laboratory analyses conducted as part of the ESI study and to compare these results to existing USFDA action levels and to data for other reference areas in the region where historic data are available to assess the potential risks to recreational fishermen.

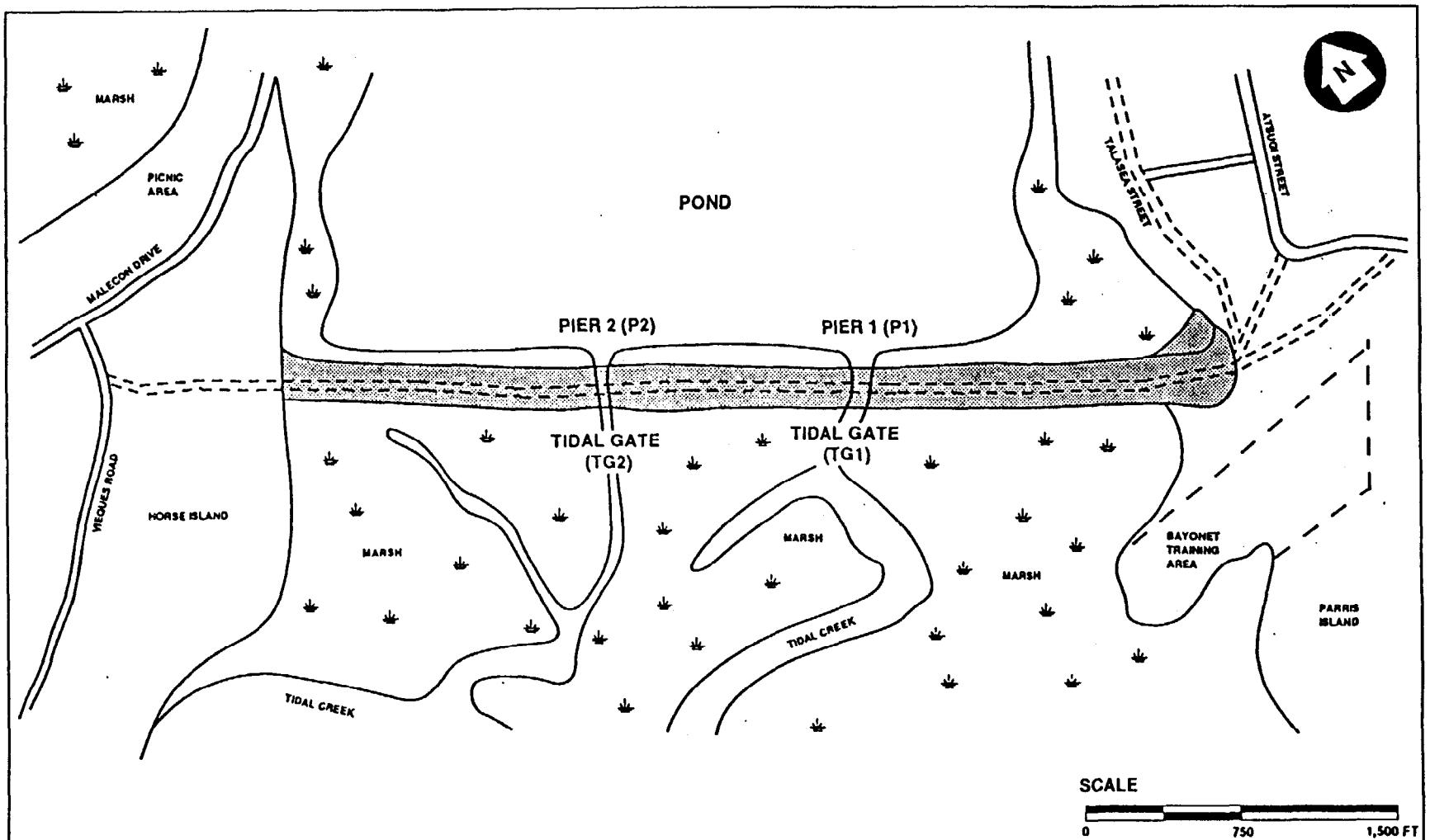


FIGURE 1-3

SAMPLING LOCATIONS

EXTENDED SITE INSPECTION

MARINE CORPS RECRUIT DEPOT
CAUSEWAY LANDFILL,
PARRIS ISLAND,
SOUTH CAROLINA

FIGURE DERIVED FROM NEESA 13-094, 1986

2.0 TECHNICAL APPROACH

This study was conducted, in general, according to the workplan developed by KEMRON (1990) entitled, *Extended Site Inspection Workplan, The Causeway Landfill, MCRD, Parris Island, South Carolina.* Because both USEPA and SCDHEC had previously reviewed and approved this workplan, ABB-ES was directed to follow this workplan to carry out the ESI. The following subsections describe the sampling plan (including any changes to KEMRON's Workplan). The actual locations of samples collected were finally determined by the temporal and spatial availability of target species and limited site access related to tidal conditions, boat availability, restrictions due to use of the firing range, and the presence of endangered or threatened species that precluded the use of an outboard motor on the pond side. In each case, samples were collected as close as possible to the four stations originally proposed (Figure 1-3).

Field collection methods used to collect each species of fish and shellfish and laboratory analytical methods used to measure chemical concentrations in tissues are also described. Tissue sampling preparation and laboratory analysis for each class of compounds (i.e., PAHs, PCBs, pesticides, and mercury) are described in Section 2.2

2.1 SAMPLING PLAN. As outlined in KEMRON's workplan, six species were proposed for collection and analysis: mullet, crabs, clams, oysters, shrimp, and an additional fish species (if available). These species were selected because they represent the primary species harvested in the local area for human consumption. These species also represent different food webs and trophic levels and, therefore, provide a broad range of biological indicators.

Based on a site visit conducted by ABB-ES on July 10 and 11, 1991, as well as subsequent discussions with the Engineer-in-Charge and the analytical laboratory, the KEMRON workplan was slightly modified. The workplan was modified only where it could easily be changed to provide useful data without requiring additional review. Changes to the workplan included: identifying sampling locations, increasing the number of field samples and quality control samples, and specifying more appropriate laboratory analyses for the study.

KEMRON's workplan did not specify sampling locations except to say that samples would be taken on each side of the causeway. Four specific sampling locations (P1, P2, TG1, and TG2) were proposed by ABB-ES (see Figure 1-3). These locations were identified because they represent the areas where most fishing occurs. These four locations would also permit possible discrimination of contamination among these locations. The revised sampling plan partitioned the site into four general sampling areas, and added a field replicate and quality control samples. The revised sample matrix is presented in Table 2-1.

As part of the project planning process, a scientific collection permit (No. 0502, dated October 21, 1991) was obtained from the South Carolina Wildlife and Marine Resources Department to conduct fish and shellfish sampling in the waters surrounding the Causeway Landfill. Also, information on other sampling programs e.g., State of South Carolina and National Oceanic and Atmospheric Administration [NOAA]) was collected for comparison with the ESI study results.

Table 2-1
Planned Number of Samples to be Collected and Analyzed

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Species	Sample Location[1]				FR[2]	QC[3]	Total
	P1	P2	TG1	TG2			
Fish[4]							
Muscle	3	3	3	3	1	7	24
Liver	3	3	3	3	1	7	24
Mullet							
Muscle	3	3	3	3	1	7	24
Liver	3	3	3	3	1	7	24
Crab	4	4	4	4	1	7	28
Clam	4	4	4	4	1	7	28
Oyster	4	4	4	4	1	7	28
Shrimp	4	4	4	4	1	7	28
						Total	208

[1] P1 = Pier 1, P2 = Pier 2, TG1 = Tide Gate 1, and TG2 = Tide Gate 2.
[2] FR = field replicate if sufficient sample material can be collected.
[3] QC = quality control samples proposed include procedural blanks, matrix spike, and standard reference materials.
[4] One additional recreationally important fish will be collected depending on capture rates.

2.2 FIELD SAMPLING METHODS. Fish and shellfish samples were collected as close as practicable to the four stations identified in the Plan of Action for this task order (Figure 1-3); one by each fishing pier (P1 and P2) on the pond side and one by each tide gate (TG1 and TG2) on the marsh side of the causeway. These stations, particularly P1 and P2, were close to the areas subject to the greatest fishing pressure.

2.2.1 Fish Sampling Methods A variety of fishing gear was used to collect biological samples for tissue analysis (Table 2-2). Gear was selected based on target species behavior or habitat as well as the results of a preliminary site visit conducted to clarify site conditions and logistical constraints.

Table 2-2
Summary of Sampling Gear Used to Collect Fish and Shellfish

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Gear Type	Target Species					
	Mullet	Fish	Crab	Clam	Oyster	Shrimp
Gill net[1]	X	X	X			
Cast net[2]	X	X	X			X
Crab trap[3]			X			
Trot line[4]			X			
Rake				X	X	
Hand					X	

[1] The gill nets used were experimental gill nets with stretched mesh size ranging from 1.5 to 4 inches. Gill nets were deployed to minimize by-catch, avoid interference with anglers, and to minimize entanglement by diving birds.
[2] An 8-foot (mullet) and a 6-foot (shrimp) cast net were used.
[3] Crab traps were a standard local variety of vinyl-coated wire.
[4] Trot lines were simple baited hooks used locally for crabs.

Fish were collected using experimental gill nets and cast nets. Two experimental V (variable mesh size) gill nets were fabricated from five, 15-by-6 foot panels of 1.5-, 2-, 3-, 3.5- and 4-inch stretched monofilament net. The two cast nets used included a 6-foot diameter shrimp net and an 8-foot diameter mullet net. The cast nets were deployed either from the pier or from a small johnboat. Gill nets were deployed from the small johnboat, anchored in place, and marked with floats.

Gill nets were deployed about 100 feet from each pier on the pond side of the causeway parallel to the shore in order to avoid interference from recreational cast nets and angling gear. Gill nets were not deployed in the tidal creeks due to hangs (snags), limited access, and tidal conditions. Cast nets were used primarily from boats at high tide on the tide gate side where oyster beds and rubble prevented deployment of cast nets from the tide gates, and made deployment of gill nets difficult. Cast nets were deployed on the tide gate side starting at the gate or as close to the gate as the boat could reach and moved outward until either the sample was collected or collection efforts were limited by tide,

daylight, or boat availability. Cast nets were also cast on the pond side from the fishing piers. Striped mullet (*Mugil cephalus*) were collected with both cast nets and experimental gill nets. Mullet were available on both sides of the causeway.

Based on the results of the first few gill net deployments on the pond side, the summer flounder (*Paralichthys dentatus*) was selected as a second fish species to be collected. Flounder were selected because they were present in sufficient numbers on the pond side, are likely to be resident in the pond for considerable periods of time, are high on the food chain (likely to bioaccumulate contaminants), and are targeted by local fishermen. Summer flounder was the only large predatory fish captured in any number (sufficient numbers of other fish species were not available). Despite considerable effort, only one specimen was caught on the tidal creek side. Summer flounder are probably only marginally vulnerable to cast nets due to high burst speed swimming behavior.

2.2.2 **Shellfish Sampling Methods** Shellfish samples of crustaceans and mollusks included blue crabs, hard clams, and American oysters. Shrimp were not available in sufficient abundance during the sampling period due to declining water temperatures and either reduced activity or migration to deeper waters. White shrimp (*Penaeus setiferus*) are very susceptible to low temperatures (Anderson and Lunz, 1965).

Blue crabs (*Callinectes sapidus*) were fished using gill nets, cast nets, crab traps, and trot lines (baited hooks). Crabs were collected on the pond side from the gill nets deployed about 100 feet from P1 and P2. Because gill nets could not be readily deployed on the tidal creek side of the causeway, efforts were made to use trot lines and traps in proximity to TG1 and TG2 and additional efforts were made at both tidal streams on the tidal creek side using cast nets.

Hard clams (*Mercenaria mercenaria*) were collected using a four-tined long handle rake or shorter three-tined short handled garden tool. Efforts were initially directed at the sample stations; however, based on lack of sampling success these efforts were extended outward from the proposed sample stations to those areas having indications of clams (shell, siphon evidence, or appropriate habitat conditions).

American oysters (*Crassostrea virginica*) were collected using either a long-handled, four-tined hand rake, three-tined short handled garden tool, or by hand, depending on the habitat. The tide gate stations had some hard substrate in proximity to the gates; however, beyond the gates oysters were found on mud flats or shell banks. On the pond side, oysters were removed by hand from hard, rubble substrate near the causeway. Oysters were found in the intertidal habitats on the tidal creek side of the landfill and subtidally on the pond side of the causeway.

Sampling for shrimp was limited to cast nets deployed either from the fishing piers, tide gate structures, or from a small Johnboat deployed in the pond or tidal streams. The soft, "quicksand-like" composition of mud on the tidal creek side made it impossible to sample from shore on the tidal creek side of the causeway. Shrimp were not collected during this field effort.

Procedures used for sample collection, handling, and shipping are included in Appendix A-1. A complete data package including all field and laboratory chain-

of-custody forms are contained in the project files. The only variance with these procedures was the storage of samples at the base ice house until Monday, November 25, 1991, when they were all shipped to the laboratory. However, all samples were packed on dry ice in the field and while in cold storage (<-20 degrees Celsius [°C]). This modification was made due to limited access to dry ice and transit time to late evening shipping points.

2.3 LABORATORY ANALYTICAL METHODS. The list of analytes and methods proposed by KEMRON (1990) were USEPA RCRA procedures (SW846 Methods) that was developed primarily to identify and quantify the hazardous substances present in soil, solid waste, and groundwater at hazardous waste sites or RCRA units. These methods were optimized for soil or solid waste matrices and not intended for tissue analyses. These methods include the following: semivolatile organics (Method 8250), polynuclear aromatic hydrocarbons [PAH (Method 8100)], PCBs, chlorinated pesticides (Method 8080), and mercury (Method 7471).

For this study, however, ABB-ES used the analytes and methods that are used in the Mussel Watch Project and Environmental Monitoring and Assessment Program (EMAP). These methods have been developed specifically for the analysis of these contaminants in marine shellfish and fish tissue, and the list of analytes have been carefully selected as contaminants of importance in marine and estuarine resources. These methods, by and large, offer greater sensitivity, accuracy, and precision in animal tissues than do the comparable SW846 methods and provide more valuable information for the purposes of this study. The method used for mercury analysis is a new Mussel Watch method that uses microwave digestion, and has been fully validated in the Mussel Watch Project (NOAA, 1989). The proposed methods for organic pollutant analysis have also been thoroughly validated, have been used for several years in the Mussel Watch project, and were recently adopted for use in the USEPA EMAP national monitoring program (USEPA, 1992). Using these methods not only provides high-quality data, but also provides data that can be confidently compared to data generated in these other national monitoring programs, including data from sites in the South Carolina coastal environment. Because no reference samples were proposed for this study, the availability of these comparable data was essential.

Table 2-3 lists the analytical parameters for the inorganic (mercury) and organic (PAH, PCB, and pesticide) analyses, along with the associated Method Detection Limits (MDLs). Table 2-3 All sample processing and analysis methods were performed according to the procedures used in the Mussel Watch. Laboratory analyses were performed by Battelle Ocean Sciences, Duxbury, Massachusetts. Validated protocols and standard operating procedures (SOPs) were followed in all relevant aspects of this work. A list of some of the pertinent SOPs used in conducting this work is presented in Appendix A.

2.3.1 Preliminary Laboratory Sample Preparation Preliminary sample processing was conducted in a flow-through hood to minimize atmospheric contamination. Bivalve mollusks (oysters and clams) were shucked, and all the tissue from the animals that constituted one sample were placed in a precleaned glass jar. The tissue samples for analysis from the fish (mullet and flounder) was liver tissue and edible fillet tissue as presented in the original KEMRON (1990) workplan. Mullet and summer flounder were carefully filleted, and the liver and edible tissue fillets isolated and placed in precleaned glass jars. The bivalve and fish tissue were thoroughly homogenized using an Omni™ homogenizer. Crabs that

Table 2-3
Analytical Parameters and Method Detection Limits (MDLs)

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Parameter	Method Detection Limit (ng/g dry weight)[1]
Polycyclic Aromatic Hydrocarbons	
Naphthalene	11.39
2-methylnaphthalene	14.21
1-methylnaphthalene	13.99
Biphenyl	18.49
2,6-dimethylnaphthalene	16.41
Acenaphthylene	15.77
Acenaphthene	14.35
1,6,7-trimethylnaphthalene	14.01
Fluorene	13.17
Phenanthrene	18.19
Anthracene	13.36
1-methylphenanthrene	24.37
Fluoranthene	30.38
Pyrene	28.04
Benzo[a]anthracene	25.54
Chrysene	26.44
Benzo[b]fluoranthene	46.94
Benzo[k]fluoranthene	31.55
Benzo[e]pyrene	24.12
Benzo[a]pyrene	24.78
Perylene	29.72
Indeno[1,2,3-c,d]pyrene	12.08
Dibenzo[a,h]anthracene	17.25
Benzo[g,h,i]perylene	22.28
Chlorinated Pesticides	
Hexachlorobenzene	2.35
Lindane (gamma-BHC)	1.89
Heptachlor	3.17
Aldrin	1.42
Heptachlorepoxide	1.18
2,4'-DDE	0.79
cis-Chlordane	1.36
trans-Nonachlor	1.45
Dieldrin	2.36
4,4'-DDE	1.75
2,4'-DDD	2.20
Endrin	7.35
4,4'-DDD	2.36
2,4'-DDT	1.75
4,4'-DDT	8.15
Mirex	2.68

See notes at end of table.

Table 2-3 (Continued)
Analytical Parameters and Method Detection Limits (MDLs)

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Parameter	Method Detection Limit (ng/g dry weight)[1]
Mercury	
Mercury	[2]1 to 11
Polychlorinated Biphenyls	
Cl_2(8)	6.75
Cl_3(18)	4.02
Cl_3(28)	2.79
Cl_4(52)	5.13
Cl_4(44)	2.58
Cl_4(66)	1.33
Cl_5(101)	1.93
Cl_4(77)	3.07
Cl_5(118)	1.72
Cl_6(153)	1.24
Cl_5(105)	1.10
Cl_6(138)	2.79
Cl_5(126)	3.01
Cl_7(187)	2.23
Cl_6(128)	0.80
Cl_7(180)	1.38
Cl_7(170)	5.55
Cl_8(195)	1.61
Cl_9(206)	1.73
Cl_{10}(209)	5.20
Aroclor 1016/1242	20
Aroclor 1221	20
Aroclor 1232	20
Aroclor 1248	20
Aroclor 1254	20
Aroclor 1260	20

[1] Polynuclear aromatic hydrocarbons (PAH), pesticide, and polychlorinated biphenyl (PCB) congener MDLs were determined by Battelle in Phase 6 (1991) of the National Status and Trends (NST) Mussel Watch Project. These organic MDLs were determined using seven replicate oyster tissues, with an average tissue dry weight of 2.23 grams.

[2] The range of mercury MDLs in this study. Separate mercury MDLs were determined for each batch.

Note: ng/g = nanograms per gram.
DDE = dichlorophenyl dichloroethylene.
DDD = dichlorophenyl dichloroethane.
DDT = dichlorophenyl trichloroethane.

represented one sample were processed by placing them whole in a precleaned Waring™ blender, and homogenizing. The homogenate was then placed in a precleaned glass jar for storage. The tissue homogenate was used for PAH, PCB, pesticide, and mercury analyses.

2.3.2 Polynuclear Aromatic Hydrocarbons (PAHs), polychlorinated biphenyls (PCB), and Pesticide Analysis The analytes determined in the organic analyses are listed in Table 2-3, along with their respective detection limits. All sample processing and analysis methods for organics was performed according to the procedures used in the Mussel Watch Project (NOAA, 1989).

2.3.2.1 **Tissue Sample Preparation** An aliquot of approximately 30 grams (g) (wet weight) was taken from the tissue homogenate for organic compound analysis. At this time, a separate 5-g aliquot of the homogenate was removed for dry-weight determination. The appropriate surrogate internal standards (SIS) were added to the 30-g subsample to allow accurate measurement of target organic compounds. The PAH surrogate compounds were d_8-naphthalene, d_{10}-acenaphthene, and d_{12}-benzo[*a*]pyrene. The PCB and pesticide surrogate compounds were dibromo-octafluorobiphenyl (DBOFB), and tetrachloronaphthalene (TCN). Sodium sulfate was added to absorb water from the sample to facilitate extraction with organic solvent. The homogenate was macerated twice for 2 minutes each with a Tissumizer™, using methylene chloride (DCM) as the extraction solvent. The sample was centrifuged between the extractions, and the solvent decanted into a precleaned, labeled Erlenmeyer flask. After the two maceration steps, DCM was added to the sample and the jar was shaken for approximately 30 minutes. Once again, the sample was centrifuged and the solvent decanted into the Erlenmeyer flask. A 10-ml aliquot was removed from the combined extract and was dried for lipid-weight determination. The combined extract was passed through a 20-g alumina cleanup column and concentrated, using Kuderna-Danish (KD) techniques followed by gentle evaporation with nitrogen gas, to a final volume of approximately 900 microliters ($\mu\ell$). The volume of the concentrated extract was measured exactly with a syringe, and 600 $\mu\ell$ were processed by size-exclusion high-performance liquid chromatography (HPLC) (the remaining 300 $\mu\ell$ were archived). The HPLC cleanup step was calibrated by using standards containing lipid, sulfur, and the first and last eluting analytes of interest.

After HPLC fractionation, the extract was concentrated to approximately 500 $\mu\ell$ using nitrogen gas evaporation methods, spiked with recovery internal standards (to allow the determination of SIS recovery), and split for the two separate analyses [PAHs by gas chromatography with mass spectrometry (GC/MS) and PCBs and pesticides by gas chromatography and electron-capture detection (GC/ECD)]. The extract intended for PCB and pesticide analysis was solvent-substituted with isooctane, concentrated to 250 $\mu\ell$, and analyzed by GC/ECD. The portion of the extract intended for PAH analysis remained in the extraction solvent, methylene chloride, and was analyzed by GC/MS.

2.3.2.2 **PAH Analysis** Instrumental methods, maintenance, and quality control (QC) related to the GC/MS analysis of samples for PAH were performed according to a modification of USEPA Method 8270 (which in itself is an improvement over Methods 8250 and 8100 for PAH analysis) using a 3-point calibration curve. The modifications include the use of selected ion monitoring (SIM) to improve method sensitivity and the use of surrogates as internal standards to improve method accuracy. Analytes were quantified by the internal standard method by using d_8-naphthalene (for the quantification of naphthalene through acenaphthylene), d_{10}-

acenaphthene (for acenaphthene through chrysene), and d_{12}-benzo[*a*]pyrene (for benzo[*b*]fluoranthene through benzo[*g,h,i*]perylene) as the SIS. Just prior to instrumental analysis, the recovery internal standards (RIS), d_{10}-biphenyl, d_{10}-phenanthrene, and d_{12}-benzo[*e*]pyrene were added to the samples to measure recovery of the SIS. Gas chromatographic separation was carried out on a 30-meter (m) DB-5 capillary column (J&W Scientific, Inc.). The target analytes are listed in Table 2-3.

2.3.2.3 **PCB and Chlorinated Pesticide Analysis** Instrument methods, maintenance, and QC applicable to GC/ECD analysis of samples for pesticides and PCBs conformed to guidance presented in laboratory SOPs. The Battelle method uses a 3-point calibration curve and is a modification of USEPA Method 8080. This method modification includes the use of capillary column chromatography for improved analyte resolution and quantification of discrete PCB congeners using SIS for improved accuracy. All analytes were quantified by the method of internal standards using DBOFB and TCN as the SIS. Just prior to instrumental analysis, the RIS tetrachloro-*m*-xylene (TCMX) was added to samples to measure recovery of the DBOFB and TCN. Primary, quantitative analysis was carried out on a 30-m DB-5 capillary column (J&W Scientific, Inc.). Secondary qualitative confirmation analysis was performed on 20 percent of the samples using a 30-m DB-17 capillary column (J&W Scientific, Inc.). The target analytes are listed in Table 2-3.

2.3.3 **Mercury Analysis**. Mercury analysis is the only nonorganic analysis in this study. The detection limit for the mercury analyses is listed in Table 2-3.

2.3.3.1 **Tissue Sample Preparation** Tissue samples were prepared and analyzed using methods that have been developed for optimum performance with marine samples. Tissue samples were homogenized, freeze-dried, and digested using nitric acid and microwave heating. Teflon™ digestion vessels were used throughout the processing steps to minimize laboratory contamination.

2.3.3.2 **Mercury Analysis** The analyses for mercury were performed by cold vapor atomic absorption (CVAA).

2.4 **QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**. Data generated during the ESI required sufficient precision, accuracy and documentation to present a valid characterization of the site and to serve as a basis for deciding whether this site poses a threat to humans consuming fish and shellfish associated with the site. A rigorous QC program was implemented for this study because little tissue analysis work has been performed under NEESA guidelines. Both field and laboratory QA/QC procedures were implemented as part of this study.

2.4.1 **Field Sampling** Field QA/QC procedures included determining the locations of sampling sites, selecting the appropriate sample collection methods for different animals, obtaining the necessary boat and sampling equipment, and identifying qualified sampling personnel. A senior field scientist monitored the sample collection effort and was responsible for the custody and integrity of all samples collected for chemical analyses.

During sample collection, Sample Collection Forms were completed and included such information as location, sample identification, date, time, and person(s) collecting the field sample. Sample labeling, chain-of-custody, and log-in procedures adhered to SOPs. Sample collection forms were completed by the field personnel and remained in the custody of the senior field scientist while in the

field. Field chain-of-custody forms accompanied the samples when they were shipped from the field to the laboratory. Upon receipt of the samples at the laboratory, custody was released to the laboratory sample custodian who examined the samples, verified that sample specific information recorded on the chain-of-custody form was accurate, and logged in the received samples.

All samples were wrapped in aluminum foil and placed in Ziploc™ bags before being shipped in coolers with dry ice by Federal Express to the laboratory. Upon arrival at the laboratory, the sample custody was transferred to the Laboratory Sample Custodian and all samples were stored at or below -20 °C until sample preparation could begin.

2.4.2 Laboratory Analysis As much of the preliminary sample processing (filleting of fish, shucking of clams and oysters, and sample homogenization) as practically possible was conducted in a flow-through hood to minimize atmospheric contamination.

Level E QC of the NEESA guidelines were in effect for this study (NEESA, 1988). NEESA Level E is functionally equivalent to the USEPA Contract Laboratory Program (CLP) Data Quality Level V or "Special Analytical Services" to be used for the application of "non-standard" (i.e., not CLP or SW846 methods) methods analysis of unusual environmental matrices such as waste or tissue. Level E QC is also suitable for the assessment of sites that are located away from a populated area, not on the National Priorities List, and have a low probability of litigation. The samples for this study were processed in seven analytical batches. Each batch of 7 to 17 field samples also included 5 (PAH, PCB, and pesticide) or 7 (mercury) laboratory QC samples. These QC samples were as follows.

> **PAH, PCB, and Pesticide Analysis**: One procedural blank, one matrix spike, one blank spike, one blank spike duplicate, and one standard reference material (SRM) sample were included with each of the seven batches of field samples. Additionally, surrogate recoveries were tracked in all samples.
>
> **Mercury Analysis**: Two procedural blanks, one matrix spike, one blank spike, one blank spike duplicate, one laboratory duplicate, and one SRM were included with each of the seven batches of field samples.

Laboratory QC sample criteria goals in effect for this work can be found in Table A-2 in Appendix A.

All project documentation and data were reviewed by the laboratory's QA unit. This review included system inspections, performance data audits, and document review.

2.5 COMPARISON WITH U.S. FOOD AND DRUG ADMINISTRATION (USFDA) ACTION LEVELS. As specified in KEMRON's workplan, data were interpreted based on USFDA action levels. Using this approach as specified, mean contaminant levels plus one standard error of the mean are compared to USFDA levels. According to KEMRON's workplan, if these levels are not exceeded, the aquatic fauna are deemed safe for human consumption. It should be noted that although this approach can be used as a screening tool, its application and utility are limited. The USFDA is primarily responsible for regulating risks in foods sold in interstate commerce. USFDA action levels are developed in response to national needs and are based on national patterns of consumption that are often different than those of local

sport or subsistence anglers. Furthermore, USFDA action levels are not solely risk based but also consider the adverse economic impacts on commercial fishing.

Because USFDA action levels are available for only a few chemicals (Table 2-4) and because there are uncertainties associated with this approach, contaminant levels are also compared to regional data available through SCDHEC and the Mussel Watch national monitoring program.

Table 2-4
Summary of U.S. Food and Drug Administration (USFDA) Action Levels

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Chemical(s)	USFDA Action Level[1] (ppm)	Reference[2]
Aldrin and dieldrin	0.3	CPG 7141.01-B1,4/1/87
Chlordane	0.3	CPG 7141.01-B3, 11/20/89
DDT, DDE, and DDD	5.0	CPG 7141.01-B5, 4/1/87
Endrin	[3]0.3	CPG 7141.01-B.7, 12/17/86
Heptachlor and heptachlor epoxide	[3]0.3	CPG 7141.01-B.9, 9/28/89
Mercury	[4]1.0	CPG 7108.07, 11/6/84
Mirex	[3]0.1	CPG 7141.01-B.11, 12/17/86
Polychlorinated biphenyls (PCBs)	2.0	21 CFR 109.30
Toxaphene	[3]5.0	CPG 7141.01-B.12, 12/17/86

[1] For fish, edible portion unless otherwise noted.
[2] Food and Drug Administration, Compliance Policy Guides, *FDA Action Levels for Unavoidable Residues in Food and Animal Feed* (1987) and 21 Code of Federal Regulations (CFR) 109.30.
[3] Fish and shellfish specified.
[4] Fish, shellfish, crustaceans, and other aquatic organisms.

Note: ppm = parts per million.
DDT = dichlorophenyl trichloroethane.
DDE = dichlorophenyl dichloroethylene.
DDD = dichlorophenyl dichloroethane.

3.0 RESULTS

Field sampling methods and specific collection locations were briefly discussed in Section 2.0. Field sampling results are presented in Section 3.1. Laboratory analytical results are discussed in Section 3.2 for PAHs, PCBs and pesticides, and mercury. Laboratory summary data tables can be found in Appendix B. Quality control sample results are presented in Appendix C.

3.1 FIELD SAMPLING RESULTS. Weather conditions were generally good during the sampling effort, however, unexpected cold weather on Sunday, November 24, and dramatically changed the water temperature and clarity of water on the pond side of the Causeway Landfill and thereby altered species availability.

After several attempts to collect a sample or series of samples at a given location had failed, due to either absence of target species, adverse weather or tidal conditions, or practical constraints, it was necessary to terminate sampling on that day at that site. If, based on initial collection effort, adequate numbers of specimens were not available at the originally proposed site, sampling efforts were moved outward from the originally proposed site until an adequate sample was obtained or schedule constraints precluded further effort.

3.1.1 Fish and Shellfish Samples Collected

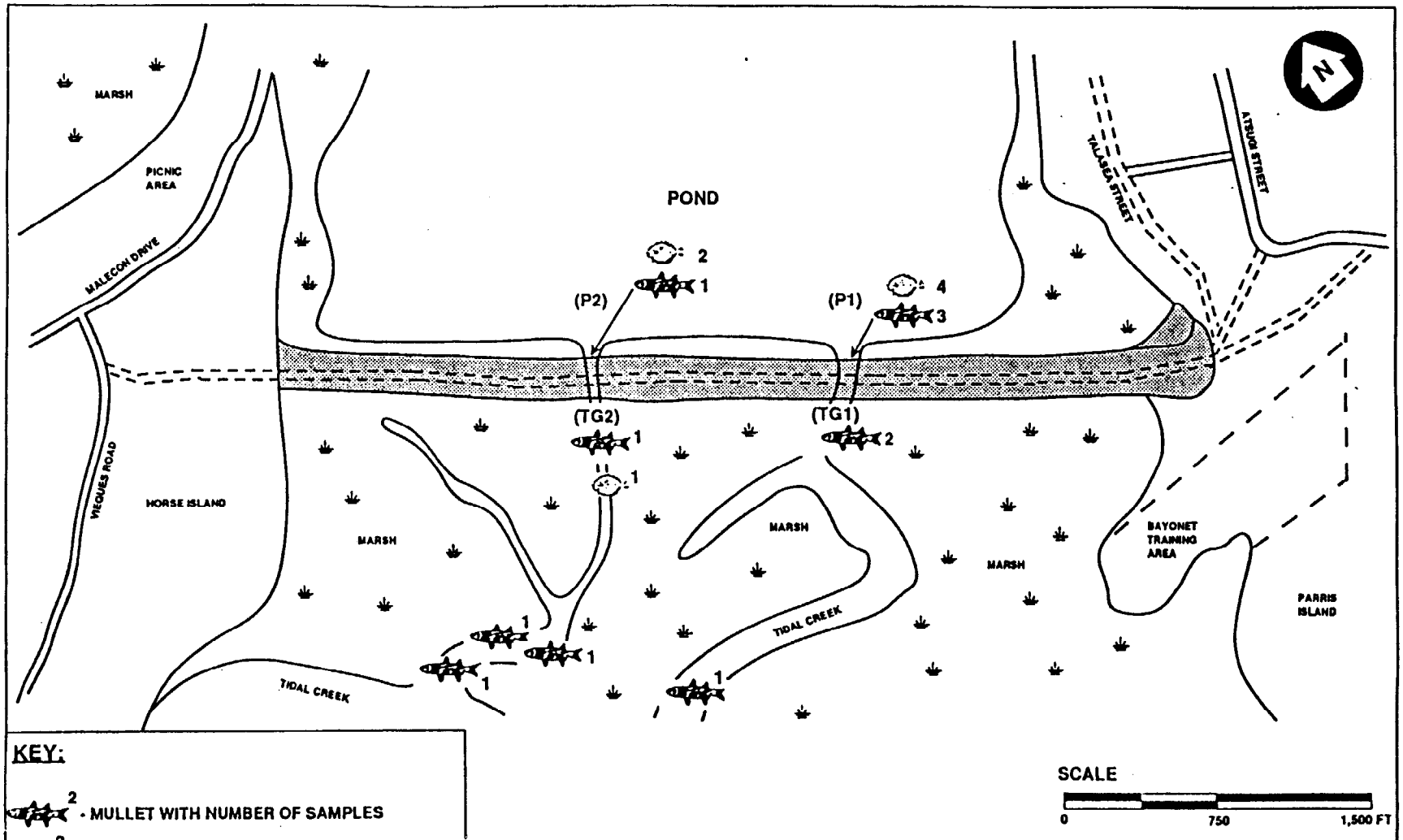
3.1.1.1 **Mullet** Mullet sample sites and the number of samples collected at each site are shown in Figure 3-1 and Table 3-1, respectively. A total of 11 mullet samples were collected. Three samples were collected from P1 on the pond side and one mullet sample was collected from P2. Two samples were collected at TG1, and an additional mullet sample was collected approximately 1500-feet down the tidal creek that leads from TG1.

One mullet sample was collected at TG2 and three additional mullet samples were collected approximately 1,500 feet downstream from TG2. With the exception of one specimen taken at TG1, all specimens were striped mullet.

3.1.1.2 **Summer Flounder** Four samples of summer flounder were collected from P1; two flounder were collected from P2. Despite considerable effort on the two days during which boat access was allowed on the tidal creek side of the causeway, it was only possible to collect one flounder from TG2 using a mullet cast net. Sample sites and the number of samples collected at each site are shown in Figure 3-1 and Table 3-1.

3.1.1.3 **Blue Crabs** Four blue crab samples were collected at both P1 and P2 and a field replicate was collected at P1 (Figure 3-2). Two samples of crab were collected about 1,500 feet from TG2 using cast nets, however, it was not possible to obtain samples near TG1. The only sample collected at TG1 was in a recently molted (soft shell) condition and therefore not suitable for comparative analysis. Total soak time (period of active fishing) for baited traps and trot lines at TG1 and TG2 exceeded 24 hours at each site.

3.1.1.4 **Hard Clams** At TG2, two hard clam samples were collected within 30 feet of the tide gate and two additional samples as well as a field replicate were collected about 800 feet further down the tidal creek on that side of the causeway (Figure 3-2). No clams were found at TG1; however, two samples were



KEY:

- MULLET WITH NUMBER OF SAMPLES
- FLOUNDER WITH NUMBER OF SAMPLES

P1 - PIER 1
P2 - PIER 2
TG1 - TIDE GATE 1
TG2 - TIDE GATE 2

FIGURE DERIVED FROM NEESA 13-094, 1986

FIGURE 3-1

FISH SAMPLES COLLECTED

EXTENDED SITE INSPECTION

MARINE CORPS RECRUIT DEPOT
CAUSEWAY LANDFILL,
PARRIS ISLAND,
SOUTH CAROLINA

Table 3-1
Numbers and Types of Samples Analyzed

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Species[1]	Analytical Batch No.	Sample Type	Total Number of Samples			
			Field	Field Dup.	QC[2]	Total[3]
Fish[4]	1	Muscle	6	[5]1	5/7	12/14
	2	Liver	6	[5]1	5/7	12/14
Mullet	3	Muscle[6]	10	1	5/7	16/18
	4	Liver[6]	9	1	5/7	15/17
Crab	5	Whole organism	10	1	5/7	16/18
Clam	6	Edible tissue	6	1	5/7	12/14
Oyster	7	Edible tissue	16	1	5/7	22/24
		Total	63	7	34/49	105/119

1 The species used in this study were as follows.
Fish were summer flounder (*Paralychtys dentatus*).
Mullet were striped mullet (*Mugil cephalus*) except for TG2-FI-01, which was a southern species of mullet (Mugilidae family) not redfish as indicated on the sample collection form.
Crabs were blue crab (*Callinectes sapidus*).
Clams were hard clam or quahog (*Mercenaria mercenaria*).
Oysters were American/eastern oyster (*Crassostrea virginica*).

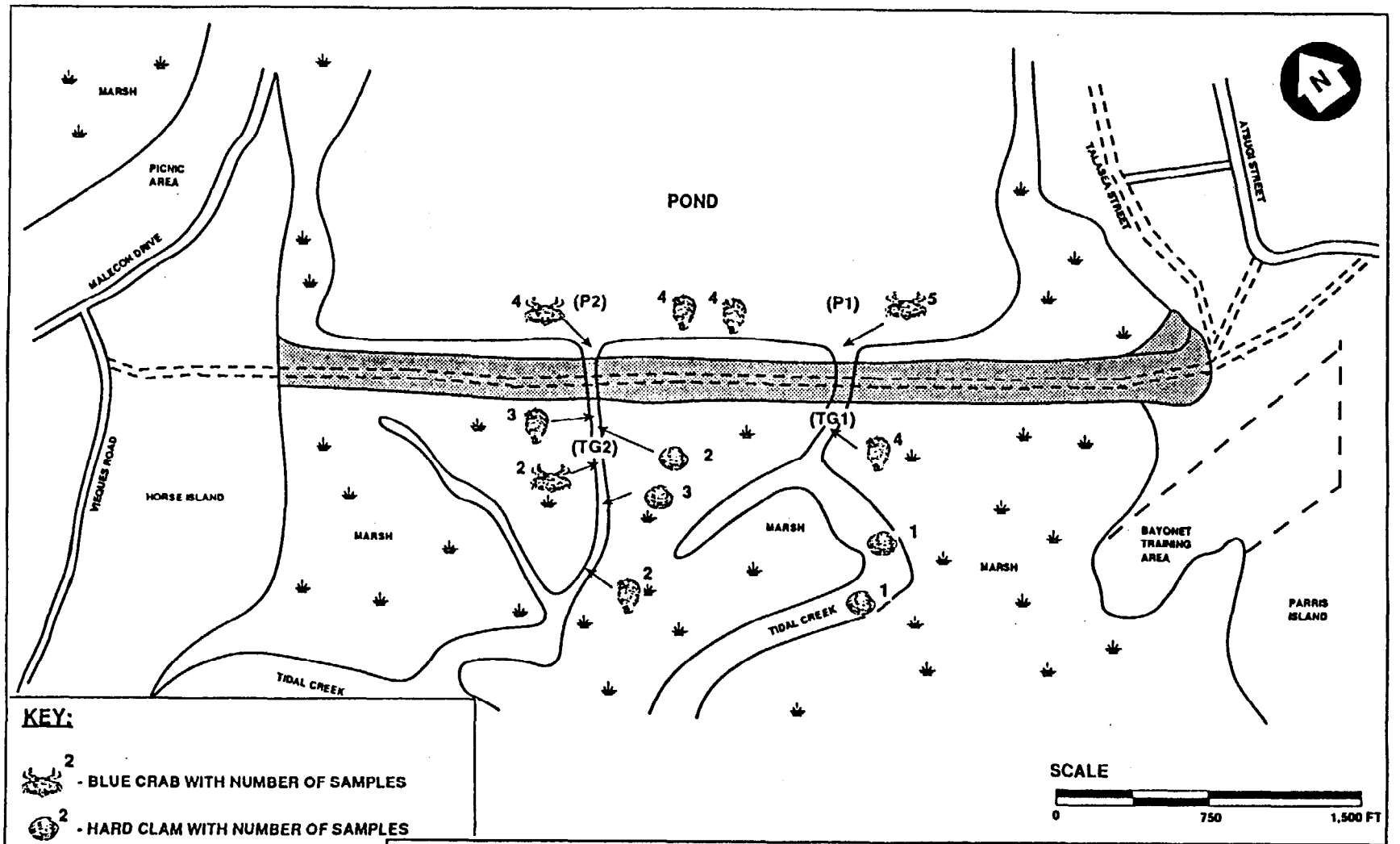
2 The laboratory quality control (QC) samples were as follows.
Organics: one procedural blank, one blank spike, one blank spike duplicate, one matrix spike, and one standard reference material (SRM) with each of the seven batches.
Mercury: two procedural blanks, one blank spike, one blank spike duplicate, one matrix spike, one SRM, and one laboratory duplicate with each of the seven batches. There were five and seven QC samples for each batch of organics and mercury analysis, respectively.

3 The total number of samples listed reflects the number of QC samples for organic (first number) and mercury (second number) analysis.

4 Includes six summer flounder and one southern mullet species (a different mullet species than the fish that were caught for the mullet sample matrix) sample.

5 Samples P1-FIM-ARCH (muscle) and P1-FIL-ARCH (liver) were reported as the field duplicate samples for the fish matrix, however, these samples were treated as additional samples rather than duplicates.

6 There were 9 mullet liver and 10 mullet muscle samples. The livers were too small to accurately isolate from the fish for one of the mullet samples.



KEY:

- 2 - BLUE CRAB WITH NUMBER OF SAMPLES
- 2 - HARD CLAM WITH NUMBER OF SAMPLES
- 2 - AMERICAN OYSTER WITH NUMBER OF SAMPLES
- P1 - PIER 1
- P2 - PIER 2
- TG1 - TIDE GATE 1
- TG2 - TIDE GATE 2

FIGURE DERIVED FROM NEESA 13-094, 1986

FIGURE 3-2

SHELLFISH SAMPLES COLLECTED

EXTENDED SITE INSPECTION

MARINE CORPS RECRUIT DEPOT
CAUSEWAY LANDFILL,
PARRIS ISLAND,
SOUTH CAROLINA

collected at about 600 and 800 feet down the tidal stream on this side. No clams were found on the pond side despite considerable sampling effort.

3.1.1.5 **American Oysters** A total of eight American oyster samples were collected from subtidal rubble substrate at two locations between P1 and P2 (Figure 3-2). Four samples were collected from intertidal rocks and mud close to TG1. Two samples and a field replicate were collected near TG2 and two additional samples were collected about 500 yards up the tidal creek that connects to TG2. The latter samples were collected from mud and shell banks. Oysters collected on the pond side were much larger than those on the tidal creek side of the causeway. This was probably because these oysters are submerged for a longer period of time, are found on hard elevated substrate rather than directly on mud flats, and probably have access to a more food-rich environment.

3.1.1.6 **Shrimp** Efforts to collect shrimp using cast nets either from piers on the pond side or from a small boat on the tidal gate side were unsuccessful. Shrimp were not available in any abundance because of the cold temperatures. Although shrimp were reported to have been caught in reasonable numbers up until a week before sampling, the season had passed and only a few, not enough for a sample, were caught on the pond side. No shrimp were observed or collected on the tidal creek side despite extensive cast net effort. Substantial recreational and subsistence fishing during the survey period confirmed the absence of shrimp.

3.1.2 Sampling Constraints and Potential Consequences for Data Interpretation

Operational and logistical constraints as well as variations in habitat conditions at the four sample locations all reduced the completeness of the originally proposed sample collection matrix. These differences have potential consequences for data interpretation.

Sample collection activities were constrained by access limitations, gear restrictions, tidal conditions, and the presence of endangered species near the site during the survey period. Restrictions on the tidal creek side were due to limited boat availability, safety issues related to soft mud on the creek banks, use of the firing range (tidal creeks are in the impact zone and access is restricted during firing), and extreme tidal conditions (full moon) during the survey period. Access to the tidal creek side of the causeway was not possible during the November 22 to 25 sampling period due to activity at the range (despite earlier coordination that indicated no firing was scheduled during this week). Gill nets were not used on the tidal creek side because of the presence of hangs and access limitations that raised concerns about net retrieval and damage to natural resources. Additionally, recent sighting of a bald eagle on the pond side precluded the use of a motor on the John boat, which increased the time needed to sample on the pond side.

In addition, variations in physical circulation and habitat conditions between the pond and tidal creek sides of the Causeway Landfill also influenced collection plans by affecting species presence, distribution, size, abundance, or exposure. The tidal creek side of the landfill is composed of a well-flushed tidal creek habitat characterized by tidally-induced changes in water depth and flow conditions and very soft mud embankments. In contrast, the pond side of the landfill has restricted circulation and relatively constant water levels as a result of the tide gates and coarser substrate composition.

Some of the primary effects of the different environmental conditions include the following:

- Oysters were found subtidally on hard artificial substrate on the pond side and intertidally and primarily on mud flats on the tide gate side of the causeway.

- Clams were absent or considerably less abundant on the pond side of the causeway.

- Residence time in proximity to the causeway for mobile crabs, mullet, and flounder was probably much greater on the pond side of the causeway.

These conditions and resulting effects on species distribution or the ability to use certain gear types, precluded some of the location comparisons and eliminated one species (shrimp) from the sample collection effort as originally planned. However, five species representing a range of feeding types and trophic levels were collected in adequate numbers to characterize fish and shellfish tissue contaminant levels at the Causeway Landfill.

3.2 LABORATORY ANALYSIS. A summary of the laboratory analytical results is presented PAHs, PCBs, pesticides, and mercury in the following subsections. Laboratory results are presented in summary tables in Appendix B. Data are presented as both wet weight and dry weight concentrations. The significance of these results is presented in Sections 4.3 and 4.4.

3.2.1 Polynuclear Aromatic Hydrocarbons (PAHs) The results of the field sample analysis for PAHs are presented in micrograms per kilogram (µg/kg) dry weight, which is equivalent to nanograms per gram (ng/g). The data for all 24 PAHs are presented in Appendix B. The tables also include the sample dry weight, lipid weight, and analytical batch number. Concentrations below the MDL are reported if the analyst could confidently identify and quantify the analyte in that particular sample, and are qualified with a "J". Additional data tables presenting wet weight contaminant concentrations are also presented in Appendix B.

With the exception of some of the liver samples, the PAH levels in the tissue samples were generally low, with most PAHs either not detected at all or reported at levels below the detection limit. Individual PAHs including naphthalenes, phenanthrene, and/or fluorene were detected at levels slightly above the MDL in flounder muscle, mullet muscle, crab, and clam tissue samples. Fluoranthene was generally the most abundant PAH in the oyster tissue samples. Data tables D-1 through D-25 summarize the range of PAHs detected, the mean concentrations, and frequencies of detection for each matrix.

Contaminant concentration, dry weight (moisture content), and lipid weight (lipid content) data are reported with a low degree of confidence for 12 liver samples and are considered estimates. Four flounder liver samples in Batch 2 (P1-FIL-03, P1-FIL-ARCH, P2-FIL-02, and TG2-FIL-01) and eight liver samples in Batch 4 (P1-MUL-01, P1-MUL-02, P1-MUL-03, TG1-MUL-02, TG2-MUL-01, TG2-MUL-02, TG2-MUL-03, and TG2-MUL-DUP) had so little material available for sample processing that accurate data could not be obtained. Because approximately 1 g or less of wet tissue was used for the extraction of these liver samples (0.059 g for P1-FIL-03, for

instance), dry weights could not be determined individually. Average moisture content from the other liver samples in the batch were therefore used to calculate approximate dry weights. These dry weights may or may not have been representative of these samples, and probably result in erroneous concentrations of unknown discrepancy. Lipid content values of the liver samples are also estimates because of the little tissue and lipid material extracted and used for the determination. The lipid data for P1-FIL-03, for instance, indicated that the sample was >100 percent lipid, which obviously is an error, and is a result of not having enough material for the extraction and accurate lipid determination.

3.2.2 Polychlorinated Biphenyls (PCB) and Chlorinated Pesticides The results of the field sample analysis for PCB and chlorinated pesticides are presented in Appendix B in micrograms per kilogram ($\mu g/kg$) dry weight, which is equivalent to ng/g. The data are presented for the 16 chlorinated pesticides, 20 individual PCB congeners, and total PCB as the most predominant Aroclor. The tables also include the sample dry weight, lipid weight, and analytical batch number (see Appendix B). Tables summarizing wet weight conversions are also presented. Concentrations below the MDL are reported if the analyst could confidently identify and quantify the analyte in that particular sample, and are qualified with a "J".

The total PCB (by Aroclor) determination was done using the sum of the areas under the curve of each of the 20 congeners that could be reliably detected and integrated. For this reason, peaks with areas that represented little in individual congener concentration were used in the total PCB determination if they could be reliably identified and integrated. On the other hand, a total PCB value, by Aroclor, could not be determined unless sufficient numbers of congeners were detected in the sample to identify an Aroclor pattern. In some instances a few major congeners were identified, and reported, without being able to identify an Aroclor. The most abundant Aroclor was identified by pattern recognition and the response factor, determined using the detectable congeners in the standard of the identified Aroclor, was applied to the sum of the areas of all identified congeners to obtain a total PCB value. Congeners Cl_2(08), Cl_4(77), Cl_5(126), Cl_7(170), and Cl_{10}(209) were excluded from the total PCB determination for both the Aroclor response factor and field sample total area calculation (thereby not affecting concentration determinations), because these congeners are susceptible to matrix interference. These congeners are relatively minor in Aroclor 1254, which was the predominant Aroclor in all samples for which Aroclors could be identified. However, Cl_7(170) and Cl_{10}(209) were included in the total PCB determination for sample P1-FIL-01, after carefully reviewing the chromatogram to ensure accurate determination, because this sample had a significant contribution of Aroclor 1260 in addition to Aroclor 1254 (relative contribution was estimated at a ratio of approximately 60:40 of Aroclor 1254:1260).

As with the PAH data, the PCB and pesticide concentration, dry weight (moisture content), and lipid weight (lipid content) data for 12 liver samples should be considered estimates, and are reported with a low degree of confidence. Four flounder liver samples (Batch 2) (P1-FIL-03, P1-FIL-ARCH, P2-FIL-02, and TG2-FIL-01) and eight mullet liver samples (Batch 4) (P1-MUL-01, P1-MUL-02, P1-MUL-03, TG1-MUL-02, TG2-MUL-01, TG2-MUL-02, TG2-MUL-03, and TG2-MUL-DUP) had so little material available for sample processing that accurate data could not be obtained.

As stated above, not all samples for which PCB congeners were reported in the primary analysis could be reported as Aroclor. However, for samples with a distinguishable PCB pattern, the pattern was more similar to that of Aroclor 1254 than any other Aroclor.

The dichlorophenyl trichloroethane (DDT) metabolite/degradation product 4,4'-dichlorophenyl dichloroethylene (4,4'-DDE) was consistently the most abundant pesticide. Other pesticides that were frequently determined to be present in these samples include dichlorophenyl dichloroethane (4,4'-DDD), trans-nonachlor, cis-chlordane, and mirex. Summary statistics are presented for PCBs and pesticides in Appendix D.

The PCB and pesticide data table for the oyster samples (Batch 7) includes the sum of the 20 PCB congener concentrations, which generally represents between 40 and 60 percent of the total PCB in environmental samples. An approximate total PCB value can be obtained by multiplying this sum of congener concentrations by 2. This total PCB value generally approximates the reported total PCB value obtained by Aroclor determination.

The oyster data also include the sum of the six DDT/DDD/DDE compounds (ΣDDT). These analyte sums include any analytes reported at levels below the detection limit and non-confirmed analytes, but these data contribute relatively little to the total sum. These PCB and pesticide data are compared to the Mussel Watch oyster data in Section 4.2.

3.2.3 Mercury The results of the field sample analyses for mercury are presented in Appendix B in micrograms per gram (μg/g) dry weight. The table also includes the sample batch number as presented in the workplan, and the batch number relating to the mercury sample processing in the laboratory. The field sample data reported for this study have not been background corrected. To obtain true field sample concentrations, background subtraction, a routine practice for reporting mercury and other metals data, was performed using the procedural blank (PB) data reported for the mercury analysis in the QC data section. Data presented in the mercury wet weight summary tables have been modified using background correction.

3.3 QUALITY CONTROL SAMPLE RESULTS. QC sample results are presented in Appendix C.

3.4 SUMMARY OF RESULTS. Mullet and oyster were the only species collected at all of the proposed sampling stations (P1, P2, TG1, TG2). Flounder and crab were not collected at TG1 and clams were only present on the tidal creek side of the causeway.

PAH levels, with the exception of some liver samples, were generally low, with most PAHs either not detected at all or reported below the detection limit. Fluoranthene was generally the most abundant PAH in oyster tissue. Aroclor 1254 was reported most often. Highest PCB concentrations were detected on the pond side of the causeway. Samples collected on the tidal creek side had lower concentrations of PCBs than the pond side of the causeway. The DDT metabolite/degradation product 4,4-DDE was consistently the most abundant pesticide. Other pesticides that were frequently determined to be present included 4,4-DDD, trans-nonchlor, cis-chlordane, and mirex. Mercury concentrations were uniformly low among the different Parris Island sites.

4.0 DISCUSSION

The original workplan called for a comparison of tissue levels detected at the Causeway Landfill with established USFDA action levels for the selected chemicals. This section evaluates the site data by comparing them to existing USFDA action levels as well as to regional and national reference data. This section also includes a comparison of tissue levels on the tidal creek and pond sides of the causeway.

Section 4.1 presents the comparison of site tissue data with USFDA action levels for those chemicals for which such levels currently exist. In order to place the site findings in regional context, detected tissue levels were also compared with data from NOAA Mussel Watch and SCDHEC monitoring programs in Section 4.2. Observed differences between pond side and tidal creek sample data and between species variations are briefly discussed in Section 4.3 along with a description of the local environment and species behavior-ecology that may affect this variability. A review of relevant aspects of the biology of each of the collected species is included in Appendix E. Data adequacy issues are reviewed in Section 4.4.

4.1 COMPARISON WITH USFDA ACTION LEVELS. Table 4-1 compares tissue concentration data by chemical, species, and pond or tidal creek side of the Causeway Landfill with available USFDA action levels. The tissue data are presented in mean wet weight concentrations plus one standard error of the mean as specified in the KEMRON workplan. SCDHEC data are also summarized using the mean plus one standard error of the mean. It should be noted, however, that the use of the arithmetic mean implies a normal distribution which may not be appropriate for such a small data set. Using the mean plus one standard error as a comparison shows that USFDA action levels are not exceeded for any of the chemicals examined. Further evaluation indicates that even the maximum observed levels do not exceed USFDA action levels.

A review of the recent literature (USEPA 1989, Quantitative Risk Assessment Committee [QRAC], 1990 and Reinert, *et al.*, 1991), however, raised some concern regarding the appropriateness of USFDA action levels for the recreational or subsistence fishing scenario at the Causeway Landfill. These issues together with recommended approaches for resolving them are described in the Section 5.0.

4.2 COMPARISON WITH NATIONAL AND REGIONAL DATABASES. Because USFDA action levels were developed to be protective nationally, rather than on a regional or local basis, data collected for this study were also compared to data from NOAA's Mussel Watch Project and the SCDHEC monitoring Program in order to put the observed data in a regional context. These two comparisons are presented in sections 4.2.1 and 4.2.2, respectively. Mussel Watch sampling sites and the South Carolina sampling site (Broad River only) are presented in Figure 4-1.

4.2.1 Comparison with National Oceanic and Atmospheric Administration (NOAA) Mussel Watch Database The NOAA Mussel Watch Project includes the annual collection and chemical analysis of mussels and oysters from 177 sites around the coastal and estuarine United States. Several of these sites are located in the South Atlantic coastal areas (Figure 4-1). The chemical contaminants analyzed have included PAHs, PCBs, chlorinated pesticides, and trace elements. The main

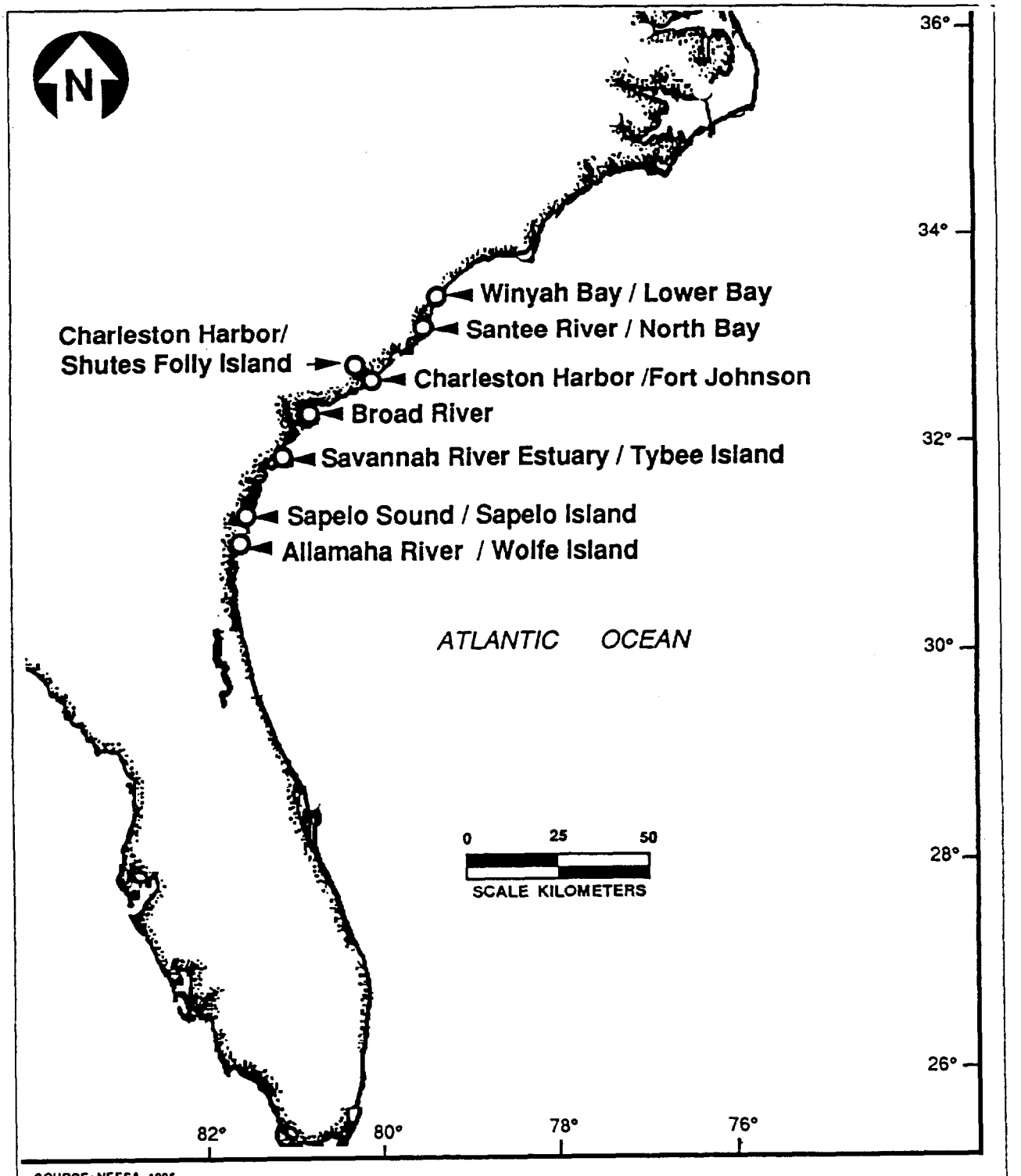
Table 4-1
Data Comparison with USFDA Action Levels

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Chemical	USFDA Action Level		Concentrations in Species[1] (ppb)										Values Above USFDA Levels
	(ppm)	(ppb)	Flounder		Mullet		Crab		Clam		Oyster		
			Pond	Tidal	Pond	Tidal	Pond	Tidal	Pond	Tidal	Pond	Tidal	
Aldrin	0.3	300	--	--	0.17	0.17	--	--	--	--	--	--	--
Dieldrin	0.3	300	--	--	0.43	0.57	0.43	0.98	--	0.094	--	--	--
Chlordane	0.3	300	0.53	--	1.2	1.3	0.57	0.52	--	0.18	0.99	0.4	--
DDT (2,4)	5	5,000	--	--	0.21	0.21	--	--	--	0.0696	0.29	--	--
DDT (4,4)	5	5,000	--	--	0.98	1.1	--	--	--	0.32	--	--	--
DDE (2,4)	5	5,000	0.53	--	0.095	0.31	0.2	--	--	0.11	0.565	0.29	--
DDE (4,4)	5	5,000	24	1.3	45	25	18	14	--	0.41	15.7	3.1	--
DDD (2,4)	5	5,000	--	--	0.26	0.27	--	--	--	0.088	--	--	--
DDD (4,4)	5	5,000	7.4	0.25	7.1	6.6	8.5	2.5	--	0.0936	7.5	0.97	--
Endrin	0.3	300	--	--	0.88	0.89	--	--	--	--	--	--	--
Heptachlor	0.3	300	--	--	0.38	0.38	--	--	--	--	--	--	--
Heptachlor epoxide	0.3	300	--	--	0.14	0.14	0.38	0.95	--	--	--	--	--
Mercury	1	1,000	66	58	5.6	7.8	28	59	--	8.2	13	9.6	--
Mirex	0.1	100	1.5	0.4	2.3	1.1	1.4	1.1	--	--	0.469	0.14	--
PCB (Aroclor 1254)	2	2,000	54	2.1	59	47	--	--	--	--	58	--	--

[1] Concentrations are reported as mean wet weight plus one standard error.

Notes: USFDA = U.S. Food and Drug Administration.
ppm = parts per million.
ppb = parts per billion.
DDT = dichlorophenyl trichloroethane.
DDE = dichlorophenyl dichloroethylene.
DDD = dichlorophenyl dichloroethane.
PCB = polychlorinated biphenyls.



SOURCE: NEESA, 1986

FIGURE 4-1

SOUTHEAST ATLANTIC COAST
MUSSEL WATCH AND SOUTH CAROLINA
SAMPLING SITES

EXTENDED SITE INSPECTION

MARINE CORPS RECRUIT DEPOT
CAUSEWAY LANDFILL,
PARRIS ISLAND,
SOUTH CAROLINA

reason for analyzing these mollusks is to establish temporal trends; however, these data provide a useful comparison for this study as well.

Comparative data available from the NOAA Mussel Watch Project are restricted to oysters. Table 4-2 presents 1991 Georgia and South Carolina Mussel Watch data for oyster tissue and the maximum concentrations found near the Causeway Landfill. Figure 4-1 illustrates the Mussel Watch sample sites used for comparison purposes. Table 4-2 includes the total PAHs for oysters, defined as the sum of the 24 individual PAH analytes, including any PAHs reported at levels below the detection limit. This sum does not include PAHs that were not analyzed. The total PAH concentrations in oysters from the P1 and P2 sites are higher than from the TG1 and TG2 sites, but most sites have concentrations that are in the range found at the South Carolina and Georgia Mussel Watch sites (Table 4-2).

Table 4-2 also includes total PCBs for oysters, defined as the sum of the 20 individual PCB congener analytes. The PCB concentrations in oysters from the P1 and P2 sites were considerably higher than from the TG1 and TG2 sites and higher than the South Carolina and Georgia Mussel Watch sites. The PCB levels in oysters from the TG1 and TG2 sites were comparable to the less contaminated South Carolina and Georgia Mussel Watch sites. The DDT concentrations in oysters from the P1 and P2 sites were higher than from the TG1 sites, which in turn were higher than the TG2 sites. The P1, P2, and TG1 sites all had oyster DDT levels that were higher than the South Carolina and Georgia Mussel Watch sites (Table 4-3). The levels in oysters from the TG2 sites were comparable to the Mussel Watch sites. The 4,4'-DDE levels comprised more than 60 percent (generally 60 to 70 percent) of the sum of the six DDT/DDD/DDE compounds in all oyster samples, and DDT consistently contributed less than 5 percent to the sum, suggesting that this contamination is not due to recent DDT inputs.

The mercury concentrations were quite uniform among the different Parris Island sites, ranging from 0.053 to 0.122 gram per gram (g/g) dry weight for the 17 oyster samples, after background and blank correction (using the average of the two procedural blank values for the sample batch). These concentrations are in the range of those of the South Carolina and Georgia Mussel Watch sites (Table 4-2).

4.2.2 Comparison with South Carolina Department of Health and Environmental Control (SCDHEC's) Database SCDHEC maintains a statewide monitoring network that includes a component that evaluates the presence and concentration of potentially hazardous substances in aquatic organisms. Sixteen stations are maintained in the major estuarine areas of the State; one of these stations is located on the Broad River (latitude 32° 20'35" and longitude 80° 42' 30") near Parris Island. American oysters and blue crabs were collected from this station during 1984 to 1986 (oysters) and in 1986 (crabs) and analyzed for heavy metals, pesticides, PCBs, PAHs, and volatile organic compounds. Tables 4-3 and 4-4 present SCDHEC data for PAH and pesticide levels, respectively, for oysters and blue crabs compared to maximum concentrations at the Causeway Landfill. PCB data were not comparable and are not included in this discussion.

Based on the 1984 to 1988 data, SCDHEC concluded (SCDHEC, 1987) that the 16 estuarine areas they had sampled were not contaminated by toxic organic or inorganic chemicals within the context of the analysis conducted. Levels of contaminants measured in oysters or crabs did not approach the available USFDA action levels. Maximum PAH levels at the Broad River SCDHEC sampling site

Table 4-2
Mussel Watch Oyster Tissue Data From South Carolina and Georgia Sites, 1991

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Site No.	Site Location	Analyte Concentration[1]				
		Mercury	ΣPAH[2]	ΣPCB[3]	ΣDDTs[4]	4,4-DDE
225	Lower Bay, Winyah Bay, SC	0.103	62.3	7.54	4.87	4.87
226	North Bay, Santee River, SC	0.096	41.1	0.38	7.33	7.33
44	Fort Johnson, Charleston Harbor, SC	0.113	1,165	14.8	19.3	12.3
45	Shutes Folly Island, Charleston Harbor, SC	0.092	1,208	26.2	31.0	19.5
	Causeway Landfill, Parris Island, SC					
	Pond	[5]0.114	[6]324	[7]212	[8]224	[9]137
	Tidal Creek	[5]0.123	[6]104.1	[7]92	[8]49.7	[9]35.19
46	Tybee Island, Savannah River Estuary, GA	0.142	450	25.0	12.8	7.63
47	Sapelo Island, Sapelo Sound, GA	0.071	52.2	5.86	4.69	4.69
227	Wolfe Island, Altamaha River, GA	0.069	52.4	10.8	5.97	5.97

[1] Concentrations are in micrograms per kilogram (μg/kg) nanograms per gram (ng/g) dry weight for organics, and micrograms per gram (μg/g) dry weight for mercury. Concentrations are 1991 (Phase 6) site averages calculated from three samples, representing three stations, from each site (Battelle, 1991). A value of 0 was used for non detects in the determination of these average Mussel Watch concentration values, for easy comparison to the data generated in this study.
[2] ΣPAH is the sum of the 24 individual polynuclear aromatic hydrocarbons (PAH) analytes.
[3] ΣPCB is the sum of the 20 individual polychlorinated biphenyls (PCB) congener analytes.
[4] ΣDDTs is the sum of 4,4-dichlorophenyl trichloroethane (DDT), 4,4-dichlorophenyl dichloroethane (DDD), 4,4-dichlorophenyl dichloroethylene (DDE), 2,4-DDT, 2,4-DDD, and 2,4-DDE.
[5] Concentrations are maximum dry weight concentrations.
[6] Total PAHs are defined as the sum of the 24 PAH analytes, including any PAH reported at levels below the detection limit. This sum does not include PAHs that were not analyzed.
[7] Total PCB (by Aroclor) was determined using the sum of the areas of each of the 20 congeners that could be reliably detected and integrated.
[8] Sum of the six DDT/DDD/DDE compounds for any analyte reported at or below the detection limit.
[9] Maximum dry weight concentrations.

Table 4-3
Data Comparison with Statewide Summary of PAH Levels in Oysters and Blue Crabs

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Compound	Maximum Level in Oysters[1] (ppb)		Maximum Level in Blue Crabs[1,2] (ppb)	
	SCDHEC[3]	Causeway Landfill	SCDHEC[3]	Causeway Landfill
Acenaphthene	55	0.67	–	1.8
Acenaphthylene	–	0.95	–	2.7
Anthracene	428	0.42	–	1.6
Benzo(a)anthracene	987	2.1	245	ND
Benzo(a)pyrene	42	1.6	21	4.1
Benzo(b)fluoranthene	10	2.8	51	6.9
Benzo(g,h,i)perylene	2	0.78	28	3.7
Benzo(k)fluoranthene	[4] 2[2]	1.9	24	4.7
Chrysene	34	3.1	195	3.9
Fluoranthene	142	11.0	149	0.45
Fluorene	–	0.55	–	0.48
Indeno[1,2,3-c,d]pyrene	–	0.89	30	2.0
Naphthalene	–	1.4	–	1.6
Phenanthrene	44	2.2	157	0.61
Pyrene	74	6.2	207	0.39

[1] Maximum wet weight concentration.
[2] South Carolina Department of Health and Environmental Control (SCDHEC) tissue levels include somatic muscle only; hepatopancreatic material was not included in the analysis. Causeway Landfill data represent whole body concentrations.
[3] Data represent maximum concentrations reported for the statewide summary, 1984-86 (SCDHEC, 1987).
[4] Benzo(k)fluoranthene was the PAH detected with highest levels in oysters at the Broad River location (SCDHEC) in 1986. PAHs were not detected at this station in 1984 or 1985.

Notes: ppb = parts per billion.
SCDHEC = South Carolina Department of Health and Environmental Control.
– = concentration below the lower detection limit.
ND = not detected.

Table 4-4
Data Comparison with Statewide Summary of Pesticide Levels in Oysters and Blue Crabs

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Compound	Maximum Level in Oysters (ppb)		Maximum Level in Blue Crabs[1] (ppb)	
	Broad River SCDHEC	Causeway Landfill	Broad River SCDHEC	Causeway Landfill
Aldrin	<5	–	<5	–
Dieldrin	<5	–	<5	0.9
Endrin	<5	–	<5	–
Chlordane	<5	1.2	<5	0.6
DDD	<5	10	<5	12
DDE	15.6	20	<5	22
DDT	<5	0.36	177	–
Lindane	<5	–	<5	–
Heptachlor	<5	–	<5	–
Heptachlor epoxide	<5	–	<5	0.9
HCB	<5	–	<5	–
Methoxychlor	<5	–	<5	–
a-BHC	7.0	–	<5	–
b-BHC	<5	–	<5	–
Mirex	<5	0.53	<5	1.7

[1] South Carolina Department of Health and Environmental Control (SCDHEC) tissue levels include somatic muscle only; hepatopancreatic material was not included in the analysis. Causeway Landfill data represent whole body concentrations.

Notes: ppb = parts per billion.
SCDHEC = South Carolina Department of Health and Environmental Control
– = concentration below the lower detection limit.

exceeded those at the Causeway Landfill. Maximum PAH tissue levels for oysters and crabs observed at the Causeway Landfill were considerably lower than maximum statewide levels reported by SCDHEC. PAHs were not detected at the SCDHEC Broad River station during the 1984 and 1985 surveys. In 1986, however, PAHs were detected and benzo(k)fluoranthene was the PAH detected at the highest concentrations (2 μg/kg) which is close to the 1.9 μg/kg detected in oysters collected near the causeway.

DDD and DDE levels in oysters and crabs collected from at the Causeway Landfill exceeded the maximum levels observed statewide (SCDHEC, 1987).

4.3 VARIATION IN TISSUE CONCENTRATIONS BETWEEN LOCATIONS AND SPECIES. A review of the tissue concentration level data from the four locations sampled in this study during the comparison with regional and national data suggested that there were some differences between the pond and tidal creek sides of the causeway. In some cases, such as for oysters, the sum of individual analytes for PAH, PCB, and DDT were greater on the pond side. However, individual analytes were not consistent with this pattern. Observed differences between locations may be due to physical factors related to circulation or flushing, the behavior/ecology of the sampled species, or the distribution of contaminants in the landfill.

Although some analytes, such as 4-4 DDD, 4-4 DDE, PCB (Aroclor 1254), and mirex were consistently higher on the pond side for all species, there was no consistent relationship in tissue concentrations based on trophic levels. This may be due to differences in residence periods for mobile species, the number of samples, and size differences in those with a limited number of samples on the tidal gate side, such as flounder and crab. Although tissue concentrations in oysters were consistently higher on the pond side, concentrations may be influenced by the fact that these oysters were subtidal and larger than those on the tidal creek side.

Due to differences in fishing practices and issues related to potential off-station migration of contaminants of concern, it was of interest to determine whether organisms occurring in the pond and tidal creek sides of the causeway had differing tissue concentrations of detected contaminants. Fishing primarily occurs on the pond side and based on a review of the species ecology and site observations, it is also likely that mobile species such as mullet, summer flounder, and crab are resident for longer periods on the pond side (Appendix E).

To determine whether significant differences in average tissue concentrations exist between these two habitats, the two data sets were compared using a non-parametric statistical test. A non-parametric test was required due to the small sample sizes obtained during the sampling program and uneven sample size. Small sample size made it impossible to determine whether the two distributions being compared were distributed normally (an assumption of any parametric test). The uneven sample sizes (and variances) generally precludes a more rigorous treatment of the data (i.e., a more powerful parametric test such as a t-test). Consequently, Wilcoxon's matched pairs signed-rank test was used to test the null hypothesis that there were no significant differences between the pier (pond) and tide gate (tidal creek) arithmetic averages across individual analytes.

No statistical analysis was attempted for the mercury data because the single analysis precluded statistical treatment using Wilcoxon's test, and this contaminant is sufficiently different from the other compounds analyzed that it

is not reasonable to include it with one of the other data sets. In addition, no comparison was possible for clams due to the fact that no clams were collected on the pier side and mullet liver samples was not evaluated due the small number of analytes that were detected in either area. For the remaining chemicals, the Wilcoxon matched pairs signed-ranked test was used on each data set to test the hypothesis that there is no statistical difference between the arithmetic average pier and tidal gate data across individual analytes. Of the available non-parametric tests, Wilcoxon's is one of the more powerful because it uses information concerning both the direction (i.e., the area with the greater average concentration, for each analyte) and magnitude of the difference in mean values between the two areas being evaluated (Siegel, 1956).

To conduct the test, the difference in the arithmetic average for each analyte was calculated, the absolute value of the results was sorted from smallest to largest, and the results were ranked from 1 to n where n is the total number of analytes in the data set for which the particular analyte was detected in at least one of the two areas (Sokal and Rohlf, 1969). Finally, the original sign of each difference was assigned to the corresponding rank value and the positive and negative ranks summed. A table of two-tailed critical values for this particular test (Siegel, 1956) was used to determine if the lesser of the sum of positive and negative ranked values were significantly different from that expected under the null hypothesis.

The results of the Wilcoxon test for the PAHs, PCB, and pesticide data sets are presented in Tables 4-5 and 4-6. In the analysis of the PAH data set, it was determined that the arithmetic average concentrations of all detected analytes were significantly higher ($\alpha = 0.01$) in the tide gate data set for the flounder muscle, mullet muscle, and crab data sets relative to pier side data. No significant differences were detected for the two fish liver data sets or for oysters. Mean analyte concentrations of PCB and pesticides were determined to be significantly higher in the pond data sets for four of the five data sets evaluated; significantly higher average concentrations of PCBs and pesticides were detected for the flounder muscle and Table 4-5 liver, crab, and oyster data sets relative to the tide gate data sets. No significant difference was detected between average concentrations of PCBs and pesticides for mullet muscle, however.

4.4 ADEQUACY OF SAMPLE COLLECTION. Due to operational and logistical constraints noted in Section 3.0, the complete set of proposed samples was not obtained. However, the revisions to the workplan which increased sample numbers and applied a more appropriate sample analysis procedure as well as range of species sampled compensated for potential data gaps. The species collected represented at least three trophic levels and a variety of feeding types, as shown in Table 4-7 and described in detail in Appendix E, and present an adequate picture of contamination levels at the site, particularly on the pond side of the causeway where fishing is concentrated.

The suite of species sampled adequately represents the primary, secondary, and tertiary consumers in the aquatic food web at the Causeway Landfill. It includes sessile filter feeders with long-term residence at the site as well as top predatory carnivores. Long lived, sessile filter feeders such as the hard clam and oyster make good test organisms because they integrate conditions over time and provide site-specific data. Mobile secondary or tertiary consumers with high growth rates, such and the crab and summer flounder, provide some integration over the area of concern, particularly on the pond side where residence times are

Table 4-5
Wilcoxon's Matched Pairs Signed-Ranks Test, Summary of Polynuclear Aromatic Hydrocarbons (PAHs)

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Species	Batch No.	n[1]	Sum of Ranks[2]		Significance Levels[3]
			-	+	
Flounder (muscle)	1	21	191	40	<0.005
Flounder (liver)	2	22	82	171	NS
Mullet (muscle)	3	19	183	7	<0.005
Mullet (liver)	4	18	118	53	NS
Blue crab	5	22	217	36	<0.005
Hard clam	[4]6				
American oyster	7	24	171	129	NS

[1] Total number of analytes in the particular data set that were detected at least once in either the pier or tide gate sides of the causeway.
[2] Sum of the negative and positive ranks. These values should be roughly equal if neither data set consistently has higher average analyte concentrations (see text).
[3] As provided in Siegel, 1956.
[4] No analysis of Batch No. 6 (clams) data was done because no clams were collected on the pier side of the causeway.

Note: NS = not significant.

Table 4-6
Wilcoxon's Matched Pairs Signed-Ranks Test, Summary of Polychlorinated Biphenyls (PCBs) and Pesticides

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Species	Batch No.	n[1]	Sum of Ranks[2]		Significance Levels[3]
			-	+	
Flounder (muscle)	1	22	13	240	<0.005
Flounder (liver)	2	25	1	324	<0.005
Mullet (muscle)	3	42	404	499	NS
Mullet (liver)	[4]4				
Blue crab	5	23	60	216	<0.01
Hard clam	[5]6				
American oyster	7	20	0	210	<0.005

[1] Total number of analytes in the particular data set that were detected at least once in either the pier or tide gate sides of the causeway.
[2] Sum of the negative and positive ranks. These values should be roughly equal if neither data set consistently has higher average analyte concentrations (see text).
[3] As provided in Siegel, 1956.
[4] No analysis of Batch No. 4 (mullet liver) data was done because of insufficient sample size.
[5] No analysis of Batch No. 6 (clams) data was done because no clams were collected on the pier side of the causeway

Note: NS = not significant.

Table 4-7
Profiles of Species

Extended Site Inspection
Causeway Landfill, MCRD
Parris Island, South Carolina

Species	Description	Trophic Level (principle)	Feeding Mode (adult)	Primary Food
Striped mullet	Transient fish	Primary consumer	Benthic herbivore and detritivore	Aquatic vegetation detritus, and inorganic sediment.
Summer flounder	Migratory fish	Tertiary consumer	Active carnivore	Fish and large invertebrates.
Blue crab	Mobile epifauna	Secondary/tertiary consumer	Active omnivore	Fish, macro invertebrates, and aquatic vegetation.
Hard clam	Sessile infauna	Primary consumer	Filter feeder	Plankton and microorganisms[1].
American oyster	Sessile epifauna	Primary consumer	Filter feeder	Plankton and microorganisms[1].
Shrimp[2]	Mobile	Primary/secondary consumer	Active encounter omnivore	Plant detritus, algae, microorganisms, and invertebrates.

[1] Including diatoms, flagellates, bacteria, detritus, and silt.
[2] Not sampled, but shown for reference purposes.

likely to be much greater. Mobile fish species that may inhabit one source area for only a small part of their life (such as would be the case on the tide gate side) would receive only a limited exposure to any contaminant and never come into equilibrium (USEPA, 1991).

Due to fishing activity at the site described in Subsection 3.1.2 as well as the longer residence times expected for mobile species on the pond side, samples for this area should provide a worst case scenario for analysis. The more complete sample set from this side represents an adequate hazard scenario for contaminant uptake in biota. Because this is also where the majority of fishing effort is concentrated, any human exposure is also maximized on the pond side. An analysis of information from this side of the causeway provides, essentially, a worst case exposure scenario that permits a conservative assessment and affords adequate protection to potential recreational fishermen.

5.0 CONCLUSIONS

Results of the ESI indicate that maximum chemical tissue concentrations for the five species sampled (mullet, flounder, crab, clam, and oyster) are below USFDA action levels for samples collected on both the pond and tidal creek side of the causeway. PAHs and mercury concentrations in oysters collected from the pond and tidal creek were in the range of those of the South Carolina and Georgia Mussel Watch sites. PCB concentrations in oysters from the P1 and P2 sites were considerably higher than from the TG1 and TG2 sites (tidal creek) and higher than the South Carolina and Georgia Mussel Watch sites. The P1, P2, and TG1 sites all had oyster DDT levels that were higher than the South Carolina and Georgia Mussel Watch sites.

Although there were no cases where USFDA action levels were exceeded at the Causeway Landfill site, it is not possible to conclude that there is no public health risk associated with the consumption of seafood caught at the site based on these findings. USFDA action levels are not appropriate or adequately protective for the Causeway Landfill because (1) the USFDA approach does not explicitly provide a clear link between levels of actual risk used in a risk assessment approach; (2) USFDA action levels are not suitable for subpopulations of anglers, such as those at the MCRD, who may tend to consume more fish than the general public and often fish in the same location; and (3) not all contaminants of concern have USFDA action levels.

USFDA action levels are designed to protect the general public from fish shipped in interstate commerce. These established action levels are based on a risk management approach that includes a consideration of the adverse economic impacts likely to accrue to the commercial fishery as a result of an advisory or closure. As such, they reflect a balance between public health protection and the economics involved in the loss of commercial fish to the consumer. Although perhaps appropriate for purchased seafood and "average" consumers, the USFDA action level approach does not explicitly provide the same link between levels of risk and the levels of fish consumption as in a risk assessment approach (Reinert, *et al.*, 1991).

As a result of the focus on interstate commerce, USFDA action levels are based on national patterns of consumption that are often quite different than those of local recreational and/or subsistence anglers (USEPA, 1989). Although the results from the tissue analysis indicated the maximum observed levels from the causeway site were far below the USFDA action levels, anglers at the Causeway Landfill are recreational fishermen (there is no commercial fishery) and, therefore, the exposure scenario used in the USFDA approach may not be valid for these fishermen. However, the base population at MCRD is highly transient and the area around the causeway is not used for shellfishing, thereby reducing the potential exposures.

A preliminary review of risk-based levels established by USEPA Region III, Water Quality Standards Unit in their "Toxic Substance Spreadsheet" (October 29, 1991, edition) suggests that these values are much more conservative than USFDA action levels. Data from the Causeway Landfill fall somewhere between USFDA and USEPA levels. These USEPA fish tissue concentrations are the fish tissue values from which the USEPA human health water quality criteria are calculated using established bioconcentration factors. These are used to evaluate the health risk associated with fish tissue data for priority pollutants.

Before drawing conclusions regarding human health risk using these criteria, the data must be further reviewed, the statistical attributes of the data evaluated, and the appropriate summary statistics (e.g., 95 percent upper confidence limit or other estimates of maximum probable concentration) developed to assess risk.

REFERENCES

Anderson, W.W., and Lunz, G.R., 1965. "Marine Resources of the Atlantic Coast; Southern Shrimp"; Leaflet No. 4; Atlantic States Marine Fisheries Commission; 6pp.

Bahr, L.M. and W.P. Lanier, 1981. "The Ecology of Intertidal Oyster Reefs of the South Atlantic Coast: A Community Profile". U.S. Fish and Wildlife Service, Biological Services Program, Washington, D.C. FWS/OBS 81/15.

Battelle, 1991. "Phase 6, Draft Final Report. Collection of Bivalve Mussels and Surficial Sediments from Coastal U.S. Atlantic and Pacific Locations and Analyses for Organics and Trace Metals"; prepared for the Department of Commerce, National Oceanic and Atmospheric Administration, Ocean Assessment Division.

Burrell, V.G. Jr., 1986. "Species Profiles: Life Histories and Environmental Requirements Coastal Fishes and Invertebrates (South Atlantic) -- American Oyster"; U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.57); U.S. Army Corps of Engineers, TR EL-82-4; 17pp.

Calabrese, A., 1972. "How Some Pollutants Affect Embryos and Larvae of American Oyster and Hard Shell Clam"; U.S. Nat. Mar. Fish. Serv. Mar. Fish Rev.

Collins, M.R., 1985. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Florida) -- Striped Mullet"; U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.34); U.S. Army Corps of Engineers; TR EL-82-4; 11pp.

Cunningham, P.A., J.M. McCarthy, and D. Zutlan, 1990. "Results of the 1989 Census of State Fish/Shellfish Consumption Advisory Programs"; Research Institute Report, Research Triangle Park, NC.

Enge, K.M. and R. Mulholland, 1985. "Habitat Suitability Index Models: Southern and Gulf Flounders"; U.S. Fish Wildl. Serv. Biol. Rep. 82(10.92). 25pp.

Eversole, A.G., 1987. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic) -- Hard Clam"; U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.75); U.S. Army Corps of Engineers; TR EL-82-4; 33pp.

Galtsoff, P.S., 1964. "The American Oyster, Crassostrea viginica, Gmelin" U.S. Fish and Wildlife Service, Fisheries Bulletin, 480 p.

KEMRON Environmental Services, Inc., 1990. Extended Site Inspection Work Plan. The Causeway Landfill, Marine Corps Recruit Depot, Parris Island, South Carolina, UIC: M00263. KEMRON, Atlanta, Georgia.

REFERENCES (Continued)

Mulholland, R., 1984. "Habitat Suitability Index Models: Hard Clam"; U.S. Fish Wildl. Serv. FWS/OBS-82/10.77. 21pp.

NEESA, 1985. "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program'; Prepared for the Department of Energy; Environmental Restoration Department; Naval Energy and Environmental Support Activity 20.2-047B.

NEESA, 1986. "Initial Assessment Study of Marine Corps Recruit Depot, Parris Island, South Carolina"; Prepared by Dames and Moore, Bethesda, MD for the Environmental Restoration Department of the Navy Energy and Environmental Support Activity.

NEESA, 1988. "Remedial Investigation, Marine Corp Recruit Depot, Verification Step, Parris Island, South Carolina, UIC: M00263. McClelland Engineers, Inc., Houston, Texas; September 1988.

National Oceanic and Atmospheric Administration (NOAA), 1989. "A Summary of Data on Tissue Contamination from the First Three Years (1986-1988) of the Mussel Watch Project"; NOAA Technical Memorandum NOS OMA 49; August 1989.

Quantitative Risk Assessment Committee, (QRAC) 1990. "Estimation of Risk Associated with the Consumption of Oil Contaminated Fish and Shellfish by Alaskan Subsistence Fishermen Using a Benzo[a]pyrene Equivalency Approach.

Reinert, R.E., B.A. Knuth, M.A. Kamrin, and Q.J. Stober, 1991. "Risk Assessment, Risk Management, and Fish Consumption Advisories in the United States"; Fisheries, Vol. 16, No. 6, pp. 5-12.

Rogers, S.G., and M.J. Van Den Avyle, 1983. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic) Summer Flounder"; U.S. Fish. Wildl. Serv. FWS/OBS-82/11.15. U.S. Army Corps of Engineers, TR EL-82-4. 14pp.

Siegel, S. 1956. "Nonparametric Statistics for the Behavioral Sciences" McGraw-Hill Book Company, New York; 311 pp.

Sokal, R.R., and F.J. Rohlf, 1969. "Biometry - The Principles and Practice of Statistics in Biological Research"; W.H. Freeman and Company; San Francisco; 776 pp.

SCDHEC, 1990. "State of South Carolina Monitoring Strategy for Fiscal Year 1991"; Technical Report No. 007-90.

U.S. Environmental Protection Agency (USEPA), 1989. "Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual"; Office of Water Regulations and Standards, EPA-503/8-89-002

REFERENCES (Continued)

U.S. Environmental Protection Agency (USEPA), 1991. "Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

USEPA, 1991. "Technical Support Document for Water Quality-Based Toxics Control"; EPA/505/2-90-001; Office of Water.

USEPA, 1992. "EMAP Monitor, Environmental Monitoring and Assessment Program"; USEPA Office of Research and Development, March 1992; EPA 600/M-91-051.

U.S. Department of Health and Human Services, 1991. "Pesticide Residues, USFDA's Criteria for Enforcement Actions"; No. 7141.01.

U.S. Food and Drug Administration (USFDA), 1987. "Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed."

Van Den Aryle, M.J. and D.L. Fowler, 1984. Species Profiles: Life History and Environmental Requirements of Coastal Fishes and Invertebrates (South Atlantic) Blue Crab; U.S. Army Corps of Engineers, TR EL-82-4. 16 pp.

Varanasi, U., Chan, S.L., MacLeod, W.D., Stien, J.E., D.W. Burrows, D.G. Tilbury, K.L. Landahl, C.A. Wigren, and S.M. Pierce, 1990. "Survey of Subsistence Fish and Shellfish for Exposure to Oil Spilled from the Exxon Valdez, Summary Cycles I-III", Environmental Conservation Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOA, Settle, Washington.

APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL

A-1

Field Sampling Plan

SAMPLE COLLECTION, HANDLING AND SHIPPING

Sample Collection

Four samples of each of mullet and fish, and five samples of each of shrimp, oyster, clam, and crab will be collected at each of four sites. This includes one sample of each matrix/type from each of the four sites as a sample for archival (**ARCH**). Additionally, one field duplicate (**DUP**) will be collected for each of the six sample matrices/types. It is important that all animals collected for each matrix/type be of the same species (i.e., all clams collected at all sites should be of the same species).

- If possible, collect sufficient biomass to yield a final, laboratory homogenized, tissue sample volume of 1 to 2 cups. This is equivalent to approximately 20 average (7 to 10 cm shell length) size oysters. Remember, crab and shrimp will be homogenized whole body but only the edible tissue of the clam, oyster, and fish will be used for analysis. If large amounts of animals are caught at a station, select an appropriate number of representative animals for the sample. Remove any debris and rinse off any excess mud using water from the site. Use polyethylene gloves at all times when handling the samples. Rinse and/or change gloves whenever necessary.

- Place the newly caught, undisturbed animals on the dull side of a 2' to 3' piece of aluminum foil. Wrap the sample, trying to completely seal the sample with the aluminum foil. Place the wrapped sample on the dull side of a second piece of aluminum foil, and wrap securely. If necessary, split the animals that comprise the sample into more than one "package" should there be more animals than will fit into one package and one Ziploc bag.

- Complete the information needed on the Sample Collection Form and the Sample Labels, using a non-erasable pen. If the sample is a field duplicate write -**DUP** in the space immediately following the pre-printed sample ID on each of the labels. If the sample is one of the samples for archival indicae the site rep/station identification (01, 02, 03, or 04) where the -**ARCH** sample was collected when completing the Sample Collection Form for that sample. The Comments/Visual Observations part of the form can be used for this type of information. The following identification codes will be used whenever abbreviated:

Site ID:	P1, P2, TG1, and TG2
Sample Matrix/Type	MU (mullet)
FI (fish)	
	SH (shrimp)
	OY (oyster)
	CL (clam)
	CR (crab)
Site Rep:	01, 02, 03, 04, and ARCH for shrimp, oyster, clam, and crab

01, 02, 03, and ARCH for mullet and fish (only three site replicates collected for analysis).

- Affix one of the labels to the Sample Collection Form, one label to the aluminum-foil package(s), and one label to the Ziploc bag(s).

- Wrap the aluminum-foil package at least twice completely around with clear packaging tape, ensuring the tape covers the label on the package. Place the package inside the Ziploc bag and seal. Place the sample package in a cooler with dry ice.

Handling

- Keep the samples on dry ice or in a freezer at all times following sample collection.

- At the end of each day's sampling activities, place the completed Sample Collection Forms in Ziploc bags and inside the cooler containing the samples to which the forms correspond. Tape the Ziploc bag to the inside of the lid of the cooler.

- The ABB Field Scientist has custody of all samples at all times in the field. At the end of each day's sampling activities, complete the Field Chain-of-Custody Forms and place them in Ziploc bags and inside the cooler containing the samples to which the forms correspond. Tape the Ziploc bag to the inside of the lid of the cooler.

Shipping

- Ship samples at the end of each sample collection day. Do not store samples for shipping on another day, unless absolutely necessary. Sample shipping is expected to occur on 11/22 (Friday), 11/23 (Saturday), and 11/24 (Sunday), with the possibility of a final shipment on 11/25 (Monday).

- Replenish the dry ice in the coolers at the end of the day, shortly before sealing the coolers for shipping. If the coolers will not be delivered in the morning of the following day (a possibility with Saturday shipment) make sure there is enough dry ice in the coolers to ensure that the samples remain frozen until delivery. Affix the completed Federal Express label and seal the cooler securely with the reinforced packaging tape. Remember to indicate that the coolers contain dry ice.

- Ship the coolers with the samples, Sample Collection Forms, and Chain-of-Custody Forms to Battelle Ocean Sciences in Duxbury, MA, using Federal Express next-day morning-delivery service. Do not use the afternoon delivery option. If there is no Sunday delivery and you have samples for Saturday shipment then ensure that they will be delivered on Monday morning.

- Call the Battelle Project Manager on the day of shipment, or in the morning of the next day, to notify him of each shipment.

TABLE A-1

LIST OF PERTINENT STANDARD OPERATING PROCEDURES USED IN THIS STUDY

SOP 6-007	Chemistry Laboratory Sample Custody and Laboratory Sample Identification
SOP 6-010	Chemistry Laboratory Sample Control
SOP 5-190	Tissue Extraction for Trace Level Semivolatile Organic Compounds Including Lipid Weight Determination
SOP 5-157	Identification and Quantification of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Selective Detector (GC/MSD)
SOP 5-191	HPLC Cleanup of Sediment and Tissue Extracts for Semi-Volatile Organic Contaminants
SOP 5-025	Gas Chromatography Protocols
SOP 5-140	Preparation of Wet Tissue Samples for Trace Metal Analysis Using MDS-81D Microwave Digestion System
SOP 5-128	Identification and Quantification of Polychlorinated Biphenyls (by Congeners and Aroclor) and Pesticides by Gas Chromatography/Electron Capture Detection
SOP 5-088	The Analyses of Prepared Samples for Mercury Analysis
SOP 3-089	Operation of the MDS-81D Microwave Digestion System
SOP 3-070	Operation of an LDC Mercury Monitor

A-2

Laboratory Analysis

TABLE A-2

QUALITY CONTROL DATA CRITERIA GOALS

Organics (PAH and PCB/Pesticides)	
Surrogate recovery	40%-120%
Blank spike analyte *relative* recovery	50%-150%[a]
Blank spike analyte *absolute* recovery	40%-120%[a]
Blank spike precision	30% RPD[b]
Matrix spike analyte *relative* recovery	50%-150%[a]
Matrix spike analyte *absolute* recovery	40%-120%[a]
Matrix spike precision	30% RSD[c]
SRM accuracy	±30% of certified value[d]
SRM quantification precision	30% RSD[e]
Procedural blank	<5 × detection limit
Mercury	
Blank spike analyte recovery	50%-120%
Blank spike precision	20% RPD[b]
Matrix spike analyte recovery	50%-120%
Matrix spike precision	20% RSD[c]
SRM accuracy	±20% of certified value[d]
Sample duplicate precision	20% RPD[f]
Procedural blank	<5 × detection limit

[a] *Relative* recoveries are based on quantification relative to the quantification internal standards (surrogate compounds), and is the way the field samples were quantified. *Absolute* recoveries are based on quantification relative to the recovery internal standard, and is the way surrogate recoveries were determined. Relative recoveries of target analytes were reported in the organics BS and MS tables because this is the information that best represents the accuracy of the field sample quantification. However, since the relative recovery criteria were not specified in the Work Plan, the more stringent absolute recovery criteria were used to qualify BS and MS data.
[b] RPD of recoveries determined for the two duplicates in each analytical batch of samples.
[c] Precision in the recoveries determined for the seven MS samples.
[d] Accuracy of PAH and mercury determination of SRM samples relative to certified values.
[e] Precision of PCB/pesticide quantification of the seven SRM samples. No certified values exist for PCB/pesticides.
[f] RPD in values determined for the two laboratory duplicates in each analytical batch of samples.

TABLE A-3

FIELD SAMPLE COLLECTION, RECEIPT, AND HOLDING TIME EXPIRATION DATES

Tissue Type and Field ID	Date Collected	Date Received	Holding Time I[a]	Expiration Data II[b]
Fish – muscle (Batch #1)				
P1-FI-01	11/23/91	11/26/91	12/21/91	02/02/92
P1-FI-02	11/23/91	11/26/91	12/21/91	02/02/92
P1-FI-03	11/25/91	11/26/91	12/23/91	02/02/92
P1-FI-ARCH	11/24/91	11/26/91	12/22/91	02/02/92
P2-FI-01	11/23/91	11/26/91	12/21/91	02/02/92
P2-FI-02	11/23/91	11/26/91	12/21/91	02/02/92
TG2-FI-01	11/23/91	11/26/91	12/21/91	02/02/92
Fish – liver (Batch #2)				
P1-FI-01	11/23/91	11/26/91	12/21/91	02/04/92
P1-FI-02	11/23/91	11/26/91	12/21/91	02/04/92
P1-FI-03	11/25/91	11/26/91	12/23/91	02/04/92
P1-FI-ARCH	11/24/91	11/26/91	12/22/91	02/04/92
P2-FI-01	11/23/91	11/26/91	12/21/91	02/04/92
P2-FI-02	11/23/91	11/26/91	12/21/91	02/04/92
TG2-FI-01	11/23/91	11/26/91	12/21/91	02/04/92
Mullet – muscle (Batch #3)				
P1-MU-01	11/24/91	11/26/91	12/22/91	02/08/92
P1-MU-02	11/24/91	11/26/91	12/22/91	02/08/92
P1-MU-03	11/24/91	11/26/91	12/22/91	02/08/92
P2-MU-01	11/25/91	11/26/91	12/23/91	02/08/92
TG1-MU-01	11/23/91	11/26/91	12/21/91	02/08/92
TG1-MU-02	11/23/91	11/26/91	12/21/91	02/08/92
TG1-MU-03	11/23/91	11/26/91	12/21/91	02/08/92
TG2-MU-01	11/23/91	11/26/91	12/21/91	02/08/92
TG2-MU-02	11/23/91	11/26/91	12/21/91	02/08/92
TG2-MU-03	11/23/91	11/26/91	12/21/91	02/08/92
TG2-MU-DUP	11/23/91	11/26/91	12/21/91	02/08/92
Mullet – liver (Batch #4)				
P1-MU-01	11/24/91	11/26/91	12/22/91	02/10/92
P1-MU-02	11/24/91	11/26/91	12/22/91	02/10/92
P1-MU-03	11/24/91	11/26/91	12/22/91	02/10/92
P2-MU-01	11/25/91	11/26/91	12/23/91	02/10/92
TG1-MU-01	11/23/91	11/26/91	12/21/91	02/10/92
TG1-MU-02	11/23/91	11/26/91	12/21/91	02/10/92
TG2-MU-01	11/23/91	11/26/91	12/21/91	02/10/92
TG2-MU-02	11/23/91	11/26/91	12/21/91	02/10/92
TG2-MU-03	11/23/91	11/26/91	12/21/91	02/10/92
TG2-MU-DUP	11/23/91	11/26/91	12/21/91	02/10/92

[a] Completion of sample extraction for organics and completion of instrumental analysis for mercury.
[b] Completion of instrumental analysis for organics (60 days after actual sample extraction).

TABLE A-3 (Continued)

FIELD SAMPLE COLLECTION, RECEIPT, AND HOLDING TIME EXPIRATION DATES

Tissue Type and Field ID	Date Collected	Date Received	Holding Time I[a]	Expiration Data II[b]
Crab (Batch #5)				
P1-CR-01	11/23/91	11/26/91	12/21/91	02/11/92
P1-CR-02	11/23/91	11/26/91	12/21/91	02/11/92
P1-CR-03	11/23/91	11/26/91	12/21/91	02/11/92
P1-CR-04	11/23/91	11/26/91	12/21/91	02/11/92
P1-CR-DUP	11/23/91	11/26/91	12/21/91	02/11/92
P2-CR-01	11/23/91	11/26/91	12/21/91	02/11/92
P2-CR-02	11/23/91	11/26/91	12/21/91	02/11/92
P2-CR-03	11/23/91	11/26/91	12/21/91	02/11/92
P2-CR-04	11/23/91	11/26/91	12/21/91	02/11/92
TG2-CR-01	11/23/91	11/26/91	12/21/91	02/11/92
TG2-CR-02	11/23/91	11/26/91	12/21/91	02/11/92
Clam (Batch #6)				
TG1-CL-01	11/24/91	11/26/91	12/22/91	02/14/92
TG1-CL-02	11/24/91	11/26/91	12/22/91	02/14/92
TG2-CL-01	11/23/91	11/26/91	12/21/91	02/14/92
TG2-CL-02	11/23/91	11/26/91	12/21/91	02/14/92
TG2-CL-03	11/23/91	11/26/91	12/21/91	02/14/92
TG2-CL-04	11/23/91	11/26/91	12/21/91	02/14/92
TG2-CL-DUP	11/24/91	11/26/91	12/22/91	02/14/92
Oyster (Batch #7)				
P1-OY-01	11/25/91	11/26/91	12/23/91	02/15/92
P1-OY-02	11/25/91	11/26/91	12/23/91	02/15/92
P1-OY-03	11/25/91	11/26/91	12/23/91	02/15/92
P1-OY-04	11/25/91	11/26/91	12/23/91	02/15/92
P2-OY-01	11/25/91	11/26/91	12/23/91	02/15/92
P2-OY-02	11/25/91	11/26/91	12/23/91	02/15/92
P2-OY-03	11/25/91	11/26/91	12/23/91	02/15/92
P2-OY-04	11/25/91	11/26/91	12/23/91	02/15/92
TG1-OY-01	11/24/91	11/26/91	12/22/91	02/15/92
TG1-OY-02	11/24/91	11/26/91	12/22/91	02/15/92
TG1-OY-03	11/24/91	11/26/91	12/22/91	02/15/92
TG1-OY-04	11/24/91	11/26/91	12/22/91	02/15/92
TG2-OY-01	11/23/91	11/26/91	12/21/91	02/15/92
TG2-OY-02	11/23/91	11/26/91	12/21/91	02/15/92
TG2-OY-03	11/23/91	11/26/91	12/21/91	04/03/92[c]
TG2-OY-04	11/24/91	11/26/91	12/22/91	02/15/92
TG2-OY-DUP	11/24/91	11/26/91	12/22/91	02/15/92

[a] Completion of sample extraction for organics and completion of instrumental analysis for mercury.
[b] Completion of instrumental analysis for organics (60 days after actual sample extraction).
[c] Sample was re-extracted and received a new analysis holding time expiration date.

TABLE A-4

FIELD SAMPLE EXTRACTION AND INSTRUMENTAL ANALYSIS DATES

Tissue Type and Field ID	Sample Extraction Date Organics	Instrumental Mercury	Analysis Data PAH	PCB/Pesticide
Fish – muscle (Batch #1)				
P1-FI-01	12/04/91	12/05/91	12/18/91	12/28/91
P1-FI-02	12/04/91	12/05/91	02/01/92	02/15/92[a]
P1-FI-03	12/04/91	12/05/91	01/15/92	01/18/92
P1-FI-ARCH	12/04/91	12/05/91	02/01/92	02/15/92[a]
P2-FI-01	12/04/91	12/05/91	02/01/92	02/15/92[a]
P2-FI-02	12/04/91	12/05/91	02/01/92	02/28/92[a]
TG2-FI-01	12/04/91	12/05/91	02/01/92	02/15/92[a]
Fish – liver (Batch #2)				
P1-FI-01	12/06/91	12/11/91	12/19/91	12/29/91
P1-FI-02	12/06/91	12/11/91	01/15/92	01/18/92
P1-FI-03	12/06/91	12/11/91	02/01/92	02/16/92[a]
P1-FI-ARCH	12/06/91	12/11/91	01/15/92	01/18/92
P2-FI-01	12/06/91	12/11/91	01/15/92	01/19/92
P2-FI-02	12/06/91	12/11/91	01/15/92	01/19/92
TG2-FI-01	12/06/91	12/11/91	02/01/92	02/28/92[a]
Mullet – muscle (Batch #3)				
P1-MU-01	12/10/91	12/06/91	12/31/91	01/02/92
P1-MU-02	12/10/91	12/06/91	12/31/91	01/02/92
P1-MU-03	12/10/91	12/06/91	12/31/91	01/02/92
P2-MU-01	12/10/91	12/10/91	12/31/91	01/02/92
TG1-MU-01	12/10/91	12/06/91	12/27/91	01/01/92
TG1-MU-02	12/10/91	12/06/91	12/27/91	01/01/92
TG1-MU-03	12/10/91	12/06/91	12/28/91	01/02/92
TG2-MU-01	12/10/91	12/06/91	12/30/91	01/02/92
TG2-MU-02	12/10/91	12/06/91	12/30/91	01/02/92
TG2-MU-03	12/10/91	12/10/91	12/31/91	01/02/92
TG2-MU-DUP	12/10/91	12/06/91	12/31/91	01/02/92
Mullet – liver (Batch #4)				
P1-MU-01	12/12/91	12/11/91	12/31/91	01/02/92
P1-MU-02	12/12/91	12/11/91	12/31/91	01/02/92
P1-MU-03	12/12/91	12/11/91	12/31/91	01/03/92
P2-MU-01	12/12/91	12/11/91	01/02/92	01/03/92
TG1-MU-01	12/12/91	12/11/91	01/02/92	01/03/92
TG1-MU-02	12/12/91	12/11/91	01/03/92	01/03/92
TG2-MU-01	12/12/91	12/11/91	01/03/92	01/03/92
TG2-MU-02	12/12/91	12/11/91	01/03/92	01/03/92
TG2-MU-03	12/12/91	12/11/91	01/06/92	01/04/92
TG2-MU-DUP	12/12/91	12/11/91	01/03/92	01/04/92

[a] Originally analyzed on 12/28/91. Archived sample extract was re-fractionated through cleanup column and re-analyzed due to poor surrogate recoveries.

TABLE A-4 (Continued)

FIELD SAMPLE EXTRACTION AND INSTRUMENTAL ANALYSIS DATES

Tissue Type and Field ID	Sample Extraction Date Organics	Instrumental Mercury	Analysis Data PAH	PCB/Pesticide
Crab (Batch #5)				
P1-CR-01	12/13/91	12/10/91	01/03/92	01/16/92
P1-CR-02	12/13/91	12/10/91	01/03/92	01/16/92
P1-CR-03	12/13/91	12/10/91	01/03/92	01/17/92
P1-CR-04	12/13/91	12/10/91	01/03/92	01/17/92
P1-CR-DUP	12/13/91	12/10/91	01/03/92	01/17/92
P2-CR-01	12/13/91	12/10/91	01/03/92	01/17/92
P2-CR-02	12/13/91	12/10/91	01/03/92	01/17/92
P2-CR-03	12/13/91	12/10/91	01/03/92	01/17/92
P2-CR-04	12/13/91	12/11/91	01/04/92	01/17/92
TG2-CR-01	12/13/91	12/11/91	01/04/92	01/17/92
TG2-CR-02	12/13/91	12/11/91	01/04/92	01/17/92
Clam (Batch #6)				
TG1-CL-01	12/16/91	12/10/91	01/06/92	01/17/92
TG1-CL-02	12/16/91	12/10/91	01/07/92	01/17/92
TG2-CL-01	12/16/91	12/10/91	01/07/92	01/18/92
TG2-CL-02	12/16/91	12/10/91	01/07/92	01/18/92
TG2-CL-03	12/16/91	12/10/91	01/07/92	01/18/92
TG2-CL-04	12/16/91	12/10/91	01/07/92	01/18/92
TG2-CL-DUP	12/16/91	12/10/91	01/07/92	01/18/92
Oyster (Batch #7)				
P1-OY-01	12/17/91	12/10/91	01/08/92	01/25/92
P1-OY-02	12/17/91	12/10/91	01/08/92	01/25/92
P1-OY-03	12/17/91	12/10/91	01/08/92	01/25/92
P1-OY-04	12/17/91	12/10/91	01/08/92	01/26/92
P2-OY-01	12/17/91	12/10/91	01/08/92	01/26/92
P2-OY-02	12/17/91	12/10/91	01/08/92	01/26/92
P2-OY-03	12/17/91	12/10/91	01/08/92	01/26/92
P2-OY-04	12/17/91	12/10/91	01/08/92	01/26/92
TG1-OY-01	12/17/91	12/10/91	01/08/92	01/26/92
TG1-OY-02	12/17/91	12/10/91	01/08/92	01/26/92
TG1-OY-03	12/17/91	12/10/91	01/08/92	01/26/92
TG1-OY-04	12/17/91	12/10/91	01/08/92	01/26/92
TG2-OY-01	12/17/91	12/10/91	01/08/92	01/26/92
TG2-OY-02	12/17/91	12/10/91	01/08/92	03/04/92[b]
TG2-OY-03	02/03/92[c]	12/10/91	02/08/92[c]	02/16/92[c]
TG2-OY-04	12/17/91	12/10/91	01/08/92	01/27/92
TG2-OY-DUP	12/17/91	12/10/91	01/09/92	01/26/92

[b] Originally analyzed on 01/26/91. Sample was re-analyzed because the datafile was overwritten.
[c] Originally extracted on 12/17/91 and analyzed on 01/08/92 (PAH) and 01/26/92 (PCB/pesticides). Sample was re-extracted and re-analyzed due to poor surrogate recoveries.

TABLE A-5

CERTIFIED ANALYTE CONCENTRATIONS IN SRM MATERIALS

Analyte	Analyte Concentration (ng/g, dry weight)	
	SRM74[a]	SRM 1566a[a]
Phenanthrene	45 ± 11	
Anthracene	6.1 ± 1.7	
Fluoranthene	272 ± 47	
Pyrene	276 ± 30	
Perylene	8.5 ± 2.4	
Benzo[b]fluoranthene	52.3 ± 9.4	
Benzo[a]pyrene	18.6 ± 3.8	
Benzo[g,h,i]perylene	20.0 ± 2.3	
Indeno[1,2,3-cd]pyrene	14.6 ± 2.7	
Mercury	64.2 ± 6.7	

[a] Concentrations are from National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) certification documentation. The certified concentrations are means of results from two analytical techniques. The uncertainty limits cover the concentrations of approximately 95% of samples of this SRM. SRM 1974 is a mussel (*Mytilus edulis*) material. SRM 1566a is an oyster material.

A-3

Field and Laboratory Chain-of-Custody Forms

Cooler #6

000246

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type CL

Storage Conditions Dry Ice

Completed by A.F. Date 11-25-91

Sample Field IDs

	✓ TG1-CL-01	Package	of	
	✓ TG1-CL-02	Package	of	
No	TG1-CL-03	Package	of	
	✓ TG2-CL-CUP	Package	of	
	✓ TG2-CL-ARCH	Package	of	
	✓ TG2-CL-03	Package	of	
	✓ TG2-CL-02	Package	of	
	✓ TG2-CL-01	Package	of	
	✓ TG2-CL-04	Package	of	
		Package	of	
		Package	of	
		Package	of	
Sample	TG1-CL-03 Did not arrive. DPB 11-26-91	Package	of	
		Package	of	
		Package	of	
		Package	of	
		Package	of	
		Package	of	
		Package	of	
		Package	of	

Relinquished by (init/date)	Transport	Received by (init/date)
		DPB / 11-26-91

Cooler # 7

00024

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type MU - FI

Storage Conditions Dry Ice

Completed by Anita Pease Date 11-25-91

Sample Field ID			
P1 - MU - 01	Package 1	of	1
P1 - MU - 02	Package 1	of	1
P1 - MU - 03	Package 1	of	1
P2 - MU - 01	Package 1	of	1
TG1 - MU - 01	Package 1	of	1
TG1 - MU - 02	Package 1	of	1
TG1 - MU - 03	Package 1	of	1
TG1 - MU - ARCH	Package 1	of	1
TG2 - MU - 01	Package 1	of	1
TG2 - MU - 02	Package 1	of	1
TG2 - MU - 03	Package 1	of	1
TG2 - MU - ARCH	Package 1	of	1
TG2 - MU - DUP	Package 1	of	1
[illegible]	Package [illegible]	of	[illegible]
P1 - FI - 02	Package 1	of	1
P1 - FI 03	Package 1	of	1
P1 - FI - ARCH	Package 1	of	1
P2 - FI - 02	Package 1	of	1
TG2 - FI - 01	Package 1	of	1
P2 - FI - 01	Package 1	of	1

Relinquished by (init/date)	Transport	Received by (init/date)
		DRB / 11-26-91

Cooler #2

000248

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type OY

Storage Conditions [illegible]

Completed by AF Date 11.25.91

[redacted]			
P1-04-01	Package 1	of 2	
P1-04-01	Package 2	of 2	
P2-04-03	Package 1	of 2	
P2-04-03	Package 2	of 2	
P2-04-04	Package 1	of 2	
P2-04-04	Package 2	of 2	
P2-04-02	Package 1	of 2	
P2-04-02	Package 2	of 2	
P1-04-02	Package 1	of 2	
P1-04-02	Package 2	of 2	
P2-04-01	Package 1	of 2	
P2-04-01	Package 2	of 2	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	

Relinquished by (init/date)	Transport	Received by (init/date)
		DPB / 11-26-91

Cooler #5

000249

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type OY

Storage Conditions Dry Ice

Completed by Anita Rease Date 11-25-91

Sample Field ID			
✓ TG2-OY-04	Package 1	of	3
✓ TG2-OY-04	Package 2	of	3
✓ TG2-OY-04	Package 3	of	3
✓ TG2-OY-ARCH	Package 1	of	3
✓ TG2-OY-ARCH	Package 2	of	3
✓ TG2-OY-ARCH	Package 3	of	3
✓ TG2-OY-DUP	Package 1	of	3
✓ TG2-OY-DUP	Package 2	of	3
✓ TG2-OY-DUP	Package 3	of	3
✓ P1-OY-ARCH	Package 1	of	2
✓ P1-OY-ARCH	Package 2	of	2
✓ P1-OY-03	Package 1	of	2
✓ P1-OY-03	Package 1	of	2
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	

Relinquished by (init/date)	Transport	Received by (init/date)
		DPB / 11-26-91

Cooler 1 - Oysters

000250

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type OY

Storage Conditions Dry Ice

Completed by Anita Pease Date 11-25-91

Sample Field IDs

✓ TG1-OY-01	Package	1	of	3
✓ TG1-OY-01	Package	2	of	3
✓ TG1-OY-01	Package	3	of	3
✓ TG1-OY-02	Package	1	of	3
✓ TG1-OY-02	Package	2	of	3
✓ TG1-OY-02	Package	3	of	3
✓ TG1-OY-03	Package	1	of	3
✓ TG1-OY-03	Package	2	of	3
✓ TG1-OY-03	Package	3	of	3
✓ TG1-OY-04	Package	1	of	3
✓ TG1-OY-04	Package	2	of	3
✓ TG1-OY-04	Package	3	of	3
	Package		of	
	Package		of	
	Package		of	
	Package		of	
	Package		of	
	Package		of	
	Package		of	
	Package		of	

Relinquished by (init/date)	Transport	Received by (init/date)
		Daniel P. Bandor / 11-26-91

Cooler 3

000251

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type OY

Storage Conditions On Ice

Completed by Anita Rease Date 11-25-91

Sample Field IDs			
✓ TG1-OY-ARCH	Package 1	of	3
✓ TG1--OY-ARCH	Package 2	of	3
✓ TG1--OY-ARCH	Package 3	of	3
✓ TG2-OY-01	Package 1	of	3
✓ TG2-OY-01	Package 2	of	3
✓ TG2-OY-01	Package 3	of	3
✓ TG2-OY-02	Package 1	of	3
✓ TG2-OY-02	Package 2	of	3
✓ TG2-OY-02	Package 3	of	3
✓ TG2-OY-03	Package 1	of	3
✓ TG2-OY-03	Package 2	of	3
✓ TG2-OY-03	Package 3	of	3
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	
	Package	of	

Relinquished by (init/date)	Transport	Received by (init/date)
		DPB / 11-26-91

Cooler #4

000252

ABB/BATTELLE OCEAN SCIENCES

PARRIS ISLAND ENVIRONMENTAL ASSESSMENT STUDY

FIELD CHAIN-OF-CUSTODY FORM

ABB Project # 07540-04

Battelle Project # G2135-0001

Sample Matrix/Type CR - FI - 04

Storage Conditions Ring 10

Completed by AP Date 11.25.91

Sample Field IDs

✓ P2 - CR - 01	Package 1	of 1
✓ P2 - CR - 02	Package 1	of 1
✓ P2 - CR - 03	Package 1	of 1
✓ P2 - CR - 04	Package 1	of
✓ P2 - CR - ARCH	Package 1	of 1
✓ P1 - CR - 01	Package 1	of 1
✓ P1 - CR - 02	Package 1	of 1
✓ P1 - CR - 03	Package 1	of 1
✓ P1 - CR - 04	Package 1	of 1
✓ P1 - CR - DUP	Package	of
✓ P1 - CR - ARCH	Package 1	of
✓ T-2 - CR - 01	Package	of
✓ T-2 - CR - 02	Package	of
✓ P1 - FI - 01	Package	of
✓ P2 - 04 - ARCH	Package 1	of 2
✓ P2 - 04 - ARCH	Package 2	of 2
✓ P1 - 04 - 04	Package 1	of 2
✓ P1 - 04 - 04	Package 2	of 2
	Package	of
	Package	of

Relinquished by (init/date)	Transport	Received by (init/date)
		DPB / 11-26-91

Battelle Duxbury Operations
SAMPLE RECEIPT FORM

000253

Project Number 62135-0001 Client ABB / Parris Island Environmental Assessment Study

No. of Shipping Containers 11 Date/Time Received 11-26-91 / 1015
7 full of samples, 4 empty

SHIPMENT

Method of Delivery: ✓ Commercial Carrier (Airbill No. _____)
___ Hand delivered

COC Forms: ✓ Shipped with samples
___ No forms

COC Seal: ___ Seal on each container ___ Seal intact for each shippi
✓ No COC seal ___ Seal broken (list impacte

FEDERAL	900 5973 033
FEDERAL	900 5973 024
FEDERAL	900 5972 997
FEDERAL	900 5973 015
FEDERAL	900 5973 042
FEDERAL	900 5972 963
FEDERAL	900 5972 954
FEDERAL	900 5973 006
FEDERAL	900 5972 98
FEDERAL	900 5972 97

CUSTOMER PACKAGE TRACKING NUMBER — PULL UP

SAMPLES

Sample Labels: ✓ Sample labels agree with COC forms
___ Discrepancies (list below)

One Sample Missing - TG1-GL-03

COC Seal: ___ Seal on each sample container ___ Seal intact for each sample container
✓ No COC seal ___ Seal broken (list impacted samples)

Condition of Samples: ✓ Sample containers intact
___ Sample containers broken/leaking
(list impacted samples with description of problem)

Temperature upon receipt: ___ Ambient ___ Cool ✓ Frozen
Note: If temperature upon receipt differs from required conditions, describe deviation and list impacted samples:

Storage Location: Freezer # MW

Additional Comments:

Samples logged in by: David R. Burdon Date/Time 11-26-91 / 1200

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number 62135-0003 Sample matrix mullet liver

Storage conditions Freeze

Homogenized samples logged in by (initial/date) CWD /11-27-91

Sample IDs

TG2-MUL-03 ✓
TG2-Mul-01 ✓
TG2-Mul-02 ✓
P1,-Mul-01 ✓
P2-Mul-01 ✓
P1,Mul-03 ✓
TG1-Mul-02 ✓
P1-Mul-02 ✓
TG2-Mul-Dup ✓
TG1-Mul-01 ✓

Relinquished by (initial/date)	Received by (initial/date)	Storage location
CWD 11-27-91	JA / 11-27-91	walk-in freezer

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number 62135-0003 Sample matrix mullet meat

Storage conditions Freeze

Homogenized samples logged in by (initial/date) GWD / 12-02-91

Sample IDs

P2-MUM-01
P1-MUM-01
P1-MUM-02
P1-MUM-03
TG2-MUM-03
TG2-MUM-02
TG2-MUM-01
TG2-MUM-DUP
TG1-MUM-01
TG1-MUM-02
TG1-MUM-03

Relinquished by (initial/date)	Received by (initial/date)	Storage location
GWD / 12-02-91	JSA / 12-2-91	Walk-in Freezer

~~000136~~

000260

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number G2135-0003 Sample matrix Fish Liver

Storage conditions Freeze

Homogenized samples logged in by (initial/date) GWD 11-27-91

Sample IDs

P1-FIL-Arch ✓
P1-FIL-03 ✓
TG2-FIL-01 ✓
P2-FIL-02 ✓
P2-FIL-01 ✓
P1-FIL-02 ✓
P1-FIL-01 ✓

Relinquished by (initial/date)	Received by (initial/date)	Storage location
GWD 11-27-91	JA / 11.27.91	walk-in freezer

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number 62135-0003 Sample matrix Fish Meat

Storage conditions Freeze

Homogenized samples logged in by (initial/date) GWD 11-27-91

Sample IDs

P1-FIM-03 ✓
P1-FIM-Arch ✓
TG2-FIM-01 ✓
P1-FIM-02 ✓
P2-FIM-01 ✓
P1-FIM-01 ✓
P2-FIM-02 ✓

Relinquished by (initial/date)	Received by (initial/date)	Storage location
GWD 11-27-91	MA / 11-27-91	walk-in freezer

~~000138~~

000262

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number 62135-0003 Sample matrix Crab Tissue

Storage conditions Freezer

Homogenized samples logged in by (initial/date) GWD - 11-27-91

Sample IDs

P1-CR-03 ✓
TG2-CR-02 ✓
P1-CR-02 ✓
P2-CR-02 ✓
TG2-CR-01 ✓
P2-CR-03 ✓
P2-CR-01 ✓
P1-CR-Dup ✓
P2-CR-04 ✓
P1-CR-04 ✓
P1-CR-01 ✓

Relinquished by (initial/date)	Received by (initial/date)	Storage location
GWD / 11-27-91	JA / 11.27.91	walkin

~~000139~~

000263

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number G2135-0003 Sample matrix Clam Tissue

Storage conditions Freeze

Homogenized samples logged in by (initial/date) GWD / 11-27-91

Sample IDs

TG2-CL-Dup ✓
TG2-CL-04 ✓
TG2-CL-03 ✓
TG2-CL-02 ✓
TG2-CL-01 ✓
TG1-CL-02 ✓
TG1-CL-01 ✓

Relinquished by (initial/date)	Received by (initial/date)	Storage location
GWD 11-27-91	JA / 11.27.91	Walk in

~~000140~~

000264

BATTELLE OCEAN SCIENCES

LABORATORY CHAIN-OF-CUSTODY FORM

Project Number G2135-0003 Sample matrix OYSTER TISSUE

Storage conditions Freeze

Homogenized samples logged in by (initial/date) GWD/12-03-91

Sample IDs

TG2-OY-03	✓
TG1-OY-03	✓
P2-OY-01	✓
TG1-OY-02	✓
P1-OY-02	✓
TG2-OY-04	✓
TG1-OY-04	✓
P2-OY-02	✓
P2-OY-03	✓
P2-OY-04	✓
TG2-OY-01	✓
P1-OY-01	✓
P1-OY-03	✓
TG2-OY-DUP	✓
P1-OY-04	✓
TG1-OY-01	✓
TG2-OY-02	✓

Relinquished by (initial/date)	Received by (initial/date)	Storage location
GWD / 12-03-91	RO 12/03/91	Walk-In Freezer

APPENDIX B

LABORATORY DATA

TABLE B-1

DATA QUALIFIERS

Data Qualifier	Purpose
J	Detected, but below the MDL[a].
E	Estimate; significant matrix interference.
B[b]	Analyte detected in the procedural blank at >5 × the MDL[a].
ND	Not detected; a value of 0 will be reported in the concentration/value column.
NC[c]	Not confirmed; identified and quantified using primary column analysis but was not qualitatively confirmed in the second-column analysis (PCB/pesticide data).
&	QC value outside the accuracy criteria goal.
*	QC value outside the precision criteria goal.

[a] The organics MDLs reported in the MDL table were determined with an average sample weight of 2.23 g. Separate MDLs were calculated for each matrix type (analytical batch) in this study, by correcting the original MDLs using the average sample weight for each matrix/batch. Average weights of 6.440 g (batches 1 and 3), 1.289 g (batches 2 and 4), 8.683 g (batch 5), 2.198 g (batch 6), and 3.246 g (batch 7) were used. Mercury MDLs were determined for each batch in the laboratory for this study.
[b] This qualifier was used to qualify both the Procedural Blank sample data (reported on a dry weight basis using the approximate average sample dry weight of the analytical batch) and all affected field sample data.
[c] Qualitative (not quantitative) second-column confirmation for pesticides was performed for this study. Lindane, 2,4-DDD, and 4,4-DDT coelute with Cl_3(18), Cl_5(118), and Cl_7(187), respectively, on the confirmatory column. These pesticides could therefore not be confirmed when they and the coeluting PCB congener were both identified in the primary analysis, even though the pesticide might have been present in the sample.

Field Sample Data — Polynuclear Aromatic Hydrocarbons (PAH)

Parris Island Tissue Analysis
PAH Data in ug/kg DRY WEIGHT for BATCH1
Report Date: LAL 01/21/92 15:22
G2135-0002 Edited : LAL 2/24/92
File Name: PAHFIELD.WK1

Sample Number:	P1-FIM-01	P1-FIM-02	P1-FIM-03	P1-FIM-ARCH	P2-FIM-01	P2-FIM-02	TG2-FIM-01
Batch Number:	BATCH1	BATCH1	BATCH1	BATCH1	BATCH1	BATCH1	BATCH1
Sample Dry Weight (g):	7.324	6.635	3.317	6.117	6.755	5.243	6.736
Sample Lipid Weight (g/g):	0.1876	0.0482	0.0422	0.0523	0.0380	0.0703	0.0351
naphthalene	3.36 J	6.69	19.76	6.70	6.20	10.09	6.30
2-methylnaphthalene	2.56 J	3.52 J	8.17	3.10 J	2.59 J	4.44 J	4.38 J
1-methylnaphthalene	1.98 J	2.43 J	4.47 J	2.09 J	1.95 J	3.58 J	3.20 J
biphenyl	2.45 J	3.77 J	4.37 J	6.35 J	1.68 J	3.59 J	1.39 J
2,6-dimethylnaphthalene	1.29 J	1.70 J	3.23 J	1.19 J	1.19 J	1.72 J	2.66 J
acenaphthylene	0.49 J	0.23 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
acenaphthene	0.83 J	0.67 J	0.00 ND	0.00 ND	0.60 J	0.00 ND	0.50 J
1,6,7-trimethylnaphthalene	0.48 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
fluorene	2.87 J	2.22 J	2.61 J	1.31 J	1.92 J	1.75 J	1.24 J
phenanthrene	4.44 J	3.54 J	3.33 J	1.35 J	2.70 J	1.85 J	1.25 J
anthracene	0.58 J	0.55 J	0.83 J	0.00 ND	0.15 J	0.28 J	0.20 J
1-methylphenanthrene	0.30 J	0.65 J	0.00 ND	0.27 J	0.24 J	0.53 J	0.32 J
fluoranthene	1.58 J	1.94 J	1.93 J	0.71 J	1.18 J	0.92 J	0.48 J
pyrene	0.59 J	1.35 J	1.37 J	0.66 J	0.52 J	0.76 J	0.42 J
benz[a]anthracene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
chrysene	0.27 J	0.67 J	0.92 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[b]fluoranthene	0.20 J	0.28 J	0.00 ND	0.00 ND	0.34 J	0.00 ND	0.00 ND
benzo[k]fluoranthene	0.14 J	0.16 J	0.00 ND	0.00 ND	0.15 J	0.00 ND	0.00 ND
benzo[e]pyrene	0.13 J	0.20 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[a]pyrene	0.14 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
perylene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
indeno[1,2,3-c,d]pyrene	0.00 ND	0.22 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
dibenz[a,h]anthracene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[g,h,i]perylene	0.33 J	0.70 J	0.00 ND	0.00 ND	0.47 J	0.00 ND	0.00 ND

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PAH Data in ug/kg DRY WEIGHT for BATCH3
Report Date: LAL 01/16/92 14:03
G2135-0002
File Name: PAHFIELD.WK1

Sample Number:	P1-MUM-01	P1-MUM-02	P1-MUM-03	P2-MUM-01	TG1-MUM-01	TG1-MUM-02	TG1-MUM-03	TG2-MUM-01	TG2-MUM-02	TG2-MUM-03	TG2-MUM-DUP
Batch Number:	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3
Sample Dry Weight (g):	5.359	6.299	4.932	8.521	7.261	7.388	3.939	7.579	6.626	6.733	7.070
Sample Lipid Weight (g/g):	0.1523	0.0505	0.1603	0.2195	0.3013	0.1254	0.1618	0.2516	0.1333	0.0618	0.1066
naphthalene	5.69	4.46	5.17	6.77	8.32	4.92	5.98	6.52	5.72	5.42	4.98
2-methylnaphthalene	3.15 J	2.11 J	2.59 J	5.01	13.46	4.79 J	3.59 J	11.28	4.51 J	3.98 J	5.92
1-methylnaphthalene	1.69 J	1.59 J	1.71 J	3.10 J	7.31	2.48 J	2.21 J	5.73	2.18 J	2.56 J	3.12 J
biphenyl	1.13 J	0.89 J	1.26 J	2.03 J	3.09 J	0.00 ND	0.00 ND	2.42 J	1.09 J	0.87 J	1.16 J
2,6-dimethylnaphthalene	1.20 J	0.78 J	1.09 J	2.02 J	4.76 J	1.65 J	0.00 ND	5.43 J	1.34 J	0.87 J	3.09 J
acenaphthylene	0.00 ND	0.00 ND	0.00 ND	0.62 J	0.87 J	0.00 ND	0.00 ND	1.01 J	0.00 ND	0.00 ND	0.00 ND
acenaphthene	0.91 J	0.65 J	0.00 ND	3.33 J	3.89 J	0.95 J	0.00 ND	2.42 J	0.00 ND	0.73 J	0.60 J
1,6,7-trimethylnaphthalene	0.00 ND	0.00 ND	0.00 ND	0.60 J	1.54 J	0.00 ND	0.00 ND	1.73 J	0.00 ND	0.00 ND	0.58 J
fluorene	1.74 J	1.18 J	1.42 J	4.81	5.56	1.53 J	1.30 J	4.03 J	1.09 J	1.04 J	1.25 J
phenanthrene	3.41 J	2.22 J	2.26 J	7.80	7.12	2.28 J	1.82 J	6.96	2.30 J	2.45 J	2.32 J
anthracene	0.00 ND	0.00 ND	0.00 ND	0.47 J	0.97 J	0.00 ND	0.00 ND	0.46 J	0.42 J	0.24 J	0.00 ND
1-methylphenanthrene	0.26 J	0.00 ND	0.00 ND	0.31 J	0.00 ND	0.00 ND	0.00 ND	0.35 J	0.25 J	0.28 J	0.29 J
fluoranthene	0.70 J	0.68 J	0.78 J	2.46 J	2.55 J	0.74 J	1.04 J	2.54 J	1.32 J	1.42 J	1.09 J
pyrene	0.61 J	0.37 J	0.44 J	1.07 J	1.07 J	0.32 J	0.00 ND	1.06 J	0.37 J	1.04 J	0.52 J
benz[a]anthracene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
chrysene	0.20 J	0.00 ND	0.00 ND	0.32 J	1.27 J	0.00 ND	0.00 ND	0.42 J	0.00 ND	0.23 J	0.00 ND
benzo[b]fluoranthene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	1.19 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[k]fluoranthene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.38 J	0.00 ND	0.00 ND	0.00 ND
benzo[e]pyrene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.26 J	0.00 ND	0.00 ND	0.00 ND
benzo[a]pyrene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
perylene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
indeno[1,2,3-c,d]pyrene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
dibenz[a,h]anthracene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[g,h,i]perylene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.42 J	0.00 ND	0.28 J	0.00 ND

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parri. ‹and Tissue Analysis
PAH Data in ug/kg DRY WEIGHT for BATCH5
Report Date: LAL 01/16/92 14:11
G2135-0002
File Name: PANFIELD.WK1

Sample Number:	P1-CR-01	P1-CR-02	P1-CR-03	P1-CR-04	P1-CR-DUP	P2-CR-01	P2-CR-02	P2-CR-03	P2-CR-04	TG2-CR-01	TG2-CR-02
Batch Number:	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5
Sample Dry Weight (g):	7.176	6.902	7.472	9.753	8.898	9.609	7.727	10.029	8.711	8.950	10.391
Sample Lipid Weight (g/g):	0.0614	0.1101	0.0335	0.0361	0.0327	0.0446	0.1640	0.0235	0.0331	0.0463	0.0189
naphthalene	4.31	4.81	3.77	2.19 J	3.48	5.12	4.08	2.95	3.08	4.43	3.61
2-methylnaphthalene	3.91	4.50	2.97 J	1.76 J	2.93 J	4.48	3.21 J	3.25 J	3.48 J	6.07	4.97
1-methylnaphthalene	2.20 J	2.41 J	1.41 J	1.17 J	1.97 J	2.35 J	1.60 J	4.29	2.08 J	5.81	1.88 J
biphenyl	0.98 J	1.74 J	0.00 ND	0.49 J	4.98	1.05 J	3.53 J	0.94 J	1.00 J	0.35 J	0.66 J
2,6-dimethylnaphthalene	0.86 J	1.11 J	0.00 ND	0.71 J	1.02 J	1.19 J	0.65 J	0.75 J	1.13 J	1.12 J	1.08 J
acenaphthylene	0.00 ND	0.36 J	0.00 ND	0.00 ND	0.00 ND	0.29 J	0.00 ND	0.31 J	0.25 J	0.21 J	0.00 ND
acenaphthene	1.20 J	2.67 J	0.00 ND	0.42 J	2.91 J	3.40 J	1.02 J	2.03 J	3.02 J	2.15 J	0.51 J
1,6,7-trimethylnaphthalene	0.62 J	0.00 ND	0.00 ND	0.49 J	0.00 ND	0.35 J	0.00 ND	0.29 J	0.41 J	0.00 ND	0.16 J
fluorene	1.17 J	2.15 J	0.89 J	0.86 J	1.33 J	1.24 J	0.77 J	0.94 J	1.05 J	0.50 J	0.46 J
phenanthrene	1.58 J	2.63 J	1.28 J	1.23 J	2.05 J	1.41 J	1.27 J	1.31 J	1.04 J	0.70 J	0.88 J
anthracene	0.26 J	0.36 J	0.00 ND	0.12 J	0.35 J	0.18 J	0.22 J	0.15 J	0.16 J	0.00 ND	0.13 J
1-methylphenanthrene	0.30 J	0.38 J	0.00 ND	0.56 J	0.00 ND	0.29 J	0.31 J	0.28 J	0.22 J	0.15 J	0.30 J
fluoranthene	0.90 J	2.03 J	0.73 J	0.70 J	1.40 J	0.68 J	1.16 J	0.79 J	0.65 J	0.35 J	0.46 J
pyrene	0.88 J	1.74 J	0.76 J	0.74 J	1.13 J	0.61 J	0.84 J	0.60 J	0.59 J	0.38 J	0.47 J
benz[a]anthracene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
chrysene	0.32 J	0.79 J	0.00 ND	0.31 J	0.62 J	0.21 J	0.39 J	0.26 J	0.26 J	0.00 ND	0.18 J
benzo[b]fluoranthene	0.33 J	0.95 J	0.00 ND	0.23 J	0.00 ND	0.19 J	0.37 J	0.21 J	0.21 J	0.00 ND	0.00 ND
benzo[k]fluoranthene	0.19 J	0.58 J	0.00 ND	0.17 J	0.00 ND	0.15 J	0.31 J	0.18 J	0.20 J	0.00 ND	0.00 ND
benzo[e]pyrene	0.00 ND	0.35 J	0.00 ND	0.10 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[a]pyrene	0.00 ND	0.52 J	0.00 ND	0.50 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
perylene	0.00 ND	0.27 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
indeno[1,2,3-c,d]pyrene	0.00 ND	0.27 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
dibenz[a,h]anthracene	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[g,h,i]perylene	0.00 ND	0.58 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PAH Data in ug/kg DRY WEIGHT for BATCH7
Report Date: LAL 01/17/92 07:48
G2135-0002
File Name: PAHFIELD.WK1

Sample Number:	P1-OY-01	P1-OY-02	P1-OY-03	P1-OY-04	P2-OY-01	P2-OY-02	P2-OY-03	P2-OY-04	TG1-OY-01	TG1-OY-02
Batch Number:	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7
Sample Dry Weight (g):	3.375	3.649	4.436	3.535	3.759	3.940	3.599	3.808	2.680	2.794
Sample Lipid Weight (g/g):	0.1234	0.0937	0.1114	0.0640	0.0936	0.0867	0.0845	0.1058	0.0647	0.0657
naphthalene	7.94	4.91 J	4.32 J	5.27 J	9.09	5.76 J	5.92 J	6.79 J	7.41 J	6.28 J
2-methylnaphthalene	9.38 J	6.99 J	7.62 J	6.50 J	10.51	11.20	7.89 J	8.66 J	5.12 J	4.03 J
1-methylnaphthalene	5.36 J	3.91 J	3.90 J	3.18 J	5.33 J	5.52 J	3.85 J	4.49 J	3.26 J	2.25 J
biphenyl	2.85 J	1.42 J	1.46 J	1.46 J	2.18 J	1.75 J	1.73 J	1.62 J	1.37 J	1.25 J
2,6-dimethylnaphthalene	5.90 J	4.24 J	4.16 J	3.80 J	5.38 J	5.69 J	4.97 J	4.69 J	2.70 J	2.53 J
acenaphthylene	1.72 J	0.68 J	0.64 J	0.00 ND	0.59 J	0.47 J	0.00 ND	0.70 J	0.00 ND	0.00 ND
acenaphthene	6.09 J	4.03 J	3.59 J	3.25 J	2.85 J	2.94 J	2.78 J	3.40 J	0.86 J	0.88 J
1,6,7-trimethylnaphthalene	1.96 J	1.35 J	0.88 J	0.00 ND	1.61 J	1.36 J	1.17 J	1.11 J	0.00 ND	0.49 J
fluorene	4.98 J	3.59 J	3.39 J	2.97 J	3.83 J	3.71 J	3.50 J	3.55 J	2.16 J	1.65 J
phenanthrene	19.59	14.35	14.54	13.25	14.29	15.07	13.55	13.39	6.03 J	5.25 J
anthracene	3.80 J	2.62 J	2.15 J	1.84 J	1.40 J	2.59 J	2.25 J	1.47 J	1.41 J	0.54 J
1-methylphenanthrene	4.92 J	3.05 J	2.58 J	2.21 J	2.48 J	2.34 J	1.95 J	2.29 J	0.94 J	0.98 J
fluoranthene	102.98	72.80	30.67	28.43	24.83	32.32	28.06	25.61	10.92 J	7.77 J
pyrene	56.84	43.43	15.50 J	15.64 J	10.09 J	13.76 J	11.67 J	12.18 J	5.44 J	4.65 J
benz[a]anthracene	19.36	12.24 J	5.88 J	5.85 J	3.73 J	2.52 J	2.30 J	4.25 J	0.00 ND	0.00 ND
chrysene	27.99	18.01 J	10.93 J	9.60 J	8.55 J	7.94 J	7.55 J	8.61 J	3.40 J	3.18 J
benzo[b]fluoranthene	13.74 J	9.74 J	5.03 J	5.48 J	3.35 J	6.11 J	0.00 ND	4.66 J	0.00 ND	2.15 J
benzo[k]fluoranthene	4.84 J	2.93 J	2.28 J	1.80 J	0.91 J	1.80 J	0.00 ND	1.72 J	0.00 ND	0.98 J
benzo[e]pyrene	7.88 J	5.06 J	3.45 J	3.15 J	1.83 J	1.45 J	1.64 J	2.25 J	1.25 J	0.66 J
benzo[a]pyrene	3.22 J	2.63 J	1.33 J	1.84 J	0.74 J	0.00 ND	0.00 ND	0.51 J	0.00 ND	0.53 J
perylene	2.90 J	1.44 J	1.28 J	1.23 J	0.47 J	0.58 J	0.77 J	0.78 J	1.36 J	0.81 J
indeno[1,2,3-c,d]pyrene	2.05 J	1.32 J	0.00 ND	1.29 J	0.00 ND	0.00 ND	0.45 J	0.73 J	0.92 J	0.58 J
dibenz[a,h]anthracene	0.55 J	0.39 J	0.30 J	0.49 J	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND	0.00 ND
benzo[g,h,i]perylene	7.14 J	1.41 J	1.15 J	1.70 J	0.60 J	0.59 J	0.50 J	0.73 J	1.33 J	0.49 J
Sum of PAH Analytes:	324.0	222.5	127.0	120.2	114.6	125.5	102.5	114.2	55.9	47.9

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Field Sample Data — Polychlorinated Biphenyls (PCB) and Chlorinated Pesticides

Parris Island Tissue Analysis
PCBPEST Data in ug/kg DRY WEIGHT for BATCH1
Report Date: LAL 03/20/92 15:45
G2135-0002
File Name: PCBFIELD.WK1

Sample Number:	P1-FIM-01	P1-FIM-02	P1-FIM-03	P1-FIM-ARCH	P2-FIM-01	P2-FIM-02	TG2-FIM-01
Batch:	BATCH1	BATCH1	BATCH1	BATCH1	BATCH1	BATCH1	BATCH1
Sample Dry Weight (g):	7.324	6.635	3.317	6.117	6.755	5.243	6.736
Sample Lipid Weight (g/g):	0.1876	0.0482	0.0422	0.0523	0.0380	0.0703	0.0351
CL2(8)	3.100 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEXACHLOROBENZENE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
LINDANE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(18)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(28)	1.619 NC	1.621 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEPTACHLOR	0.000 ND	0.299 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(52)	4.649 NC	1.873 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
ALDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(44)	0.000 ND	0.791 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEPTACHLOREPOXIDE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(66)	3.156 NC	3.967 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
2,4-DDE	2.071	1.938 NC	2.145 NC	0.000 ND	0.000 ND	3.631	0.000 ND
CL5(101)	9.665 NC	5.628 NC	5.235 NC	2.115 NC	1.842 NC	4.409 NC	0.647 JNC
CIS-CHLORDANE	2.243	2.593	2.335 NC	0.700 NC	1.878	0.483 NC	0.592 NC
TRANS-NONACHLOR	6.053	5.430	3.307	1.361	3.562	1.897	0.580 NC
DIELDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
4,4-DDE	128.351	47.521	60.918	18.816	19.227	103.988	6.147
CL4(77)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
2,4-DDD	0.787 NC	3.390 NC	0.512 JNC	0.000 ND	0.000 ND	5.025 NC	0.000 ND
ENDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(118)	7.016 NC	5.152 NC	6.314 NC	1.471 NC	1.534 NC	2.526 NC	0.000 ND
4,4-DDD	39.165	21.424	9.057	2.289	3.542	30.498	0.000 ND
2,4-DDT	0.000 ND	0.594 JNC	0.879 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL6(153)	22.272 NC	13.127 NC	24.690 NC	4.987 NC	2.929 NC	18.427 NC	1.526 NC
CL5(105)	0.000 ND	1.248 NC	3.221 NC	0.647 NC	0.430 NC	0.333 JNC	0.294 JNC
4,4-DDT	0.189 JNC	1.994 JNC	0.000 ND	0.000 ND	0.000 ND	0.829 NC	0.000 ND
CL6(138)	16.039 NC	9.580 NC	17.011 NC	3.966 NC	2.330 NC	12.730 NC	1.119 NC
CL5(126)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL7(187)	5.500 NC	3.147 NC	6.357 NC	1.692 NC	0.801 NC	4.243 NC	0.689 JNC
CL6(128)	1.055 NC	1.060 NC	2.330 NC	0.000 ND	0.000 ND	0.172 JNC	0.111 JNC
CL7(180)	6.253 NC	3.850 NC	7.666 NC	1.792 NC	0.907 NC	6.650 NC	0.456 JNC
MIREX	4.311	5.460	8.286	4.046	2.625	6.756	1.879
CL7(170)	3.138 NC	2.145 NC	5.377 NC	0.238 JNC	0.229 JNC	3.049 NC	0.000 ND
CL8(195)	0.000 ND	0.000 ND	0.222 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL9(206)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL10(209)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1016/1242	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1221	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1232	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1248	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1254	259.600	154.126	270.201	54.505	0.000 ND	117.972	0.000 ND
AROCLOR 1260	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND

ND - Not Detected
NC - Not Confirmed by second column analysis
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PCBPEST Data in ug/kg DRY WEIGHT for BATCH3
Report Date: LAL 03/20/92 13:24
G2135-0002
File Name: PCBFIELD.WK1

Sample Number:	P1-MUM-01	P1-MUM-02	P1-MUM-03	P2-MUM-01	TG1-MUM-01	TG1-MUM-02	TG1-MUM-03	TG2-MUM-01	TG2-MUM-02	TG2-MUM-03	TG2-MUM-DUP
Batch:	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3
Sample Dry Weight (g):	5.359	6.299	4.932	8.521	7.261	7.388	3.939	7.579	6.626	6.733	7.07
Sample Lipid Weight (g/g):	0.1523	0.0505	0.1603	0.2195	0.3013	0.1254	0.1618	0.2516	0.1333	0.0618	0.1066
CL2(8)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEXACHLOROBENZENE	0.000 ND	0.000 ND	0.000 ND	0.384 J	0.000 ND	0.000 ND	0.000 ND	0.417 J	0.000 ND	0.000 ND	0.075 J
LINDANE	1.044	0.827 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.849	0.664
CL3(18)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	1.827 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(28)	0.000 ND	0.000 ND	0.000 ND	2.337 NC	5.435 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEPTACHLOR	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(52)	0.724 JNC	0.578 JNC	0.776 JNC	5.180 NC	12.272 NC	0.000 ND	0.000 ND	1.552 JNC	0.000 ND	0.000 ND	0.000 ND
ALDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(44)	0.000 ND	0.000 ND	0.000 ND	1.994 NC	4.378 NC	0.000 ND	0.000 ND	1.091 NC	0.000 ND	0.000 ND	0.000 ND
HEPTACHLOREPOXIDE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(66)	0.382 JNC	0.567 NC	0.187 JNC	5.742 NC	0.000 ND	0.503 NC	0.000 ND	4.155 NC	0.000 ND	0.000 ND	0.000 ND
2,4-DDE	0.180 JNC	0.000 ND	0.000 ND	0.447 NC	2.152	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(101)	3.509 NC	2.841 NC	3.721 NC	14.704 NC	18.443 NC	1.431 NC	2.745 NC	5.132 NC	0.000 ND	0.000 ND	0.000 ND
CIS-CHLORDANE	1.099	1.191	1.781	6.157	8.547	2.790	2.565	3.126	0.649	0.023 J	0.451 J
TRANS-NONACHLOR	2.244	2.376	2.782	13.026	10.190	2.683	4.736	3.620	0.750	0.000 ND	0.211 J
DIELDRIN	0.000 ND	0.000 ND	0.000 ND	1.979	2.401	0.754 J	0.575 J	3.154	0.248 J	0.000 ND	0.551 J
4,4-DDE	62.867	56.848	70.077	223.146	173.431	35.700	29.679	45.642	13.208	8.891	8.238
CL4(77)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
2,4-DDD	0.000 ND	0.000 ND	0.000 ND	0.647 JNC	1.133 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
ENDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(118)	1.474 NC	1.232 NC	1.651 NC	14.441 NC	11.807 NC	0.921 NC	1.781 NC	4.551 NC	0.000 ND	0.000 ND	0.000 ND
4,4-DDD	26.386	18.995	28.219	29.011	47.083	14.384	8.103	4.133	1.905	1.716	0.759 J
2,4-DDT	0.347 JNC	0.731 NC	0.518 JNC	2.593 NC	2.037 NC	0.611 NC	0.677 NC	0.932 NC	0.000 ND	0.000 ND	0.274 JN
CL6(153)	6.743 NC	7.483 NC	8.336 NC	27.145 NC	21.488 NC	3.151 NC	7.931 NC	13.406 NC	1.381 NC	1.335 NC	1.064 NC
CL5(105)	0.158 JNC	0.080 JNC	0.003 JNC	1.859 NC	2.653 NC	0.000 ND	0.059 JNC	1.397 NC	0.000 ND	0.000 ND	0.000 ND
4,4-DDT	3.954 NC	2.894 NC	5.742 NC	4.889 NC	3.455 NC	1.016 JNC	2.013 JNC	0.000 ND	0.488 J	0.059 J	0.194 J
CL6(138)	3.652 NC	4.424 NC	4.642 NC	20.098 NC	15.591 NC	1.286 NC	3.619 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(126)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL7(187)	0.660 JNC	1.573 NC	1.352 NC	5.772 NC	3.981 NC	0.300 JNC	1.453 NC	5.353 NC	0.000 ND	0.000 ND	0.000 ND
CL6(128)	0.000 ND	0.000 ND	0.000 ND	2.144 NC	1.476 NC	0.000 ND	0.000 ND	0.292 NC	0.000 ND	0.000 ND	0.000 ND
CL7(180)	1.130 NC	2.410 NC	2.190 NC	5.950 NC	3.604 NC	0.076 JNC	1.274 NC	6.723 NC	0.000 ND	0.000 ND	0.000 ND
MIREX	0.748 J	1.266	1.647	11.875	7.359	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL7(170)	0.234 JNC	0.801 JNC	0.942 JNC	16.775 NC	10.815 NC	0.090 JNC	0.120 JNC	18.072 NC	0.000 ND	0.000 ND	0.000 ND
CL8(195)	0.000 ND	0.000 ND	0.000 ND	0.153 JNC	0.000 ND	0.000 ND	0.000 ND	0.138 JNC	0.000 ND	0.000 ND	0.000 ND
CL9(206)	0.000 ND	0.000 ND	0.000 ND	0.033 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL10(209)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1016/1242	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1221	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1232	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1248	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1254	94.261	99.501	115.245	283.814	307.113	58.454	122.731	121.267	26.404	37.999	28.607
AROCLOR 1260	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND

ND - Not Detected
NC - Not Confirmed by second column analysis
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PCBPEST Data in ug/kg DRY WEIGHT for BATCH5
Report Date: LAL 03/20/92 13:37
G2135-0002
File Name: PCBFIELD.WK1

Sample Number:	P1-CR-01	P1-CR-02	P1-CR-03	P1-CR-04	P1-CR-DUP	P2-CR-01	P2-CR-02	P2-CR-03	P2-CR-04	TG2-CR-01	TG2-CR-02
Batch:	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5
Sample Dry Weight (g):	7.176	6.902	7.472	9.753	8.898	9.609	7.727	10.029	8.711	8.950	10.391
Sample Lipid Weight (g/g):	0.0614	0.1101	0.0335	0.0361	0.0327	0.0446	0.1640	0.0235	0.0331	0.0463	0.0189
CL2(8)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEXACHLOROBENZENE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
LINDANE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(18)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(28)	1.544 NC	2.789 NC	0.000 ND	1.856 NC	2.762 NC	2.095 NC	1.483 NC	0.942 NC	1.378 NC	1.281 NC	0.000 ND
HEPTACHLOR	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(52)	0.000 ND	0.684 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
ALDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(44)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEPTACHLOREPOXIDE	1.669	0.000 ND	0.000 ND	0.720	1.266 NC	0.000 ND	0.871	1.083	1.414	3.146	2.331
CL4(66)	0.995 NC	2.661 NC	1.070 NC	1.659 NC	1.749 NC	2.356 NC	1.105 NC	0.625 NC	0.902 NC	0.856 NC	0.267 JN
2,4-DDE	0.917	1.223	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(101)	0.654 NC	3.297 NC	0.034 JNC	0.000 ND	0.894 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CIS-CHLORDANE	1.565	2.936	1.407	0.889	1.806	1.627	1.195	1.068	1.936	1.630	0.790
TRANS-NONACHLOR	2.366	5.705	2.436	2.177	3.688	4.602	2.731	2.068	5.317	2.574	1.695
DIELDRIN	1.383	2.059	1.402	0.674	1.226	1.313	0.793	1.040	1.526	3.050	1.419
4,4-DDE	32.463	75.126	28.896	45.242	44.845	67.986	67.925	22.629	44.595	41.190	8.839
CL4(77)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.106 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND
2,4-DDD	0.358 JNC	1.438 NC	0.000 ND	0.000 ND	0.464 JNC	0.096 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
ENDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(118)	2.411 NC	5.942 NC	2.179 NC	4.335 NC	4.408 NC	5.955 NC	2.756 NC	1.911 NC	3.707 NC	2.689 NC	0.891 NC
4,4-DDD	12.854	32.593	6.262	22.835	14.815	21.194	45.943	6.825	11.932	7.240	0.911
2,4-DDT	0.275 JNC	0.748 NC	0.177 JNC	0.186 JNC	0.494 NC	0.458 NC	0.000 ND	0.243 JNC	0.298 JNC	0.445 JNC	0.206 JN
CL6(153)	5.815 NC	11.908 NC	3.289 NC	7.732 NC	10.514 NC	12.183 NC	5.723 NC	3.460 NC	8.233 NC	5.241 NC	2.516 NC
CL5(105)	0.000 ND	2.103 NC	1.384 NC	1.561 NC	1.636 NC	1.877 NC	1.377 NC	0.875 NC	1.220 NC	1.119 NC	0.742 NC
4,4-DDT	0.000 ND	0.831 JNC	0.000 ND	0.000 ND	0.000 ND	0.499 JNC	0.000 ND	0.330 JNC	0.000 ND	0.293 JNC	0.000 ND
CL6(138)	2.293 NC	7.744 NC	0.673 JNC	4.158 NC	4.715 NC	7.314 NC	3.107 NC	0.994 NC	4.048 NC	2.400 NC	0.188 JN
CL5(126)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL7(187)	0.991 NC	2.632 NC	0.000 ND	0.499 JNC	1.530 NC	2.068 NC	0.753 NC	0.376 JNC	1.350 NC	0.959 NC	0.283 JN
CL6(128)	0.601 NC	1.053 NC	0.431 NC	1.083 NC	0.674 NC	1.071 NC	0.620 NC	0.424 NC	0.609 NC	0.551 NC	0.295 NC
CL7(180)	1.218 NC	2.601 NC	0.678 NC	1.654 NC	1.973 NC	2.952 NC	0.866 NC	0.759 NC	1.744 NC	1.353 NC	0.639 NC
MIREX	2.725	4.607	2.397	2.706	4.451	5.224	2.726	1.902	4.949	3.305	1.613
CL7(170)	0.460 JNC	2.018 NC	0.461 JNC	0.738 JNC	0.701 JNC	1.059 JNC	0.489 JNC	0.264 JNC	0.517 JNC	0.348 JNC	0.304 JN
CL8(195)	0.000 ND	0.014 JNC	0.000 ND	0.000 ND	0.000 ND	0.073 JNC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL9(206)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL10(209)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1016/1242	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1221	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1232	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1248	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1254	51.507	125.557	36.256	68.170	113.083	118.618	53.057	33.295	72.590	49.768	22.641
AROCLOR 1260	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND

ND - Not Detected
NC - Not Confirmed by second column analysis
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PCBPEST Data in ug/kg DRY WEIGHT for BATCH7
Report Date: LAL 03/20/92 16:01
G2135-0002
File Name: PCBFIELD.WK1

Sample Number:	P1-OY-01	P1-OY-02	P1-OY-03	P1-OY-04	P2-OY-01	P2-OY-02	P2-OY-03	P2-OY-04	TG1-OY-01	TG1-OY-02
Batch:	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7
Sample Dry Weight (g):	3.375	3.649	4.436	3.535	3.759	3.940	3.599	3.808	2.680	2.794
Sample Lipid Weight (g/g):	0.1234	0.0937	0.1114	0.0640	0.0936	0.0867	0.0845	0.1058	0.0647	0.0657
CL2(8)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEXACHLOROBENZENE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
LINDANE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(18)	9.987 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL3(28)	4.657 NC	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
HEPTACHLOR	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(52)	32.357 NC	19.880 NC	13.273 NC	8.782 NC	23.786 NC	20.643 NC	20.459 NC	20.099 NC	0.000 ND	0.000 ND
ALDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(44)	5.541 NC	3.260 NC	2.059 NC	1.839 NC	4.570 NC	2.700 NC	2.991 NC	3.548 NC	0.000 ND	0.000 ND
HEPTACHLOREPOXIDE	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL4(66)	0.000 ND	11.074 NC	8.147 NC	6.309 NC	11.262 NC	10.186 NC	8.598 NC	11.008 NC	0.000 ND	0.000 ND
2,4-DDE	4.386	3.635	4.591	4.258	3.638	3.416	3.839	3.495	3.498	3.406
CL5(101)	50.860 NC	35.113 NC	28.190 NC	27.796 NC	42.818 NC	36.726 NC	38.632 NC	38.990 NC	0.000 ND	0.000 ND
CIS-CHLORDANE	8.143	6.303	7.950	7.420	6.799	5.991	6.114	6.432	4.303	4.229
TRANS-NONACHLOR	11.698	8.545	12.240	10.945	9.362	8.776	8.511	8.885	3.231	2.687
DIELDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
4,4-DDE	109.377	78.721	137.031	123.058	87.731	74.516	79.658	91.094	34.821	35.003
CL4(77)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
2,4-DDD	5.155 NC	3.323 NC	7.200 NC	6.183 NC	4.039 NC	3.313 NC	3.237 NC	3.605 NC	0.000 ND	0.000 ND
ENDRIN	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL5(118)	33.716 NC	23.716 NC	22.017 NC	21.677 NC	30.404 NC	25.546 NC	27.195 NC	27.665 NC	2.211 NC	1.097 JNC
4,4-DDD	43.207	30.327	68.248	58.703	38.391	30.240	32.040	36.767	11.044	11.297
2,4-DDT	2.311	1.413	2.422	2.178	1.704	0.822 J	0.894 J	1.551	0.000 ND	0.000 ND
CL6(153)	39.821 NC	28.867 NC	30.408 NC	27.616 NC	35.662 NC	28.979 NC	31.757 NC	32.823 NC	1.827 NC	1.501 NC
CL5(105)	7.893 NC	5.957 NC	5.734 NC	5.932 NC	7.638 NC	6.011 NC	5.924 NC	6.390 NC	2.347 NC	2.336 NC
4,4-DDT	2.889 JNC	2.600 JNC	4.000 JNC	3.992 JNC	2.508 JNC	2.034 JNC	2.092 JNC	2.254 JNC	0.000 ND	0.000 ND
CL6(138)	21.160 NC	15.533 NC	17.893 NC	14.894 NC	20.114 NC	15.712 NC	16.564 NC	17.398 NC	0.842 JNC	0.777 JNC
CL5(126)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL7(187)	3.882 NC	2.519 NC	3.591 NC	3.197 NC	2.990 NC	2.251 NC	2.117 NC	3.067 NC	0.000 ND	0.000 ND
CL6(128)	1.637 NC	1.023 NC	1.221 NC	1.088 NC	1.486 NC	0.973 NC	1.075 NC	1.005 NC	0.000 ND	0.000 ND
CL7(180)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
MIREX	4.091	2.474	3.613	3.382	3.221	3.195	2.971	3.267	1.882	1.161 J
CL7(170)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL8(195)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL9(206)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
CL10(209)	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1016/1242	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1221	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1232	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1248	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
AROCLOR 1254	534.135	381.784	345.445	243.563	457.189	383.833	402.987	433.795	0.000 ND	0.000 ND
AROCLOR 1260	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND	0.000 ND
Sum of PCB Congeners:	211.5	146.9	132.5	119.1	180.7	149.7	155.3	162.0	7.2	5.7
Sum of DDTs, DDDs, and DDEs:	167.3	120.0	223.5	198.4	138.0	114.3	121.8	138.8	49.4	49.7

ND - Not Detected
NC - Not Confirmed by second column analysis
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Field Sample Data — Mercury

Parris Island Tissue Analysis
Mercury Data in ug/g DRY WEIGHT
G2135-0003
File Name: HGFIELD.WK1

Ed 1/23,24,28/92 EK

Sample ID	Batch # Work Plan	Batch # Mercury Analysis	Hg Conc. (ug/g)	
P1-FIM-01	1	1	0.285	B
P1-FIM-02	1	1	0.341	B
P1-FIM-03	1	1	0.293	B
P1-FIM-ARCH	1	1	0.229	B
P2-FIM-01	1	1	0.285	B
P2-FIM-02	1	1	0.276	B
TG2-FIM-01	1	1	0.298	B
P1-FIL-01	2	6	0.105	
P1-FIL-02	2	6	0.107	
P1-FIL-03	2	6	1.002	
P1-FIL-ARCH	2	6	0.140	
P2-FIL-01	2	6 & 7	0.085	
P2-FIL-02	2	6	0.162	
TG2-FIL-01	2	6	0.167	
P1-MUM-01	3	2	0.039	B
P1-MUM-02	3	2	0.043	B
P1-MUM-03	3	2	0.044	B
P2-MUM-01	3	2	0.054	B
TG1-MUM-01	3	2	0.038	B
TG1-MUM-02	3	2	0.039	B
TG1-MUM-03	3	2	0.080	B
TG2-MUM-01	3	2	0.052	B
TG2-MUM-02	3	2	0.033	B
TG2-MUM-03	3	3	0.053	B
TG2-MUM-DUP	3	2	0.044	B
P1-MUL-01	4	7	0.155	
P1-MUL-02	4	7	0.252	
P1-MUL-03	4	7	0.175	
P2-MUL-01	4	7	0.578	
TG1-MUL-01	4	7	0.354	
TG1-MUL-02	4	7	0.142	
TG2-MUL-01	4	7	0.198	
TG2-MUL-02	4	7	0.196	
TG2-MUL-03	4	7	0.351	
TG2-MUL-DUP	4	7	0.220	
P1-CR-01	5	5	0.138	B
P1-CR-02	5	5	0.134	B
P1-CR-03	5	5	0.121	B
P1-CR-04	5	5	0.080	B
P1-CR-DUP	5	5	0.063	B
P2-CR-01	5	5	0.081	B
P2-CR-02	5	5	0.093	B
P2-CR-03	5	5	0.096	B
P2-CR-04	5	5	0.065	B
TG2-CR-01	5	5	0.142	B
TG2-CR-02	5	5	0.162	B
TG1-CL-01	6	3	0.194	B
TG1-CL-02	6	3	0.211	B
TG2-CL-01	6	3	0.197	B
TG2-CL-02	6	3	0.161	B
TG2-CL-03	6	3	0.206	B
TG2-CL-04	6	3	0.221	B
TG2-CL-DUP	6	3	0.179	B
P1-OY-01	7	4	0.192	B
P1-OY-02	7	4	0.183	B
P1-OY-03	7	4	0.132	B
P1-OY-04	7	4	0.166	B
P2-OY-01	7	4	0.182	B
P2-OY-02	7	4	0.153	B
P2-OY-03	7	4	0.146	B
P2-OY-04	7	4	0.174	B
TG1-OY-01	7	4	0.157	B
TG1-OY-02	7	4	0.180	B
TG1-OY-03	7	4	0.156	B
TG1-OY-04	7	4	0.201	B
TG2-OY-01	7	4	0.153	B
TG2-OY-02	7	4	0.159	B
TG2-OY-03	7	4	0.166	B
TG2-OY-04	7	4	0.173	B
TG2-OY-DUP	7	4	0.179	B

B - Analyte detected in Procedural Blank at >5X MDL.

The data for samples P1-FIM-ARCH, P2-FIL-01, TG2-MUM-DUP, P2-MUL-01, P1-CR-DUP, TG2-CL-DUP, and TG2-OY-DUP are averages from duplicate analyses.

P2-FIL-01 is an average of duplicate analyses, with one being performed with batch 6 and the other with batch 7.

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH1

Sample Number:		P1-FIM-01		P1-FIM-02		P1-FIM-03		1-FIM-ARCH		P2-FIM-01		P2-FIM-02		TG2-FIM-01	
Batch Number:		BATCH1		BATCH1		BATCH1		BATCH1		BATCH1		BATCH1		BATCH1	
Sample Dry Weight (g):		7.324		6.635		3.317		6.117		6.755		5.243		6.736	
Sample Lipid Weight (g/g):		0.1876		0.0482		0.0422		0.0523		0.0380		0.0703		0.0351	
Sample Moisture Content (%):		75.688		78.181		80.747		80.189		78.209		80.602		78.974	
	MDL														
naphthalene	11.39	0.82	J	1.46		3.80		1.33		1.35		1.96		1.32	
2-methylnaphthalene	14.21	0.62	J	0.77	J	1.57		0.61	J	0.56	J	0.86	J	0.92	J
1-methylnaphthalene	13.99	0.48	J	0.53	J	0.86	J	0.41	J	0.42	J	0.69	J	0.67	J
biphenyl	18.49	0.60	J	0.82	J	0.84	J	1.26	J	0.37	J	0.70	J	0.29	J
2,6-dimethylnaphthalene	16.41	0.31	J	0.37	J	0.62	J	0.24	J	0.26	J	0.33	J	0.56	J
acenaphthylene	15.77	0.12	J	0.05	J	1.52	ND	1.56	ND	1.72	ND	1.53	ND	1.66	ND
acenaphthene	14.35	0.20	J	0.15	J	1.38	ND	1.42	ND	0.13	J	1.39	ND	0.11	J
1,6,7-trimethylnaphthalene	14.01	0.12	J	1.53	ND	1.35	ND	1.39	ND	1.53	ND	1.36	ND	1.47	ND
fluorene	13.17	0.70	J	0.48	J	0.50	J	0.26	J	0.42	J	0.34	J	0.26	J
phenanthrene	18.19	1.08	J	0.77	J	0.64	J	0.27	J	0.59	J	0.36	J	0.26	J
anthracene	13.36	0.14	J	0.12	J	0.16	J	1.32	ND	0.03	J	0.05	J	0.04	J
1-methylphenanthrene	24.37	0.07	J	0.14	J	2.35	ND	0.05	J	0.05	J	0.10	J	0.07	J
fluoranthene	30.38	0.38	J	0.42	J	0.37	J	0.14	J	0.26	J	0.18	J	0.10	J
pyrene	28.04	0.14	J	0.29	J	0.26	J	0.13	J	0.11	J	0.15	J	0.09	J
benz[a]anthracene	25.54	3.10	ND	2.79	ND	2.46	ND	2.53	ND	2.78	ND	2.48	ND	2.69	ND
chrysene	26.44	0.07	J	0.15	J	0.18	J	2.62	ND	2.88	ND	2.56	ND	2.78	ND
benzo[b]fluoranthene	46.94	0.05	J	0.06	J	4.52	ND	4.65	ND	0.07	J	4.55	ND	4.93	ND
benzo[k]fluoranthene	31.55	0.03	J	0.03	J	3.04	ND	3.13	ND	0.03	J	3.06	ND	3.32	ND
benzo[e]pyrene	24.12	0.03	J	0.04	J	2.32	ND	2.39	ND	2.63	ND	2.34	ND	2.54	ND
benzo[a]pyrene	24.78	0.03	J	2.70	ND	2.39	ND	2.45	ND	2.70	ND	2.40	ND	2.61	ND
perylene	29.72	3.61	ND	3.24	ND	2.86	ND	2.94	ND	3.24	ND	2.88	ND	3.12	ND
indeno[1,2,3-c,d]pyrene	12.08	1.47	ND	0.05	J	1.16	ND	1.20	ND	1.32	ND	1.17	ND	1.27	ND
dibenz[a,h]anthracene	17.25	2.10	ND	1.88	ND	1.66	ND	1.71	ND	1.88	ND	1.67	ND	1.81	ND
benzo[g,h,i]perylene	22.28	0.08	J	0.15	J	2.14	ND	2.21	ND	0.10	J	2.16	ND	2.34	ND
Sum of PAH Analytes:		16.4		19.0		39.0		36.2		25.4		35.3		35.2	

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH2

Sample Number:		P1-FIL-01		P1-FIL-02		P1-FIL-03		1-FIL-ARCH		P2-FIL-01		P2-FIL-02		TG2-FIL-01	
Batch Number:		BATCH2		BATCH2		BATCH2		BATCH2		BATCH2		BATCH2		BATCH2	
Sample Dry Weight (g):		4.707		4.035		0.025		0.100		2.957		0.114		1.311	
Sample Lipid Weight (g/g):		0.7036		0.5157		4.8000		0.0760		0.5899		0.3000		0.0899	
Sample Moisture Content (%):		53.322		61.255		57.684		57.684		58.476		57.684		57.684	
	MDL														
naphthalene	11.39	8.56	J	14.72		546.21		127.33		16.66		75.13		10.02	
2-methylnaphthalene	14.21	5.61	J	5.28	J	88.19		32.37		9.09	J	3.01	ND	4.17	J
1-methylnaphthalene	13.99	3.88	J	3.94	J	68.55		20.35		4.92	J	2.96	ND	2.26	J
biphenyl	18.49	9.31	J	26.80		3.91	ND	108.50		14.60		18.19		1.11	J
2,6-dimethylnaphthalene	16.41	3.83	ND	2.67	J	3.47	ND	3.47	ND	3.06	J	3.47	ND	3.47	ND
acenaphthylene	15.77	3.09	J	1.09	J	3.34	ND	3.34	ND	1.71	J	3.34	ND	3.34	ND
acenaphthene	14.35	1.90	J	2.83	J	3.04	ND	19.76		4.60	J	3.04	ND	3.04	ND
1,6,7-trimethylnaphthalene	14.01	1.34	J	2.71	ND	2.96	ND	2.96	ND	2.91	ND	2.96	ND	2.96	ND
fluorene	13.17	11.39		7.59	J	2.79	ND	2.79	ND	10.19		9.06	J	1.12	J
phenanthrene	18.19	21.91		16.56		48.64		44.39		22.89		14.85		1.31	J
anthracene	13.36	2.75	J	2.79	J	2.83	ND	2.83	ND	1.56	J	2.83	ND	2.83	ND
1-methylphenanthrene	24.37	0.36	J	1.42	J	5.16	ND	5.16	ND	0.84	J	5.16	ND	5.16	ND
fluoranthene	30.38	6.32	J	11.59	J	29.25		81.37		9.21	J	8.57	J	0.79	J
pyrene	28.04	1.61	J	46.95		43.22		520.36		3.70	J	12.77	J	5.93	ND
benz[a]anthracene	25.54	0.63	J	4.95	ND	5.40	ND	5.40	ND	0.56	J	5.40	ND	5.40	ND
chrysene	26.44	0.44	J	0.61	J	5.59	ND	6.47	J	1.22	J	4.46	J	5.59	ND
benzo[b]fluoranthene	46.94	10.96	ND	9.09	ND	14.25	J	9.93	ND	0.89	J	9.93	ND	0.70	J
benzo[k]fluoranthene	31.55	7.36	ND	6.11	ND	10.14	J	6.68	ND	0.50	J	6.68	ND	0.44	J
benzo[e]pyrene	24.12	5.63	ND	4.67	ND	5.10	ND	5.10	ND	0.26	J	5.10	ND	5.10	ND
benzo[a]pyrene	24.78	0.49	J	4.80	ND	5.24	ND	5.24	ND	0.27	J	5.24	ND	5.24	ND
perylene	29.72	6.94	ND	5.76	ND	6.29	ND	6.29	ND	0.43	J	6.29	ND	6.29	ND
indeno[1,2,3-c,d]pyrene	12.08	2.82	ND	2.34	ND	2.56	ND	2.56	ND	2.51	ND	2.56	ND	2.56	ND
dibenz[a,h]anthracene	17.25	4.03	ND	3.34	ND	3.65	ND	3.65	ND	3.58	ND	3.65	ND	3.65	ND
benzo[g,h,i]perylene	22.28	5.20	ND	4.32	ND	4.71	ND	10.96	J	0.54	J	4.71	ND	4.71	ND
Sum of PAH Analytes:		126.3		192.9		914.5		1037.3		116.7		219.3		87.2	

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH3

Sample Number:		P1-MUM-01	P1-MUM-02	P1-MUM-03	P2-MUM-01	TG1-MUM-01	TG1-MUM-02	TG1-MUM-03	TG2-MUM-01	TG2
Batch Number:		BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	BATCH3	
Sample Dry Weight (g):		5.359	6.299	4.932	8.521	7.261	7.388	3.939	7.579	
Sample Lipid Weight (g/g):		0.1523	0.0505	0.1603	0.2195	0.3013	0.1254	0.1618	0.2516	
Sample Moisture Content (%):		78.654	79.359	78.023	75.118	76.242	75.79	78.796	75.485	
	MDL									
naphthalene	11.39	1.21	0.92	1.14	1.68	1.98	1.19	1.27	1.60	
2-methylnaphthalene	14.21	0.67 J	0.44 J	0.57 J	1.25	3.20	1.16 J	0.76 J	2.77	
1-methylnaphthalene	13.99	0.36 J	0.33 J	0.38 J	0.77 J	1.74	0.60 J	0.47 J	1.40	
biphenyl	18.49	0.24 J	0.18 J	0.28 J	0.51 J	0.73 J	2.24 ND	1.96 ND	0.59 J	
2,6-dimethylnaphthalene	16.41	0.26 J	0.16 J	0.24 J	0.50 J	1.13 J	0.40 J	1.74 ND	1.33 J	
acenaphthylene	15.77	1.68 ND	1.63 ND	1.73 ND	0.15 J	0.21 J	1.91 ND	1.67 ND	0.25 J	
acenaphthene	14.35	0.19 J	0.13 J	1.58 ND	0.83 J	0.92 J	0.23 J	1.52 ND	0.59 J	
1,6,7-trimethylnaphthalene	14.01	1.50 ND	1.45 ND	1.54 ND	0.15 J	0.37 J	1.70 ND	1.49 ND	0.42 J	
fluorene	13.17	0.37 J	0.24 J	0.31 J	1.20	1.32	0.37 J	0.28 J	0.99 J	
phenanthrene	18.19	0.73 J	0.46 J	0.50 J	1.94	1.69	0.55 J	0.39 J	1.71	
anthracene	13.36	1.43 ND	1.38 ND	1.47 ND	0.12 J	0.23 J	1.62 ND	1.42 ND	0.11 J	
1-methylphenanthrene	24.37	0.06 J	2.52 ND	2.68 ND	0.08 J	2.89 ND	2.95 ND	2.58 ND	0.09 J	
fluoranthene	30.38	0.15 J	0.14 J	0.17 J	0.61 J	0.61 J	0.18 J	0.22 J	0.62 J	
pyrene	28.04	0.13 J	0.08 J	0.10 J	0.27 J	0.25 J	0.08 J	2.97 ND	0.26 J	
benz[a]anthracene	25.54	2.73 ND	2.64 ND	2.81 ND	3.18 ND	3.03 ND	3.09 ND	2.71 ND	3.13 ND	
chrysene	26.44	0.04 J	2.73 ND	2.91 ND	0.08 J	0.30 J	3.20 ND	2.80 ND	0.10 J	
benzo[b]fluoranthene	46.94	5.01 ND	4.84 ND	5.16 ND	5.84 ND	0.28 J	5.68 ND	4.98 ND	5.75 ND	
benzo[k]fluoranthene	31.55	3.37 ND	3.26 ND	3.47 ND	3.93 ND	3.75 ND	3.82 ND	3.34 ND	0.09 J	
benzo[e]pyrene	24.12	2.57 ND	2.49 ND	2.65 ND	3.00 ND	2.87 ND	2.92 ND	2.56 ND	0.06 J	
benzo[a]pyrene	24.78	2.64 ND	2.56 ND	2.72 ND	3.08 ND	2.94 ND	3.00 ND	2.63 ND	3.04 ND	
perylene	29.72	3.17 ND	3.07 ND	3.27 ND	3.70 ND	3.53 ND	3.60 ND	3.15 ND	3.64 ND	
indeno[1,2,3-c,d]pyrene	12.08	1.29 ND	1.25 ND	1.33 ND	1.50 ND	1.43 ND	1.46 ND	1.28 ND	1.48 ND	
dibenz[a,h]anthracene	17.25	1.84 ND	1.78 ND	1.90 ND	2.15 ND	2.05 ND	2.09 ND	1.83 ND	2.11 ND	
benzo[g,h,i]perylene	22.28	2.38 ND	2.30 ND	2.45 ND	2.77 ND	2.65 ND	2.70 ND	2.36 ND	0.10 J	
Sum of PAH Analytes:		34.0	37.0	41.3	39.3	40.1	46.7	46.4	32.3	

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

	TG2-MUM-02 BATCH3		TG2-MUM-03 BATCH3		2-MUM-DUP BATCH3	
	6.626		6.733		7.070	
	0.1333		0.0618		0.1066	
	78.113		77.819		77.031	
	1.25		1.20		1.14	
	0.99	J	0.88	J	1.36	
	0.48	J	0.57	J	0.72	J
J	0.24	J	0.19	J	0.27	J
J	0.29	J	0.19	J	0.71	J
J	1.73	ND	1.75	ND	1.81	ND
J	1.57	ND	0.16	J	0.14	J
J	1.53	ND	1.55	ND	0.13	J
J	0.24	J	0.23	J	0.29	J
	0.50	J	0.54	J	0.53	J
J	0.09	J	0.05	J	1.53	ND
J	0.05	J	0.06	J	0.07	J
J	0.29	J	0.31	J	0.25	J
J	0.08	J	0.23	J	0.12	J
ND	2.79	ND	2.83	ND	2.93	ND
J	2.89	ND	0.05	J	3.04	ND
ND	5.14	ND	5.21	ND	5.39	ND
J	3.45	ND	3.50	ND	3.62	ND
J	2.64	ND	2.68	ND	2.77	ND
ND	2.71	ND	2.75	ND	2.85	ND
ND	3.25	ND	3.30	ND	3.41	ND
ND	1.32	ND	1.34	ND	1.39	ND
ND	1.89	ND	1.91	ND	1.98	ND
J	2.44	ND	0.06	J	2.56	ND
	37.9		31.6		39.0	

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH4

Sample Number:		P1-MUL-01		P1-MUL-02		P1-MUL-03		P2-MUL-01		TG1-MUL-01		TG1-MUL-02		TG2-MUL-01		TG2-MUL-02		TG2
Batch Number:		BATCH4		BATCH4		BATCH4		BATCH4		BATCH4		BATCH4		BATCH4		BATCH4		
Sample Dry Weight (g):		0.201		0.270		0.244		1.333		0.585		0.418		0.796		0.346		
Sample Lipid Weight (g/g):		0.0806		0.0985		0.1254		0.1140		0.4677		0.1249		0.3819		0.2029		
Sample Moisture Content (%):		74.531		74.531		74.531		73.629		75.433		74.531		74.531		74.531		
	MDL																	
naphthalene	11.39	79.41		47.43		49.50		10.01		29.60		37.72		19.29		48.91		
2-methylnaphthalene	14.21	39.98		24.13		23.28		5.06	J	16.72		20.07		11.94		21.96		
1-methylnaphthalene	13.99	26.01		14.21		16.15		3.04	J	9.68		12.63		7.05		13.06		
biphenyl	18.49	23.81		17.73		13.49		3.61	J	9.85		13.75		7.44	J	16.72		
2,6-dimethylnaphthalene	16.41	2.09	ND	2.09	ND	2.09	ND	1.45	J	5.57	J	7.42		3.40	J	5.19	J	
acenaphthylene	15.77	2.01	ND	2.01	ND	2.01	ND	2.08	ND	1.94	ND	2.01	ND	2.01	ND	2.01	ND	
acenaphthene	14.35	7.94		2.56	J	2.30	J	1.22	J	1.73	J	1.80	J	1.67	J	2.38	J	
1,6,7-trimethylnaphthalene	14.01	1.78	ND	1.78	ND	1.78	ND	0.83	J	3.30	J	3.05	J	1.63	J	2.38	J	
fluorene	13.17	11.61		6.40		6.18		2.29	J	4.20	J	4.38	J	3.07	J	8.77		
phenanthrene	18.19	23.35		15.85		14.23		6.86	J	10.60		12.61		10.02		27.57		
anthracene	13.36	5.95		2.66	J	2.82	J	0.86	J	2.49	J	2.80	J	1.61	J	3.36	J	
1-methylphenanthrene	24.37	4.99	J	2.45	J	2.30	J	0.50	J	1.41	J	2.07	J	0.86	J	2.48	J	
fluoranthene	30.38	9.81	J	5.75	J	3.97	J	2.43	J	4.59	J	3.72	J	3.15	J	6.13	J	
pyrene	28.04	11.05	J	4.27	J	3.89	J	1.17	J	2.88	J	3.62	J	2.06	J	4.84	J	
benz[a]anthracene	25.54	2.57	J	3.25	ND	3.25	ND	3.37	ND	3.14	ND	3.25	ND	3.25	ND	3.25	ND	
chrysene	26.44	5.37	J	2.62	J	2.10	J	0.51	J	1.50	J	1.93	J	0.87	J	1.64	J	
benzo[b]fluoranthene	46.94	6.13	J	5.98	ND	5.98	ND	6.19	ND	5.77	ND	5.98	ND	5.98	ND	5.98	ND	
benzo[k]fluoranthene	31.55	3.83	J	4.02	ND	4.02	ND	4.16	ND	3.88	ND	4.02	ND	4.02	ND	4.02	ND	
benzo[e]pyrene	24.12	3.07	ND	3.07	ND	3.07	ND	3.18	ND	2.96	ND	3.07	ND	3.07	ND	3.07	ND	
benzo[a]pyrene	24.78	3.16	ND	3.16	ND	3.16	ND	3.27	ND	3.04	ND	3.16	ND	3.16	ND	3.16	ND	
perylene	29.72	3.78	ND	3.78	ND	3.78	ND	3.92	ND	3.65	ND	3.78	ND	3.78	ND	3.78	ND	
indeno[1,2,3-c,d]pyrene	12.08	1.54	ND	1.54	ND	1.54	ND	1.59	ND	1.48	ND	1.54	ND	1.54	ND	1.54	ND	
dibenz[a,h]anthracene	17.25	2.20	ND	2.20	ND	2.20	ND	2.27	ND	2.12	ND	2.20	ND	2.20	ND	2.20	ND	
benzo[g,h,i]perylene	22.28	31.78		1.31	J	2.84	ND	2.94	ND	0.65	J	2.84	ND	2.84	ND	2.84	ND	
Sum of PAH Analytes:		313.2		180.2		175.9		72.8		132.7		159.4		105.9		197.2		

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

	TG2-MUL-03 BATCH4		2-MUL-DUP BATCH4	
	0.441		0.335	
	0.1184		0.2257	
	74.531		74.531	
	30.95		19.90	
	16.53		14.51	
	10.01		12.73	
	11.17		5.71	J
J	4.49	J	5.66	J
ND	2.01	ND	2.01	ND
J	1.84	J	1.98	J
J	1.78	ND	4.05	J
	3.97	J	4.64	J
	11.68		5.40	J
J	2.41	J	0.99	J
J	1.82	J	1.33	J
J	4.49	J	2.71	J
J	3.17	J	1.60	J
ND	3.25	ND	3.25	ND
J	1.31	J	3.37	ND
ND	5.98	ND	5.98	ND
ND	4.02	ND	4.02	ND
ND	3.07	ND	3.07	ND
ND	3.16	ND	3.16	ND
ND	3.78	ND	3.78	ND
ND	1.54	ND	1.54	ND
ND	2.20	ND	2.20	ND
ND	2.84	ND	2.84	ND
	137.5		116.4	

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH5

Sample Number:		P1-CR-01	P1-CR-02	P1-CR-03	P1-CR-04	P1-CR-DUP	P2-CR-01	P2-CR-02	P2-CR-03
Batch Number:		BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5	BATCH5
Sample Dry Weight (g):		7.176	6.902	7.472	9.753	8.898	9.609	7.727	10.029
Sample Lipid Weight (g/g):		0.0614	0.1101	0.0335	0.0361	0.0327	0.0446	0.1640	0.0235
Sample Moisture Content (%):		76.647	77.761	75.454	68.373	70.434	68.18	74.312	66.628
	MDL								
naphthalene	11.39	1.01	1.07	0.93	0.69 J	1.03	1.63	1.05	0.98
2-methylnaphthalene	14.21	0.91	1.00	0.73 J	0.56 J	0.87 J	1.43	0.82 J	1.08 J
1-methylnaphthalene	13.99	0.51 J	0.54 J	0.35 J	0.37 J	0.58 J	0.75 J	0.41 J	1.43
biphenyl	18.49	0.23 J	0.39 J	2.27 ND	0.15 J	1.47	0.33 J	0.91 J	0.31 J
2,6-dimethylnaphthalene	16.41	0.20 J	0.25 J	2.01 ND	0.22 J	0.30 J	0.38 J	0.17 J	0.25 J
acenaphthylene	15.77	1.84 ND	0.08 J	1.94 ND	2.49 ND	2.33 ND	0.09 J	2.03 ND	0.10 J
acenaphthene	14.35	0.28 J	0.59 J	1.76 ND	0.13 J	0.86 J	1.08 J	0.26 J	0.68 J
1,6,7-trimethylnaphthalene	14.01	0.14 J	1.56 ND	1.72 ND	0.15 J	2.07 ND	0.11 J	1.80 ND	0.10 J
fluorene	13.17	0.27 J	0.48 J	0.22 J	0.27 J	0.39 J	0.39 J	0.20 J	0.31 J
phenanthrene	18.19	0.37 J	0.58 J	0.31 J	0.39 J	0.61 J	0.45 J	0.33 J	0.44 J
anthracene	13.36	0.06 J	0.08 J	1.64 ND	0.04 J	0.10 J	0.06 J	0.06 J	0.05 J
1-methylphenanthrene	24.37	0.07 J	0.08 J	2.99 ND	0.18 J	3.60 ND	0.09 J	0.08 J	0.09 J
fluoranthene	30.38	0.21 J	0.45 J	0.18 J	0.22 J	0.41 J	0.22 J	0.30 J	0.26 J
pyrene	28.04	0.21 J	0.39 J	0.19 J	0.23 J	0.33 J	0.19 J	0.22 J	0.20 J
benz[a]anthracene	25.54	2.98 ND	2.84 ND	3.13 ND	4.04 ND	3.78 ND	4.06 ND	3.28 ND	4.26 ND
chrysene	26.44	0.07 J	0.18 J	3.24 ND	0.10 J	0.18 J	0.07 J	0.10 J	0.09 J
benzo[b]fluoranthene	46.94	0.08 J	0.21 J	5.76 ND	0.07 J	6.94 ND	0.06 J	0.10 J	0.07 J
benzo[k]fluoranthene	31.55	0.04 J	0.13 J	3.87 ND	0.05 J	4.66 ND	0.05 J	0.08 J	0.06 J
benzo[e]pyrene	24.12	2.82 ND	0.08 J	2.96 ND	0.03 J	3.57 ND	3.84 ND	3.10 ND	4.02 ND
benzo[a]pyrene	24.78	2.89 ND	0.12 J	3.04 ND	0.16 J	3.66 ND	3.94 ND	3.18 ND	4.13 ND
perylene	29.72	3.47 ND	0.06 J	3.65 ND	4.70 ND	4.39 ND	4.73 ND	3.82 ND	4.96 ND
indeno[1,2,3-c,d]pyrene	12.08	1.41 ND	0.06 J	1.48 ND	1.91 ND	1.79 ND	1.92 ND	1.55 ND	2.02 ND
dibenz[a,h]anthracene	17.25	2.01 ND	1.92 ND	2.12 ND	2.73 ND	2.55 ND	2.74 ND	2.22 ND	2.88 ND
benzo[g,h,i]perylene	22.28	2.60 ND	0.13 J	2.73 ND	3.52 ND	3.29 ND	3.54 ND	2.86 ND	3.72 ND
Sum of PAH Analytes:		24.7	13.3	49.2	23.4	49.8	32.2	28.9	32.5

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

	P2-CR-04 BATCH5		TG2-CR-01 BATCH5		TG2-CR-02 BATCH5	
	8.711		8.950		10.391	
	0.0331		0.0463		0.0189	
	71.445		70.498		65.571	
	0.88		1.31		1.24	
J	0.99	J	1.79		1.71	
	0.59	J	1.71		0.65	J
J	0.29	J	0.10	J	0.23	J
J	0.32	J	0.33	J	0.37	J
J	0.07	J	0.06	J	2.71	ND
J	0.86	J	0.63	J	0.18	J
J	0.12	J	2.07	ND	0.06	J
J	0.30	J	0.15	J	0.16	J
J	0.30	J	0.21	J	0.30	J
J	0.05	J	1.97	ND	0.04	J
J	0.06	J	0.04	J	0.10	J
J	0.19	J	0.10	J	0.16	J
J	0.17	J	0.11	J	0.16	J
ND	3.65	ND	3.77	ND	4.40	ND
J	0.07	J	3.90	ND	0.06	J
J	0.06	J	6.92	ND	8.08	ND
J	0.06	J	4.65	ND	5.43	ND
ND	3.44	ND	3.56	ND	4.15	ND
ND	3.54	ND	3.66	ND	4.27	ND
ND	4.24	ND	4.38	ND	5.12	ND
ND	1.72	ND	1.78	ND	2.08	ND
ND	2.46	ND	2.54	ND	2.97	ND
ND	3.18	ND	3.29	ND	3.84	ND
	27.6		49.0		48.5	

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH6

Sample Number:		TG1-CL-01		TG1-CL-02		TG2-CL-01		TG2-CL-02		TG2-CL-03		TG2-CL-04		TG2-CL-DUP	
Batch Number:		BATCH6		BATCH6		BATCH6		BATCH6		BATCH6		BATCH6		BATCH6	
Sample Dry Weight (g):		2.243		1.947		2.085		2.186		2.277		2.574		2.131	
Sample Lipid Weight (g/g):		0.0392		0.0371		0.0781		0.0375		0.0414		0.0417		0.0412	
Sample Moisture Content (%):		92.552		93.525		93.067		92.732		92.447		91.473		92.948	
	MDL														
naphthalene	11.39	1.19		1.07		1.71		2.43		1.27		1.73		0.80	J
2-methylnaphthalene	14.21	0.74	J	0.79	J	1.09		1.36		0.72	J	0.99	J	0.61	J
1-methylnaphthalene	13.99	0.39	J	0.49	J	0.61	J	0.99	J	0.44	J	0.66	J	0.40	J
biphenyl	18.49	0.41	J	0.37	J	0.60	J	0.62	J	0.41	J	0.48	J	0.18	J
2,6-dimethylnaphthalene	16.41	0.24	J	0.32	J	0.40	J	0.38	J	0.27	J	0.40	J	0.26	J
acenaphthylene	15.77	0.59	ND	0.51	ND	0.55	ND	0.13	J	0.60	ND	0.67	ND	0.56	ND
acenaphthene	14.35	0.06	J	0.46	ND	0.50	ND	0.20	J	0.54	ND	0.15	J	0.51	ND
1,6,7-trimethylnaphthalene	14.01	0.52	ND	0.45	ND	0.49	ND	0.51	ND	0.53	ND	0.60	ND	0.49	ND
fluorene	13.17	0.14	J	0.18	J	0.25	J	0.27	J	0.17	J	0.23	J	0.16	J
phenanthrene	18.19	0.40	J	0.38	J	0.58	J	0.55	J	0.45	J	0.76	J	0.28	J
anthracene	13.36	0.09	J	0.08	J	0.30	J	0.14	J	0.14	J	0.16	J	0.05	J
1-methylphenanthrene	24.37	0.08	J	0.09	J	0.07	J	0.12	J	0.11	J	0.11	J	0.06	J
fluoranthene	30.38	0.35	J	0.29	J	0.49	J	0.55	J	0.51	J	1.16	J	0.46	J
pyrene	28.04	0.30	J	0.21	J	0.38	J	0.48	J	0.44	J	0.88	J	0.35	J
benz[a]anthracene	25.54	0.95	ND	0.83	ND	0.89	ND	0.93	ND	0.96	ND	1.09	ND	0.90	ND
chrysene	26.44	0.14	J	0.10	J	0.17	J	0.19	J	0.20	J	0.34	J	0.13	J
benzo[b]fluoranthene	46.94	0.07	J	0.05	J	0.07	J	0.13	J	0.12	J	0.21	J	0.11	J
benzo[k]fluoranthene	31.55	0.05	J	0.04	J	0.07	J	0.08	J	0.08	J	0.13	J	0.07	J
benzo[e]pyrene	24.12	0.90	ND	0.78	ND	0.84	ND	0.88	ND	0.91	ND	0.13	J	0.85	ND
benzo[a]pyrene	24.78	0.92	ND	0.80	ND	0.07	J	0.07	J	0.94	ND	0.13	J	0.05	J
perylene	29.72	0.08	J	0.96	ND	0.09	J	0.06	J	1.12	ND	0.06	J	0.07	J
indeno[1,2,3-c,d]pyrene	12.08	0.45	ND	0.39	ND	0.42	ND	0.44	ND	0.46	ND	0.52	ND	0.43	ND
dibenz[a,h]anthracene	17.25	0.64	ND	0.56	ND	0.60	ND	0.63	ND	0.65	ND	0.74	ND	0.61	ND
benzo[g,h,i]perylene	22.28	0.83	ND	0.72	ND	0.77	ND	0.81	ND	0.84	ND	0.06	J	0.79	ND
Sum of PAH Analytes:		10.5		10.9		12.0		12.9		12.9		12.4		9.2	

ND - Not Detected
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix interference

Parris Island Tissue Analysis
PAH Data in ug/kg WET WEIGHT for BATCH7

Sample Number:		P1-OY-01	P1-OY-02	P1-OY-03	P1-OY-04	P2-OY-01	P2-OY-02	P2-OY-03	P2-OY-04	T
Batch Number:		BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	
Sample Dry Weight (g):		3.375	3.649	4.436	3.535	3.759	3.940	3.599	3.808	
Sample Lipid Weight (g/g):		0.1234	0.0937	0.1114	0.0640	0.0936	0.0867	0.0845	0.1058	
Sample Moisture Content (%):		89.011	88.089	85.236	88.307	87.52	87.266	88.011	88.387	
	MDL									
naphthalene	11.39	0.87	0.58 J	0.64 J	0.62 J	1.13	0.73 J	0.71 J	0.79 J	
2-methylnaphthalene	14.21	1.03 J	0.83 J	1.13 J	0.76 J	1.31	1.43	0.95 J	1.01 J	
1-methylnaphthalene	13.99	0.59 J	0.47 J	0.58 J	0.37 J	0.67 J	0.70 J	0.46 J	0.52 J	
biphenyl	18.49	0.31 J	0.17 J	0.22 J	0.17 J	0.27 J	0.22 J	0.21 J	0.19 J	
2,6-dimethylnaphthalene	16.41	0.65 J	0.51 J	0.61 J	0.44 J	0.67 J	0.72 J	0.60 J	0.54 J	
acenaphthylene	15.77	0.19 J	0.08 J	0.09 J	0.92 ND	0.07 J	0.06 J	0.95 ND	0.08 J	
acenaphthene	14.35	0.67 J	0.48 J	0.53 J	0.38 J	0.36 J	0.37 J	0.33 J	0.39 J	
1,6,7-trimethylnaphthalene	14.01	0.22 J	0.16 J	0.13 J	0.82 ND	0.20 J	0.17 J	0.14 J	0.13 J	
fluorene	13.17	0.55 J	0.43 J	0.50 J	0.35 J	0.48 J	0.47 J	0.42 J	0.41 J	
phenanthrene	18.19	2.15	1.71	2.15	1.55	1.78	1.92	1.62	1.55	
anthracene	13.36	0.42 J	0.31 J	0.32 J	0.22 J	0.17 J	0.33 J	0.27 J	0.17 J	
1-methylphenanthrene	24.37	0.54 J	0.36 J	0.38 J	0.26 J	0.31 J	0.30 J	0.23 J	0.27 J	
fluoranthene	30.38	11.32	8.67	4.53	3.32	3.10	4.12	3.36	2.97	
pyrene	28.04	6.25	5.17	2.29 J	1.83 J	1.26 J	1.75 J	1.40 J	1.41 J	
benz[a]anthracene	25.54	2.13	1.46 J	0.87 J	0.68 J	0.47 J	0.32 J	0.28 J	0.49 J	
chrysene	26.44	3.08	2.15 J	1.61 J	1.12 J	1.07 J	1.01 J	0.91 J	1.00 J	
benzo[b]fluoranthene	46.94	1.51 J	1.16 J	0.74 J	0.64 J	0.42 J	0.78 J	2.81 ND	0.54 J	
benzo[k]fluoranthene	31.55	0.53 J	0.35 J	0.34 J	0.21 J	0.11 J	0.23 J	1.89 ND	0.20 J	
benzo[e]pyrene	24.12	0.87 J	0.60 J	0.51 J	0.37 J	0.23 J	0.18 J	0.20 J	0.26 J	
benzo[a]pyrene	24.78	0.35 J	0.31 J	0.20 J	0.22 J	0.09 J	1.58 ND	1.49 ND	0.06 J	
perylene	29.72	0.32 J	0.17 J	0.19 J	0.14 J	0.06 J	0.07 J	0.09 J	0.09 J	
indeno[1,2,3-c,d]pyrene	12.08	0.23 J	0.16 J	0.89 ND	0.15 J	0.75 ND	0.77 ND	0.05 J	0.08 J	
dibenz[a,h]anthracene	17.25	0.06 J	0.05 J	0.04 J	0.06 J	1.08 ND	1.10 ND	1.03 ND	1.00 ND	
benzo[g,h,i]perylene	22.28	0.78 J	0.17 J	0.17 J	0.20 J	0.07 J	0.08 J	0.06 J	0.08 J	

G1-OY-01	TG1-OY-02	TG1-OY-03	TG1-OY-04	TG2-OY-01	TG2-OY-02	TG2-OY-03	TG2-OY-04	TG2-OY-DUP
BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7	BATCH7
2.680	2.794	2.701	2.631	2.795	2.636	2.946	2.906	2.665
0.0647	0.0657	0.0640	0.0643	0.0651	0.0580	0.0649	0.0571	0.0630
91.103	90.71	91.024	91.354	90.714	91.307	90.283	90.39	91.184
0.66 J	0.58 J	0.43 J	0.73	0.57 J	0.34 J	1.37	0.55 J	0.46 J
0.46 J	0.37 J	0.45 J	0.47 J	0.38 J	0.20 J	1.32	0.40 J	0.30 J
0.29 J	0.21 J	0.26 J	0.30 J	0.26 J	0.12 J	0.89 J	0.26 J	0.17 J
0.12 J	0.12 J	0.10 J	0.13 J	0.11 J	0.07 J	0.51 J	0.12 J	0.10 J
0.24 J	0.24 J	0.24 J	0.28 J	0.21 J	0.10 J	0.52 J	0.18 J	0.13 J
0.70 ND	0.73 ND	0.71 ND	0.68 ND	0.73 ND	0.69 ND	0.77 ND	0.76 ND	0.70 ND
0.08 J	0.08 J	0.09 J	0.09 J	0.10 J	0.09 J	0.70 ND	0.13 J	0.12 J
0.62 ND	0.05 J	0.63 ND	0.61 ND	0.10 J	0.61 ND	0.21 J	0.67 ND	0.62 ND
0.19 J	0.15 J	0.16 J	0.20 J	0.18 J	0.14 J	0.30 J	0.18 J	0.16 J
0.54 J	0.49 J	0.46 J	0.46 J	0.47 J	0.37 J	0.77 J	0.65 J	0.61 J
0.13 J	0.05 J	0.05 J	0.05 J	0.07 J	0.05 J	0.22 J	0.10 J	0.13 J
0.08 J	0.09 J	0.10 J	0.10 J	0.09 J	0.06 J	0.26 J	0.12 J	0.10 J
0.97 J	0.72 J	0.73 J	0.66 J	0.95 J	0.76 J	1.24 J	1.35 J	1.33 J
0.48 J	0.43 J	0.44 J	0.43 J	0.54 J	0.43 J	0.88 J	0.77 J	0.78 J
1.14 ND	1.19 ND	1.15 ND	1.10 ND	1.19 ND	1.11 ND	0.24 J	0.26 J	0.27 J
0.30 J	0.30 J	0.23 J	0.26 J	0.33 J	0.27 J	0.43 J	0.47 J	0.51 J
2.09 ND	0.20 J	0.16 J	0.18 J	0.39 J	0.17 J	0.33 J	0.23 J	0.26 J
1.40 ND	0.09 J	0.09 J	0.10 J	0.14 J	0.07 J	0.32 J	0.10 J	0.13 J
0.11 J	0.06 J	0.05 J	0.07 J	0.09 J	0.06 J	0.14 J	0.09 J	0.12 J
1.10 ND	0.05 J	1.11 ND	0.06 J	0.13 J	1.08 ND	1.20 ND	0.05 J	0.05 ND
0.12 J	0.08 J	0.09 J	0.08 J	0.13 J	0.07 J	0.15 J	0.09 J	0.08 J
0.08 J	0.05 J	0.54 ND	0.06 J	0.05 J	0.53 ND	0.59 ND	0.05 J	0.04 ND
0.77 ND	0.80 ND	0.77 ND	0.75 ND	0.80 ND	0.75 ND	0.84 ND	0.83 ND	0.76 ND
0.12 J	0.05 J	1.00 ND	0.08 J	0.08 J	0.97 ND	1.08 ND	1.07 ND	0.08 J
12.8	7.2	10.0	7.9	8.1	9.1	15.3	9.5	8.0

Parris Island Tissue Analysis
PCBPEST Data in ug/kg WET WE IGHT for BATCH1

Sample Number:		P1-FIM-01		P1-FIM-02		P1-FIM-03		1-FIM-ARCH		P2-FIM-01
Batch:		BATCH1		BATCH1		BATCH1		BATCH1		BATCH1
Sample Dry Weight (g):		7.324		6.635		3.317		6.117		6.755
Sample Lipid Weight (g/g):		0.1876		0.0482		0.0422		0.0523		0.0380
Sample Moisture Content (%):		75.688		78.181		80.747		80.189		78.209
	MDL									
CL2(8)	6.75	0.75	NC	0.74	ND	0.65	ND	0.67	ND	0.74
HEXACHLOROBENZENE	2.35	0.29	ND	0.26	ND	0.23	ND	0.23	ND	0.26
LINDANE	1.89	0.23	ND	0.21	ND	0.18	ND	0.19	ND	0.21
CL3(18)	4.02	0.49	ND	0.44	ND	0.39	ND	0.40	ND	0.44
CL3(28)	2.79	0.39	NC	0.35	NC	0.27	ND	0.28	ND	0.30
HEPTACHLOR	3.17	0.39	ND	0.35	JNC	0.31	ND	0.31	ND	0.35
CL4(52)	5.13	1.13	NC	0.41	NC	0.49	ND	0.51	ND	0.56
ALDRIN	1.42	0.17	ND	0.15	ND	0.14	ND	0.14	ND	0.15
CL4(44)	2.58	0.31	ND	0.17	JNC	0.25	ND	0.26	ND	0.28
HEPTACHLOREPOXIDE	1.18	0.14	ND	0.13	ND	0.11	ND	0.12	ND	0.13
CL4(66)	1.33	0.77	NC	0.87	NC	0.13	ND	0.13	ND	0.14
2,4-DDE	0.79	0.50		0.09	NC	0.08	NC	0.08	ND	0.09
CL5(101)	1.93	2.35	NC	1.23	NC	1.01	NC	0.42	NC	0.40
CIS-CHLORDANE	1.36	0.55		0.57		0.13	NC	0.13	NC	0.41
TRANS-NONACHLOR	1.45	1.47		1.18		0.64		0.27		0.78
DIELDRIN	2.36	0.29	ND	0.26	ND	0.23	ND	0.23	ND	0.26
4,4-DDE	1.75	31.20		10.37		11.73		3.73		4.19
CL4(77)	3.07	0.37	ND	0.33	ND	0.30	ND	0.30	ND	0.33
2,4-DDD	2.2	0.27	NC	0.24	NC	0.21	JNC	0.22	ND	0.24
ENDRIN	7.35	0.89	ND	0.80	ND	0.71	ND	0.73	ND	0.80
CL5(118)	1.72	1.71	NC	1.12	NC	1.22	NC	0.29	NC	0.33
4,4-DDD	2.36	9.52		4.67		1.74		0.45		0.77
2,4-DDT	1.75	0.21	ND	0.19	JNC	0.17	NC	0.17	ND	0.19
CL6(153)	1.24	5.41	NC	2.86	NC	4.75	NC	0.99	NC	0.64
CL5(105)	1.1	0.13	ND	0.27	NC	0.62	NC	0.13	NC	0.09
4,4-DDT	8.15	0.99	JNC	0.89	JNC	0.78	ND	0.81	ND	0.89
CL6(138)	2.79	3.90	NC	2.09	NC	3.28	NC	0.79	NC	0.51
CL5(126)	3.01	0.37	ND	0.33	ND	0.29	ND	0.30	ND	0.33
CL7(187)	2.23	1.34	NC	0.69	NC	1.22	NC	0.34	NC	0.17
CL6(128)	0.8	0.26	NC	0.23	NC	0.45	NC	0.08	ND	0.09
CL7(180)	1.38	1.52	NC	0.84	NC	1.48	NC	0.36	NC	0.20
MIREX	2.68	1.05		1.19		1.60		0.80		0.57
CL7(170)	5.55	0.76	NC	0.47	NC	1.04	NC	0.05	JNC	0.05
CL8(195)	1.61	0.20	ND	0.18	ND	0.04	JNC	0.16	ND	0.18
CL9(206)	1.73	0.21	ND	0.19	ND	0.17	ND	0.17	ND	0.19
CL10(209)	5.2	0.63	ND	0.57	ND	0.50	ND	0.52	ND	0.57
AROCLOR 1016/1242	20	2.43	ND	2.18	ND	1.93	ND	1.98	ND	2.18
AROCLOR 1221	20	2.43	ND	2.18	ND	1.93	ND	1.98	ND	2.18
AROCLOR 1232	20	2.43	ND	2.18	ND	1.93	ND	1.98	ND	2.18
AROCLOR 1248	20	2.43	ND	2.18	ND	1.93	ND	1.98	ND	2.18
AROCLOR 1254	20	63.11		33.63		52.02		10.80		2.18
AROCLOR 1260	20	2.43	ND	2.18	ND	1.93	ND	1.98	ND	2.18
Sum of PCB Congeners:		23.005		14.375		18.527		7.116		6.540
Sum of DDTs, DDDs, and DDEs:		42.701		16.449		14.714		5.458		6.366

ND - Not Detected
NC - Not Confirmed by second col umn analysis
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix inte rference

Parris Island Tissue Analysis
PCBPEST Data in ug/kg WET WE

Sample Number:	P2-FIM-02		TG2-FIM-01	
Batch:	BATCH1		BATCH1	
Sample Dry Weight (g):	5.243		6.736	
Sample Lipid Weight (g/g):	0.0703		0.0351	
Sample Moisture Content (%):	80.602		78.974	
CL2(8)	ND	0.65	ND	0.71	ND
HEXACHLOROBENZENE	ND	0.23	ND	0.25	ND
LINDANE	ND	0.18	ND	0.20	ND
CL3(18)	ND	0.39	ND	0.42	ND
CL3(28)	ND	0.27	ND	0.29	ND
HEPTACHLOR	ND	0.31	ND	0.33	ND
CL4(52)	ND	0.50	ND	0.54	ND
ALDRIN	ND	0.14	ND	0.15	ND
CL4(44)	ND	0.25	ND	0.27	ND
HEPTACHLOREPOXIDE	ND	0.11	ND	0.12	ND
CL4(66)	ND	0.13	ND	0.14	ND
2,4-DDE	ND	0.70		0.08	ND
CL5(101)	NC	0.86	NC	0.14	JNC
CIS-CHLORDANE		0.13	NC	0.14	NC
TRANS-NONACHLOR		0.37		0.15	NC
DIELDRIN	ND	0.23	ND	0.25	ND
4,4-DDE		20.17		1.29	
CL4(77)	ND	0.30	ND	0.32	ND
2,4-DDD	ND	0.21	NC	0.23	ND
ENDRIN	ND	0.71	ND	0.77	ND
CL5(118)	NC	0.49	NC	0.18	ND
4,4-DDD		5.92		0.25	ND
2,4-DDT	ND	0.17	ND	0.18	ND
CL6(153)	NC	3.57	NC	0.32	NC
CL5(105)	NC	0.06	JNC	0.06	JNC
4,4-DDT	ND	0.79	NC	0.86	ND
CL6(138)	NC	2.47	NC	0.24	NC
CL5(126)	ND	0.29	ND	0.32	ND
CL7(187)	NC	0.82	NC	0.14	JNC
CL6(128)	ND	0.03	JNC	0.02	JNC
CL7(180)	NC	1.29	NC	0.10	JNC
MIREX		1.31		0.40	
CL7(170)	JNC	0.59	NC	0.58	ND
CL8(195)	ND	0.16	ND	0.17	ND
CL9(206)	ND	0.17	ND	0.18	ND
CL10(209)	ND	0.50	ND	0.55	ND
AROCLOR 1016/1242	ND	1.94	ND	2.10	ND
AROCLOR 1221	ND	1.94	ND	2.10	ND
AROCLOR 1232	ND	1.94	ND	2.10	ND
AROCLOR 1248	ND	1.94	ND	2.10	ND
AROCLOR 1254	ND	22.88		2.10	ND
AROCLOR 1260	ND	1.94	ND	2.10	ND
Sum of PCB Congeners:		13.801		5.695	
Sum of DDTs, DDDs, and DDEs:		27.966		2.896	

ND - Not Detected
NC - Not Confirmed by second col
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in
E - Estimate,significant matrix inte

Parris Island Tissue Analysis
PCBPEST Data in ug/kg WET WE IGHT for BATCH2

Sample Number:		P1-FIL-01		P1-FIL-02		P1-FIL-03		1-FIL-ARCH		P2-FIL-01
Batch:		BATCH2		BATCH2		BATCH2		BATCH2		BATCH2
Sample Dry Weight (g):		4.707		4.035		0.025		0.100		2.957
Sample Lipid Weight (g/g):		0.7036		0.5157		4.8000		0.0760		0.5899
Sample Moisture Content (%):		53.322		61.255		57.684		57.684		58.476
	MDL									
CL2(8)	6.750	1.58	ND	1.31	ND	1.43	ND	1.43	ND	1.40
HEXACHLOROBENZENE	2.350	0.55	ND	0.46	ND	0.50	ND	0.50	ND	0.49
LINDANE	1.890	0.44	ND	0.37	ND	0.40	ND	0.40	ND	0.39
CL3(18)	4.020	3.17	JNC	0.78	ND	0.85	ND	0.85	ND	0.83
CL3(28)	2.790	10.46	NC	0.54	ND	0.59	ND	0.59	ND	0.58
HEPTACHLOR	3.170	0.74	ND	0.61	ND	0.67	ND	0.67	ND	0.66
CL4(52)	5.130	14.91	NC	7.27	NC	0.74	ND	0.74	ND	0.72
ALDRIN	1.420	0.33	ND	0.28	ND	0.30	ND	0.30	ND	0.29
CL4(44)	2.580	0.95	JNC	0.76	JNC	0.55	ND	0.55	ND	0.54
HEPTACHLOREPOXIDE	1.180	0.28	ND	0.23	ND	0.25	ND	0.25	ND	0.24
CL4(66)	1.330	9.31	NC	8.63	NC	0.28	ND	0.28	ND	0.28
2,4-DDE	0.790	0.18	NC	3.50		0.17	ND	0.17	ND	0.16
CL5(101)	1.930	24.39	NC	19.52	NC	0.41	ND	0.41	ND	22.15
CIS-CHLORDANE	1.360	10.20		7.27		0.29	ND	0.29	ND	16.36
TRANS-NONACHLOR	1.450	20.90		19.65		0.31	ND	0.31	ND	37.37
DIELDRIN	2.360	1.12	J	1.83		0.50	ND	0.50	ND	0.49
4,4-DDE	1.750	347.66		238.86		386.53		211.84		192.94
CL4(77)	3.070	0.72	ND	0.59	ND	0.65	ND	0.65	ND	0.64
2,4-DDD	2.200	0.51	NC	0.43	NC	0.47	ND	0.47	ND	0.46
ENDRIN	7.350	1.72	ND	1.42	ND	1.56	ND	1.56	ND	1.53
CL5(118)	1.720	22.04	NC	20.95	NC	0.36	ND	0.36	ND	17.96
4,4-DDD	2.360	131.16		140.01		0.50	ND	0.50	ND	39.09
2,4-DDT	1.750	2.56		2.69		0.37	ND	0.37	ND	0.36
CL6(153)	1.240	54.73	NC	47.16	NC	0.26	ND	80.91	NC	45.80
CL5(105)	1.100	4.32	NC	6.50	NC	0.23	ND	43.31	NC	4.24
4,4-DDT	8.150	1.90	JNC	1.58	JNC	1.72	ND	1.72	ND	1.69
CL6(138)	2.790	44.52	NC	38.99	NC	0.59	ND	0.59	ND	31.03
CL5(126)	3.010	0.70	ND	0.58	ND	0.64	ND	0.64	ND	0.62
CL7(187)	2.230	16.28	NC	12.68	NC	0.47	ND	0.47	ND	12.72
CL6(128)	0.800	4.74	NC	3.84	NC	0.17	ND	0.17	ND	0.17
CL7(180)	1.380	20.18	NC	14.15	NC	0.29	ND	0.29	ND	11.73
MIREX	2.680	16.36		23.40		0.57	ND	0.57	NC	31.22
CL7(170)	5.550	12.88	NC	8.20	NC	1.17	ND	1.17	ND	5.09
CL8(195)	1.610	1.01	JNC	0.92	JNC	0.34	ND	0.34	ND	0.33
CL9(206)	1.730	0.37	JNC	0.34	ND	0.37	ND	0.37	ND	0.36
CL10(209)	5.200	1.21	ND	1.01	ND	1.10	ND	1.10	ND	1.08
AROCLOR 1016/1242	20.000	4.67	ND	3.87	ND	4.23	ND	4.23	ND	4.15
AROCLOR 1221	20.000	4.67	ND	3.87	ND	4.23	ND	4.23	ND	4.15
AROCLOR 1232	20.000	4.67	ND	3.87	ND	4.23	ND	4.23	ND	4.15
AROCLOR 1248	20.000	4.67	ND	3.87	ND	4.23	ND	4.23	ND	4.15
AROCLOR 1254	20.000	814.83		451.85		4.23	ND	4.23	ND	359.60
AROCLOR 1260	20.000	4.67	ND	3.87	ND	4.23	ND	4.23	ND	4.15
Sum of PCB Congeners:		248.461		194.724		11.492		135.220		158.279
Sum of DDTs, DDDs, and DDEs:		483.979		387.066		389.758		215.065		234.710

ND - Not Detected
NC - Not Confirmed by second col umn analysis
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in Blank
E - Estimate,significant matrix inte rference

Parris Island Tissue Analysis
PCBPEST Data in ug/kg WET WE

Sample Number:		P2-FIL-02		TG2-FIL-01	
Batch:		BATCH2		BATCH2	
Sample Dry Weight (g):		0.114		1.311	
Sample Lipid Weight (g/g):		0.3000		0.0899	
Sample Moisture Content (%):		57.684		57.684	
CL2(8)	ND	1.43	ND	1.43	ND
HEXACHLOROBENZENE	ND	0.50	ND	0.50	ND
LINDANE	ND	0.40	ND	0.40	ND
CL3(18)	ND	0.85	ND	0.85	ND
CL3(28)	ND	0.59	ND	0.59	ND
HEPTACHLOR	ND	0.67	ND	0.67	ND
CL4(52)	ND	0.74	ND	0.74	ND
ALDRIN	ND	0.30	ND	0.30	ND
CL4(44)	ND	0.55	ND	0.55	ND
HEPTACHLOREPOXIDE	ND	0.25	ND	0.25	ND
CL4(66)	ND	0.28	ND	0.28	ND
2,4-DDE	ND	35.54		0.17	ND
CL5(101)	NC	5.59	NC	0.41	ND
CIS-CHLORDANE		0.29	NC	0.29	ND
TRANS-NONACHLOR		28.74		0.31	ND
DIELDRIN	ND	0.50	ND	0.50	ND
4,4-DDE		747.20		6.37	
CL4(77)	ND	0.65	ND	0.65	ND
2,4-DDD	ND	0.47	NC	0.47	ND
ENDRIN	ND	1.56	ND	1.56	ND
CL5(118)	NC	15.67	NC	0.36	ND
4,4-DDD		346.52		0.50	ND
2,4-DDT	ND	0.37	NC	0.37	ND
CL6(153)	NC	61.42	NC	0.26	ND
CL5(105)	NC	25.16	NC	0.23	ND
4,4-DDT	ND	1.72	ND	1.72	ND
CL6(138)	NC	20.34	NC	0.59	ND
CL5(126)	ND	0.64	ND	0.64	ND
CL7(187)	NC	11.54	NC	0.47	ND
CL6(128)	ND	0.17	ND	0.17	ND
CL7(180)	NC	23.77	NC	0.29	ND
MIREX		30.73		0.57	ND
CL7(170)	NC	22.15	NC	1.17	ND
CL8(195)	ND	0.34	ND	0.34	ND
CL9(206)	ND	0.37	ND	0.37	ND
CL10(209)	ND	1.10	ND	1.10	ND
AROCLOR 1016/1242	ND	4.23	ND	4.23	ND
AROCLOR 1221	ND	4.23	ND	4.23	ND
AROCLOR 1232	ND	4.23	ND	4.23	ND
AROCLOR 1248	ND	4.23	ND	4.23	ND
AROCLOR 1254		886.15		4.23	ND
AROCLOR 1260	ND	4.23	ND	4.23	ND
Sum of PCB Congeners:		193.337		11.492	
Sum of DDTs, DDDs, and DDEs:		1131.822		9.601	

ND - Not Detected
NC - Not Confirmed by second col
J - Detected, but below the MDL
B - Analyte is > 5 times MDL in
E - Estimate,significant matrix inte

APPENDIX C

QUALITY CONTROL SAMPLE RESULTS

APPENDIX C
QUALITY CONTROL (QC) SAMPLE RESULTS

Polynuclear Aromatic Hydrocarbons (PAH)

The procedural blank (PB) data are reported in micrograms per kilogram ($\mu g/kg$), using the average dry weight of the field samples in the batch. The average dry weight is also reported. The PAH procedural blank data were good, indicating no evidence of significant laboratory contamination. There were no instances of an analyte being detected at levels above 5 times the MDL (the QC criteria goal) and only one instance (naphthalene in the PB for Batch 2) where an analyte was detected above the MDL.

The recoveries of the three PAH surrogates were acceptable, with 303 of the 315 surrogate recovery values falling within the criteria goal range of 40 percent to 120 percent, and the other recoveries being slightly below 40 percent. However, analyte recoveries track surrogate recoveries closely, and, because the samples were analyzed using the method of internal standards, with the surrogates used for quantification, accurate quantification is generally obtained even with the lower recoveries. This is clearly demonstrated with the blank spike duplicate sample in Batch 3, which had relatively poor surrogate recoveries but excellent accuracy in the target analyte analysis.

The blank spike (BS) and matrix spike (MS) target analyte recoveries are reported as relative recoveries, and are based on quantification relative to the surrogate compounds (quantification internal standard), because this is the way the field samples are quantified and it best represents the accuracy of the analysis. Surrogate recoveries are absolute recoveries, and are based on quantification relative to the recovery internal standard. The absolute recovery criteria range was 40 to 120 percent. The relative recovery criteria goal is generally a range from 50 to 150 percent for these types of analyses (see Battelle's Laboratory Quality Assurance Plan for Navy Installation restoration Programs). However, because no distinction was made between absolute and relative recoveries in the Workplan, the absolute recovery criteria, which were originally listed as criteria goals, were used to qualify these QC data, including the relative recovery target analyte data. Absolute recoveries for the target analytes can be determined by applying the appropriate surrogate absolute recovery value to the target analyte relative recovery value: multiply the target analyte relative recovery by the absolute recovery of the surrogate used to quantify that target analyte, and dividing by 100.

The BS data are presented in data tables, and selected, representative, analyte data are also presented in figures. The PAH BS data show acceptable accuracy and precision. The surrogate recoveries of the BSD sample in Batch 3 were slightly below 40 percent, but this was clearly an isolated occurrence. The accuracy of the BS/BSD target analyte analyses was acceptable, even for the BSD sample in Batch 3. The flagged target analyte recoveries are for data slightly outside the range of absolute recovery criterion, but are inside the range of the more appropriate relative recovery criterion. The precision in the analyses was acceptable, with most RPDs below 10 percent. There were two data points at the criteria goal (30 percent RPD).

The MS data are presented in data tables, and selected, representative, analyte data are also presented in figures. The PAH MS data show acceptable accuracy and precision. One of the surrogate recoveries of the MS sample in Batch 2 was out of range (just below 40 percent). The accuracy of the target analyte analyses was good, and there was no evidence of significant matrix effects on analyte quantification from any of the seven different sample matrices. The flagged target analyte recoveries are for data slightly above the absolute recovery criteria of 120 percent, but are within the more appropriate relative recovery criteria of up to 150 percent. The precision in the analyses was excellent, with all RSDs being 10 percent or less.

The PAH standard reference material (SRM) data are presented for the individual PAHs along with certified values for this marine tissue SRM [National Institute of Standards and Technology (NIST) mussel SRM, 1974]. The SRM accuracy and precision was good for all analytes except anthracene and benzo[g,h,i]perylene. These two analytes were present at levels below the MDL for the method used, which explains the less accurate and precise results. The recovery of benzo[b]fluoranthene was slightly above the criterion goal (132 percent, versus a goal of 130 percent) for the SRM analysis in Batch 4, but was within the criterion for all other SRM analyses even though the concentration of this analyte was just above the MDL in the SRM.

Polychlorinated Biphenyls (PCB) and Chlorinated Pesticides

The PB data are reported in μg/kg, using the average dry weight of the field samples in the batch. The average dry weights are also reported. The PCB and pesticide procedural blank data were very good, indicating no evidence of significant laboratory contamination. There were no instances of an analyte being detected at levels greater than the MDL.

The recoveries of the two PCB and pesticide surrogates were acceptable. Two field samples had low dibromo-octafluorobiphenyl (DBOFB) recoveries, 29 and 39 percent, but the tetrachloronaphthalene (TCN) recoveries were within the criteria goal. However, analyte recoveries track surrogate recoveries closely, and, because the samples were analyzed using the method of internal standards, with the surrogates used for quantification, accurate quantification is obtained even with the lower recoveries. There was a significant matrix interference with TCN in SRM 1974 samples that resulted in elevated surrogate recovery values. Historical data generated by our laboratory show similar results for past analyses, and this is the reason for the consistently elevated TCN recoveries in the SRM samples.

The BS and MS target analyte recoveries are reported as relative recoveries, and are based on quantification relative to the surrogate compounds (quantification internal standard), because this is the way the field samples are quantified and it best represents the accuracy of the analysis.

Surrogate recoveries are absolute recoveries, and are based on quantification relative to the recovery internal standard. The acceptable range was 40 to 120 percent for absolute recoveries. The acceptable range for relative recovery is generally 50 to 150 percent for these types of analyses (see Battelle's Laboratory Quality Assurance Plan for Navy Installation Restoration Programs). However, because no distinction was made between absolute and relative recoveries in the Workplan, the absolute recovery criteria, which were originally listed as

criteria goals, were used to qualify these QC data, including the relative recovery target analyte data. Absolute recoveries for the target analytes can be determined by applying the appropriate surrogate absolute recovery value to the target analyte relative recovery value (multiply the target analyte relative recovery by the absolute recovery of the surrogate used to quantify that target analyte, and divide by 100).

The BS data are presented in data tables, and selected, representative, analyte data are also presented in figures. The PCB and pesticide BS data show good accuracy and precision. The recovery of the surrogate DBOFB in the BSD sample in Batch 3 was slightly below 40 percent, but this was clearly an isolated occurrence. The accuracy of the target analyte analyses was generally good, even for the BSD sample in Batch 3. The flagged target analyte recoveries are for data outside the range of absolute recovery criterion, but, with the exception of three data points, all are inside the range of the more appropriate relative recovery criterion. The precision in the analyses was acceptable, with most RPDs below 10 percent. There were three data-points slightly above the criteria goal (30 percent).

The MS data are presented in data tables, and selected, representative, analyte data are also presented in figures. The PCB and pesticide MS data show, for the most part, acceptable accuracy and precision. The MS sample data for Batch 2 (sample JU11MS) should be disregarded because of the high background matrix analyte levels for this liver sample relative to the amount spiked into the sample for recovery determinations. The MS analyte spike amounts should, at a minimum, be several times greater than the amount in the sample to begin with, and this was not the case for JU11MS. The accuracy of the target analyte analyses was good, and there was no evidence of significant matrix effects on analyte quantification. Target analyte recoveries outside the absolute recovery range are flagged. Most of the outliers are within the more appropriate relative recovery range. The inability to recover Cl_4(77) in the MS samples in Batches 3 and 7 is due to high levels of a closely eluting major PCB congener (a frequent occurrence with this analyte) that interferes with the analysis of Cl_4(77). The low recoveries of 4,4'-DDE in the MS sample in Batch 5 and Cl_7(170) in the MS sample in Batch 3 are due to high background analyte levels in the sample used for the MS, resulting in inaccurate background correction for recovery determination. The precision in the analyses was acceptable, except for the three analytes discussed above.

There are no certified PCB or pesticide values for the SRM analyzed, or any other marine tissue SRM. Therefore, PCB and pesticide SRM data are presented for precision determination only. Only analytes with measured concentrations greater than 5 times the MDL are included in the PCB and pesticide SRM table. The precision in the analyses was acceptable, with the analyses consistently falling within the acceptable range (30 percent RSD), except for cis-chlordane and trans-nonachlor. These two analytes were present at low concentrations, with levels below 5 times the MDL measured in some of the seven MS replicates.

Mercury

The PB data are reported in $\mu g/g$, using the average dry weight of the field samples in the batch. The average dry weight is also reported. The mercury procedural blank data were acceptable, considering the method detection limits. The exceedance of 5 times MDL for several mercury PBs is a reflection of the very

low detection limits and not improper laboratory processing. The background levels are generally highly reproducible in a given batch of samples, and sample data can therefore be accurately background corrected. The field sample data reported for this study have not been background corrected.

The BS data are presented in a data table and in a figure. The mercury BS data show acceptable accuracy and precision. All recoveries were well within the criteria range, and the precision in the duplicate analyses in each batch consistently yielded RPDs below 10 percent.

The MS data are presented in a data table and in a figure. The mercury MS data show acceptable accuracy and precision. All recoveries were well within the criteria range of 50 to 120 percent (averaged 96 percent), and the precision in the seven MS analyses was also acceptable (7 percent RSD).

The SRM data showed acceptable accuracy. The mercury content of this SRM is very low (0.064 $\mu g/g$, dry weight), and blank levels were close to the SRM levels for several batches, resulting in less accurate determinations and apparent recoveries that were slightly outside the criteria range for three analyses. The precision in the replicate SRM analyses was acceptable, with a %RSD of 18 percent.

The precision in the mercury laboratory duplicate analyses was acceptable. The precision criteria goal was exceeded for the sample duplicate analysis in one of the seven batches. This was for a sample that had a mercury concentration close to the detection limit and the blank mercury levels, which results in a less precise determination.

APPENDIX D

DATA SUMMARY TABLES

TABLE D-1
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 1)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL2(8)	ND	7.5E-01	7.0E-01	4.7E-02	1 / 6	7.5E-01
CL3(28)	ND	3.9E-01	3.1E-01	5.2E-02	2 / 6	3.6E-01
CL4(52)	ND	1.1E+00	6.0E-01	2.6E-01	2 / 6	8.6E-01
CL4(44)	ND	3.1E-01	2.5E-01	4.7E-02	1 / 6	3.0E-01
CL4(66)	ND	8.7E-01	3.6E-01	3.5E-01	2 / 6	7.2E-01
2,4-DDE	ND	7.0E-01	2.6E-01	2.8E-01	2 / 6	5.3E-01
CL5(101)	4.0E-01	2.3E+00	1.0E+00	7.2E-01	6 / 6	1.8E+00
CIS-CHLORDANE	ND	5.7E-01	3.2E-01	2.1E-01	3 / 6	5.3E-01
TRANS-NONACHLOR	2.7E-01	1.5E+00	7.8E-01	4.7E-01	6 / 6	1.3E+00
4,4-DDE	3.7E+00	3.1E+01	1.4E+01	1.1E+01	6 / 6	2.4E+01
CL5(118)	2.9E-01	1.7E+00	8.6E-01	5.7E-01	6 / 6	1.4E+00
4,4-DDD	4.5E-01	9.5E+00	3.8E+00	3.5E+00	6 / 6	7.4E+00
CL6(153)	6.4E-01	5.4E+00	3.0E+00	1.9E+00	6 / 6	5.0E+00
CL5(105)	ND	6.2E-01	2.2E-01	2.1E-01	5 / 6	4.3E-01
CL6(138)	5.1E-01	3.9E+00	2.2E+00	1.3E+00	6 / 6	3.5E+00
CL7(187)	1.7E-01	1.3E+00	7.6E-01	4.6E-01	6 / 6	1.2E+00
CL6(128)	ND	4.5E-01	1.9E-01	1.6E-01	4 / 6	3.4E-01
CL7(180)	2.0E-01	1.5E+00	9.5E-01	5.7E-01	6 / 6	1.5E+00
MIREX	5.7E-01	1.6E+00	1.1E+00	3.7E-01	6 / 6	1.5E+00
CL7(170)	4.7E-02	1.0E+00	4.9E-01	3.9E-01	6 / 6	8.9E-01
CL8(195)	ND	2.0E-01	1.5E-01	5.5E-02	1 / 6	2.1E-01
AROCLOR 1254	ND	6.3E+01	3.1E+01	2.4E+01	5 / 6	5.4E+01

ND - Not Detected
Units: ug/kg wet weight

TABLE D-2
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 1)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL5(101)	1.4E-01	1.4E-01	1.4E-01	NA	1 / 1	1.4E-01
TRANS-NONACHLOR	1.5E-01	1.5E-01	1.5E-01	NA	1 / 1	1.5E-01
4,4-DDE	1.3E+00	1.3E+00	1.3E+00	NA	1 / 1	1.3E+00
CL5(118)	1.8E-01	1.8E-01	1.8E-01	NA	1 / 1	1.8E-01
4,4-DDD	2.5E-01	2.5E-01	2.5E-01	NA	1 / 1	2.5E-01
CL6(153)	3.2E-01	3.2E-01	3.2E-01	NA	1 / 1	3.2E-01
CL5(105)	6.2E-02	6.2E-02	6.2E-02	NA	1 / 1	6.2E-02
CL6(138)	2.4E-01	2.4E-01	2.4E-01	NA	1 / 1	2.4E-01
CL7(187)	1.4E-01	1.4E-01	1.4E-01	NA	1 / 1	1.4E-01
CL7(180)	9.6E-02	9.6E-02	9.6E-02	NA	1 / 1	9.6E-02
MIREX	4.0E-01	4.0E-01	4.0E-01	NA	1 / 1	4.0E-01
CL7(170)	5.8E-01	5.8E-01	5.8E-01	NA	1 / 1	5.8E-01
AROCLOR 1254	2.1E+00	2.1E+00	2.1E+00	NA	1 / 1	2.1E+00

ND - Not Detected
Units: ug/kg wet weight

TABLE D-3a
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 2)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequenc	Mean + 1 se
CL3(18)	ND	3.2E+00	1.2E+00	9.5E-01	1 / 6	2.2E+00
CL3(28)	ND	1.0E+01	2.2E+00	4.0E+00	1 / 6	6.3E+00
CL4(52)	ND	1.5E+01	4.2E+00	5.9E+00	2 / 6	1.0E+01
CL4(44)	ND	9.5E-01	6.5E-01	1.7E-01	2 / 6	8.2E-01
CL4(66)	ND	9.3E+00	3.2E+00	4.5E+00	2 / 6	7.7E+00
2,4-DDE	ND	3.6E+01	6.6E+00	1.4E+01	2 / 6	2.1E+01
CL5(101)	ND	2.4E+01	1.2E+01	1.1E+01	4 / 6	2.3E+01
CIS-CHLORDANE	ND	1.6E+01	5.8E+00	6.7E+00	3 / 6	1.2E+01
TRANS-NONACHLOR	ND	3.7E+01	1.8E+01	1.5E+01	4 / 6	3.3E+01
DIELDRIN	ND	1.8E+00	8.2E-01	5.5E-01	2 / 6	1.4E+00
4,4-DDE	1.9E+02	7.5E+02	3.5E+02	2.1E+02	6 / 6	5.6E+02
CL5(118)	ND	2.2E+01	1.3E+01	1.0E+01	4 / 6	2.3E+01
4,4-DDD	ND	3.5E+02	1.1E+02	1.3E+02	4 / 6	2.4E+02
2,4-DDT	ND	2.7E+00	1.1E+00	1.2E+00	2 / 6	2.3E+00
CL6(153)	ND	8.1E+01	4.8E+01	2.7E+01	5 / 6	7.5E+01
CL5(105)	ND	4.3E+01	1.4E+01	1.7E+01	5 / 6	3.1E+01
CL6(138)	ND	4.5E+01	2.3E+01	1.9E+01	4 / 6	4.2E+01
CL7(187)	ND	1.6E+01	9.0E+00	6.8E+00	4 / 6	1.6E+01
CL6(128)	ND	4.7E+00	1.5E+00	2.1E+00	2 / 6	3.7E+00
CL7(180)	ND	2.4E+01	1.2E+01	9.8E+00	4 / 6	2.2E+01
MIREX	ND	3.1E+01	1.7E+01	1.4E+01	4 / 6	3.1E+01
CL7(170)	ND	2.2E+01	8.4E+00	8.1E+00	4 / 6	1.7E+01
CL8(195)	ND	1.0E+00	5.5E-01	3.2E-01	2 / 6	8.7E-01
CL9(206)	ND	3.7E-01	3.6E-01	1.4E-02	1 / 6	3.7E-01
AROCLOR 1254	ND	8.9E+02	4.2E+02	3.8E+02	4 / 6	8.0E+02

ND - Not Detected
Units: ug/kg wet weight

TABLE D-3b
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 2)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequenc	Mean + 1 se
4,4-DDE	6.4E+00	6.4E+00	6.4E+00	NA	1 / 1	6.4E+00

ND - Not Detected
Units: ug/kg wet weight

TABLE D-4
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 2)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL2(8)	ND	8.4E-01	7.5E-01	6.3E-02	2 / 4	8.1E-01
HEXACHLOROBENZENE	ND	2.6E-01	2.1E-01	7.8E-02	2 / 4	2.9E-01
LINDANE	ND	2.4E-01	2.2E-01	1.7E-02	3 / 4	2.3E-01
CL3(18)	ND	5.0E-01	4.5E-01	3.7E-02	2 / 4	4.8E-01
CL3(28)	ND	5.8E-01	3.7E-01	1.4E-01	2 / 4	5.1E-01
HEPTACHLOR	ND	3.9E-01	3.5E-01	3.0E-02	2 / 4	3.8E-01
CL4(52)	1.2E-01	1.3E+00	4.3E-01	5.7E-01	4 / 4	1.0E+00
ALDRIN	ND	1.8E-01	1.6E-01	1.3E-02	2 / 4	1.7E-01
CL4(44)	ND	5.0E-01	3.3E-01	1.1E-01	2 / 4	4.4E-01
HEPTACHLOREPOXIDE	ND	1.5E-01	1.3E-01	1.1E-02	2 / 4	1.4E-01
CL4(66)	4.1E-02	1.4E+00	4.2E-01	6.8E-01	4 / 4	1.1E+00
2,4-DDE	ND	9.8E-02	8.8E-02	7.4E-03	2 / 4	9.5E-02
CL5(101)	5.9E-01	3.7E+00	1.5E+00	1.5E+00	4 / 4	2.9E+00
CIS-CHLORDANE	2.3E-01	1.5E+00	6.0E-01	6.2E-01	4 / 4	1.2E+00
TRANS-NONACHLOR	4.8E-01	3.2E+00	1.2E+00	1.4E+00	4 / 4	2.6E+00
DIELDRIN	ND	4.9E-01	3.1E-01	1.2E-01	2 / 4	4.3E-01
4,4-DDE	1.2E+01	5.6E+01	2.4E+01	2.1E+01	4 / 4	4.5E+01
CL4(77)	ND	3.8E-01	3.4E-01	2.9E-02	2 / 4	3.7E-01
2,4-DDD	ND	2.7E-01	2.4E-01	2.0E-02	2 / 4	2.6E-01
ENDRIN	ND	9.1E-01	8.2E-01	6.8E-02	2 / 4	8.8E-01
CL5(118)	2.5E-01	3.6E+00	1.1E+00	1.6E+00	4 / 4	2.8E+00
4,4-DDD	3.9E+00	7.2E+00	5.7E+00	1.4E+00	4 / 4	7.1E+00
2,4-DDT	ND	2.2E-01	1.9E-01	1.6E-02	2 / 4	2.1E-01
CL6(153)	1.4E+00	6.8E+00	2.9E+00	2.6E+00	4 / 4	5.5E+00
CL5(105)	6.6E-04	4.6E-01	1.3E-01	2.2E-01	4 / 4	3.5E-01
4,4-DDT	ND	1.0E+00	9.1E-01	7.6E-02	2 / 4	9.8E-01
CL6(138)	7.8E-01	5.0E+00	1.9E+00	2.1E+00	4 / 4	4.0E+00
CL5(126)	ND	3.7E-01	3.3E-01	2.8E-02	2 / 4	3.6E-01
CL7(187)	1.4E-01	1.4E+00	5.5E-01	6.0E-01	4 / 4	1.1E+00
CL6(128)	ND	5.3E-01	2.0E-01	2.2E-01	2 / 4	4.2E-01
CL7(180)	2.4E-01	1.5E+00	6.8E-01	5.5E-01	4 / 4	1.2E+00
MIREX	1.6E-01	3.0E+00	9.3E-01	1.3E+00	4 / 4	2.3E+00
CL7(170)	5.0E-02	4.2E+00	1.1E+00	2.0E+00	4 / 4	3.2E+00
CL8(195)	ND	1.8E-01	1.4E-01	6.7E-02	2 / 4	2.1E-01
CL9(206)	ND	1.9E-01	1.4E-01	8.8E-02	2 / 4	2.3E-01
CL10(209)	ND	6.5E-01	5.8E-01	4.8E-02	2 / 4	6.3E-01
AROCLOR 1016/1242	ND	2.5E+00	2.2E+00	1.9E-01	2 / 4	2.4E+00
AROCLOR 1221	ND	2.5E+00	2.2E+00	1.9E-01	2 / 4	2.4E+00
AROCLOR 1232	ND	2.5E+00	2.2E+00	1.9E-01	2 / 4	2.4E+00
AROCLOR 1248	ND	2.5E+00	2.2E+00	1.9E-01	2 / 4	2.4E+00
AROCLOR 1254	2.0E+01	7.1E+01	3.4E+01	2.4E+01	4 / 4	5.9E+01
AROCLOR 1260	ND	2.5E+00	2.2E+00	1.9E-01	2 / 4	2.4E+00

ND - Not Detected
Units: ug/kg wet weight

TABLE D-5
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 3)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL2(8)	ND	8.3E-01	7.7E-01	4.2E-02	3 / 7	8.2E-01
HEXACHLOROBENZENE	ND	2.8E-01	2.1E-01	1.0E-01	4 / 7	3.1E-01
LINDANE	ND	2.3E-01	2.0E-01	2.8E-02	3 / 7	2.3E-01
CL3(18)	ND	4.9E-01	4.6E-01	2.6E-02	4 / 7	4.8E-01
CL3(28)	ND	1.3E+00	4.6E-01	3.7E-01	5 / 7	8.3E-01
HEPTACHLOR	ND	3.9E-01	3.6E-01	2.0E-02	3 / 7	3.8E-01
CL4(52)	ND	2.9E+00	7.5E-01	9.5E-01	6 / 7	1.7E+00
ALDRIN	ND	1.7E-01	1.6E-01	8.9E-03	3 / 7	1.7E-01
CL4(44)	ND	1.0E+00	3.9E-01	2.9E-01	5 / 7	6.8E-01
HEPTACHLOREPOXIDE	ND	1.4E-01	1.4E-01	7.4E-03	3 / 7	1.4E-01
CL4(66)	ND	1.0E+00	2.7E-01	3.3E-01	6 / 7	6.0E-01
2,4-DDE	ND	5.1E-01	1.5E-01	1.6E-01	4 / 7	3.1E-01
CL5(101)	2.1E-01	4.4E+00	1.0E+00	1.5E+00	7 / 7	2.6E+00
CIS-CHLORDANE	5.1E-03	2.0E+00	6.1E-01	6.9E-01	7 / 7	1.3E+00
TRANS-NONACHLOR	4.8E-02	2.4E+00	7.6E-01	8.2E-01	7 / 7	1.6E+00
DIELDRIN	ND	7.7E-01	3.0E-01	2.7E-01	6 / 7	5.7E-01
4,4-DDE	1.9E+00	4.1E+01	1.1E+01	1.4E+01	7 / 7	2.5E+01
CL4(77)	ND	3.8E-01	3.5E-01	1.9E-02	3 / 7	3.7E-01
2,4-DDD	ND	2.7E-01	2.5E-01	1.4E-02	3 / 7	2.7E-01
ENDRIN	ND	9.0E-01	8.4E-01	4.6E-02	3 / 7	8.9E-01
CL5(118)	1.9E-01	2.8E+00	7.3E-01	9.8E-01	7 / 7	1.7E+00
4,4-DDD	1.7E-01	1.1E+01	2.6E+00	3.9E+00	7 / 7	6.6E+00
2,4-DDT	ND	2.1E-01	2.0E-01	1.1E-02	3 / 7	2.1E-01
CL6(153)	2.4E-01	5.1E+00	1.7E+00	1.9E+00	7 / 7	3.5E+00
CL5(105)	ND	6.3E-01	2.1E-01	2.1E-01	6 / 7	4.2E-01
4,4-DDT	ND	1.0E+00	5.7E-01	4.8E-01	3 / 7	1.1E+00
CL6(138)	3.1E-01	3.7E+00	8.7E-01	1.3E+00	7 / 7	2.1E+00
CL5(126)	ND	3.7E-01	3.5E-01	1.9E-02	3 / 7	3.6E-01
CL7(187)	7.3E-02	1.3E+00	4.8E-01	4.6E-01	7 / 7	9.4E-01
CL6(128)	ND	3.5E-01	1.2E-01	1.0E-01	5 / 7	2.2E-01
CL7(180)	1.8E-02	1.6E+00	4.7E-01	5.9E-01	7 / 7	1.1E+00
MIREX	ND	1.7E+00	5.1E-01	5.5E-01	6 / 7	1.1E+00
CL7(170)	2.2E-02	4.4E+00	1.3E+00	1.6E+00	7 / 7	2.9E+00
CL8(195)	ND	1.9E-01	1.6E-01	5.7E-02	4 / 7	2.2E-01
CL9(206)	ND	2.1E-01	2.0E-01	1.1E-02	4 / 7	2.1E-01
CL10(209)	ND	6.4E-01	6.0E-01	3.3E-02	3 / 7	6.3E-01
AROCLOR 1016/1242	ND	2.5E+00	2.3E+00	1.3E-01	3 / 7	2.4E+00
AROCLOR 1221	ND	2.5E+00	2.3E+00	1.3E-01	3 / 7	2.4E+00
AROCLOR 1232	ND	2.5E+00	2.3E+00	1.3E-01	3 / 7	2.4E+00
AROCLOR 1248	ND	2.5E+00	2.3E+00	1.3E-01	3 / 7	2.4E+00
AROCLOR 1254	5.8E+00	7.3E+01	2.3E+01	2.4E+01	7 / 7	4.7E+01
AROCLOR 1260	ND	2.5E+00	2.3E+00	1.3E-01	3 / 7	2.4E+00

ND - Not Detected
Units: ug/kg wet weight

TABLE D-6a
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 4)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

			POND			
ANALYTE	(Min)	(Max)	Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL5(101)	ND	2.5E-01	1.9E-01	1.0E-01	1 / 4	3.0E-01
4,4-DDE	1.2E+01	2.5E+01	1.8E+01	5.0E+00	4 / 4	2.3E+01
4,4-DDD	ND	2.9E+00	1.1E+00	1.2E+00	2 / 4	2.3E+00
CL6(153)	ND	1.5E+00	4.8E-01	6.5E-01	1 / 4	1.1E+00
AROCLOR 1254	ND	4.1E+01	1.2E+01	1.9E+01	1 / 4	3.2E+01

ND - Not Detected
Units: ug/kg wet weight

TABLE D-6b
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 4)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

			TIDEGATE			
ANALYTE	(Min)	(Max)	Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
4,4-DDE	1.6E+00	1.8E+01	6.7E+00	6.6E+00	6 / 6	1.3E+01
4,4-DDD	ND	2.3E+00	6.4E-01	8.3E-01	1 / 6	1.5E+00
CL6(153)	ND	2.1E+00	4.6E-01	7.9E-01	2 / 6	1.2E+00
AROCLOR 1254	ND	6.1E+01	2.1E+01	2.8E+01	2 / 6	4.9E+01

ND - Not Detected
Units: ug/kg wet weight

TABLE D-7
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 5)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL3(28)	ND	8.2E-01	5.0E-01	1.8E-01	8 / 9	6.8E-01
CL4(52)	ND	5.8E-01	4.6E-01	1.3E-01	1 / 9	5.9E-01
HEPTACHLOREPOXIDE	ND	4.0E-01	2.7E-01	1.1E-01	5 / 9	3.8E-01
CL4(66)	2.1E-01	7.5E-01	4.0E-01	2.0E-01	9 / 9	6.0E-01
2,4-DDE	ND	2.7E-01	1.4E-01	5.9E-02	2 / 9	2.0E-01
CL5(101)	ND	7.3E-01	2.9E-01	1.9E-01	4 / 9	4.8E-01
CIS-CHLORDANE	2.8E-01	6.5E-01	4.3E-01	1.3E-01	9 / 9	5.7E-01
TRANS-NONACHLOR	5.5E-01	1.5E+00	9.5E-01	3.9E-01	9 / 9	1.3E+00
DIELDRIN	2.0E-01	4.6E-01	3.4E-01	9.0E-02	9 / 9	4.3E-01
4,4-DDE	7.1E+00	2.2E+01	1.3E+01	5.0E+00	9 / 9	1.8E+01
CL4(77)	ND	5.1E-01	3.9E-01	1.5E-01	1 / 9	5.3E-01
CL5(118)	5.3E-01	1.9E+00	1.0E+00	4.7E-01	9 / 9	1.5E+00
4,4-DDD	1.5E+00	1.2E+01	5.3E+00	3.3E+00	9 / 9	8.5E+00
CL6(153)	8.1E-01	3.9E+00	2.1E+00	1.0E+00	9 / 9	3.1E+00
CL5(105)	ND	6.0E-01	3.9E-01	1.4E-01	8 / 9	5.3E-01
CL6(138)	1.7E-01	2.3E+00	1.1E+00	7.0E-01	9 / 9	1.8E+00
CL7(187)	ND	6.6E-01	3.4E-01	1.9E-01	8 / 9	5.3E-01
CL6(128)	1.1E-01	3.4E-01	2.0E-01	8.6E-02	9 / 9	2.9E-01
CL7(180)	1.7E-01	9.4E-01	4.5E-01	2.4E-01	9 / 9	6.9E-01
MIREX	5.9E-01	1.7E+00	9.8E-01	4.0E-01	9 / 9	1.4E+00
CL7(170)	8.8E-02	4.5E-01	2.0E-01	1.2E-01	9 / 9	3.2E-01
CL8(195)	ND	2.7E-01	1.8E-01	9.8E-02	2 / 9	2.8E-01

Units: ug/kg wet weight

TABLE D-8
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 5)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
CL3(28)	ND	4.8E-01	4.3E-01	7.2E-02	1 / 2	5.0E-01
HEPTACHLOREPOXIDE	8.0E-01	9.3E-01	8.7E-01	8.9E-02	2 / 2	9.5E-01
CL4(66)	9.2E-02	2.5E-01	1.7E-01	1.1E-01	2 / 2	2.9E-01
CIS-CHLORDANE	2.7E-01	4.8E-01	3.8E-01	1.5E-01	2 / 2	5.2E-01
TRANS-NONACHLOR	5.8E-01	7.6E-01	6.7E-01	1.2E-01	2 / 2	8.0E-01
DIELDRIN	4.9E-01	9.0E-01	6.9E-01	2.9E-01	2 / 2	9.8E-01
4,4-DDE	3.0E+00	1.2E+01	7.6E+00	6.4E+00	2 / 2	1.4E+01
CL5(118)	3.1E-01	7.9E-01	5.5E-01	3.4E-01	2 / 2	8.9E-01
4,4-DDD	3.1E-01	2.1E+00	1.2E+00	1.3E+00	2 / 2	2.5E+00
CL6(153)	8.7E-01	1.5E+00	1.2E+00	4.8E-01	2 / 2	1.7E+00
CL5(105)	2.6E-01	3.3E-01	2.9E-01	5.3E-02	2 / 2	3.5E-01
CL6(138)	6.5E-02	7.1E-01	3.9E-01	4.5E-01	2 / 2	8.4E-01
CL7(187)	9.7E-02	2.8E-01	1.9E-01	1.3E-01	2 / 2	3.2E-01
CL6(128)	1.0E-01	1.6E-01	1.3E-01	4.3E-02	2 / 2	1.8E-01
CL7(180)	2.2E-01	4.0E-01	3.1E-01	1.3E-01	2 / 2	4.4E-01
MIREX	5.6E-01	9.8E-01	7.7E-01	3.0E-01	2 / 2	1.1E+00
CL7(170)	1.0E-01	1.0E-01	1.0E-01	1.4E-03	2 / 2	1.1E-01

Units: ug/kg wet weight

TABLE D-9
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 6)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency
CL2(8)	0.0E+00	ND			
HEXACHLOROBENZENE	0.0E+00	ND			
LINDANE	0.0E+00	ND			
CL3(18)	0.0E+00	ND			
CL3(28)	0.0E+00	ND			
HEPTACHLOR	0.0E+00	ND			
CL4(52)	0.0E+00	ND			
ALDRIN	0.0E+00	ND			
CL4(44)	0.0E+00	ND			
HEPTACHLOREPOXIDE	0.0E+00	ND			
CL4(66)	0.0E+00	ND			
2,4-DDE	0.0E+00	ND			
CL5(101)	0.0E+00	ND			
CIS-CHLORDANE	0.0E+00	ND			
TRANS-NONACHLOR	0.0E+00	ND			
DIELDRIN	0.0E+00	ND			
4,4-DDE	0.0E+00	ND			
CL4(77)	0.0E+00	ND			
2,4-DDD	0.0E+00	ND			
ENDRIN	0.0E+00	ND			
CL5(118)	0.0E+00	ND			
4,4-DDD	0.0E+00	ND			
2,4-DDT	0.0E+00	ND			
CL6(153)	0.0E+00	ND			
CL5(105)	0.0E+00	ND			
4,4-DDT	0.0E+00	ND			
CL6(138)	0.0E+00	ND			
CL5(126)	0.0E+00	ND			
CL7(187)	0.0E+00	ND			
CL6(128)	0.0E+00	ND			
CL7(180)	0.0E+00	ND			
MIREX	0.0E+00	ND			
CL7(170)	0.0E+00	ND			
CL8(195)	0.0E+00	ND			
CL9(206)	0.0E+00	ND			
CL10(209)	0.0E+00	ND			
AROCLOR 1016/1242	0.0E+00	ND			
AROCLOR 1221	0.0E+00	ND			
AROCLOR 1232	0.0E+00	ND			

TABLE D-10
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 6)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency
LINDANE	ND	8.1E-02	6.9E-02	6.1E-03	6 / 7
CL4(52)	ND	1.3E-01	1.2E-01	1.7E-02	1 / 7
CL4(44)	ND	6.3E-01	1.7E-01	2.0E-01	1 / 7
CL4(66)	ND	1.2E-01	7.4E-02	3.5E-02	3 / 7
2,4-DDE	ND	1.9E-01	5.1E-02	6.0E-02	3 / 7
CIS-CHLORDANE	ND	2.9E-01	8.3E-02	9.3E-02	3 / 7
TRANS-NONACHLOR	ND	1.6E-01	6.7E-02	4.0E-02	4 / 7
DIELDRIN	ND	1.0E-01	8.6E-02	7.6E-03	6 / 7
4,4-DDE	3.0E-01	4.7E-01	3.6E-01	6.0E-02	7 / 7
2,4-DDD	ND	9.4E-02	8.1E-02	7.1E-03	1 / 7
CL5(118)	ND	7.3E-02	5.8E-02	1.4E-02	1 / 7
4,4-DDD	ND	1.0E-01	8.6E-02	7.6E-03	1 / 7
2,4-DDT	ND	7.5E-02	6.4E-02	5.6E-03	1 / 7
CL5(105)	ND	1.8E-01	5.9E-02	5.2E-02	1 / 7
4,4-DDT	ND	3.5E-01	3.0E-01	2.6E-02	1 / 7

ND - Not Detected
Units: ug/kg wet weight
No clams on pond side of the landfill

TABLE D-11
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 7)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequenc	Mean + 1 se
CL3(18)	ND	1.1E+00	3.6E-01	3.0E-01	1 / 8	6.6E-01
CL3(28)	ND	5.1E-01	2.2E-01	1.2E-01	1 / 8	3.4E-01
CL4(52)	1.0E+00	3.6E+00	2.4E+00	7.4E-01	8 / 8	3.1E+00
CL4(44)	2.2E-01	6.1E-01	4.0E-01	1.3E-01	8 / 8	5.3E-01
CL4(66)	ND	1.4E+00	1.0E+00	4.5E-01	7 / 8	1.5E+00
2,4-DDE	4.1E-01	6.8E-01	4.8E-01	8.5E-02	8 / 8	5.7E-01
CL5(101)	3.3E+00	5.6E+00	4.5E+00	7.3E-01	8 / 8	5.3E+00
CIS-CHLORDANE	7.3E-01	1.2E+00	8.5E-01	1.5E-01	8 / 8	9.9E-01
TRANS-NONACHLOR	1.0E+00	1.8E+00	1.2E+00	2.6E-01	8 / 8	1.5E+00
4,4-DDE	9.4E+00	2.0E+01	1.2E+01	3.7E+00	8 / 8	1.6E+01
CL5(118)	2.5E+00	3.8E+00	3.2E+00	4.1E-01	8 / 8	3.6E+00
4,4-DDD	3.6E+00	1.0E+01	5.3E+00	2.2E+00	8 / 8	7.5E+00
2,4-DDT	1.0E-01	3.6E-01	2.0E-01	8.4E-02	8 / 8	2.9E-01
CL6(153)	3.2E+00	4.5E+00	3.9E+00	4.8E-01	8 / 8	4.4E+00
CL5(105)	6.9E-01	9.5E-01	7.9E-01	9.3E-02	8 / 8	8.8E-01
CL6(138)	1.7E+00	2.6E+00	2.1E+00	3.2E-01	8 / 8	2.5E+00
CL7(187)	2.5E-01	5.3E-01	3.6E-01	8.8E-02	8 / 8	4.5E-01
CL6(128)	1.2E-01	1.9E-01	1.5E-01	3.0E-02	8 / 8	1.8E-01
MIREX	2.9E-01	5.3E-01	4.0E-01	6.9E-02	8 / 8	4.7E-01
AROCLOR 1254	2.8E+01	5.9E+01	4.9E+01	9.2E+00	8 / 8	5.8E+01

ND - Not Detected
Units: ug/kg wet weight

TABLE D-12
DATA SUMMARIES FOR PCB/PESTICIDE ANALYSES (BATCH 7)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

			TIDEGATE			
ANALYTE	(Min)	(Max)	Arithmetic average	Standard error	Detection Frequenc	Mean + 1 se
CL4(44)	ND	6.1E-01	1.1E-01	1.6E-02	1 / 9	1.3E-01
2,4-DDE	ND	6.8E-01	1.5E-01	1.3E-01	4 / 9	2.8E-01
CL5(101)	ND	5.6E+00	1.0E-01	8.1E-02	2 / 9	1.8E-01
CIS-CHLORDANE	ND	1.2E+00	2.5E-01	1.5E-01	6 / 9	4.0E-01
TRANS-NONACHLOR	ND	1.8E+00	1.7E-01	8.3E-02	7 / 9	2.5E-01
4,4-DDE	9.4E+00	2.0E+01	2.0E+00	1.1E+00	9 / 9	3.0E+00
CL5(118)	ND	3.8E+00	1.1E-01	4.0E-02	8 / 9	1.5E-01
4,4-DDD	ND	1.0E+01	5.4E-01	4.3E-01	8 / 9	9.7E-01
CL6(153)	ND	4.5E+00	1.2E-01	6.9E-02	6 / 9	1.9E-01
CL5(105)	ND	9.5E-01	1.6E-01	6.7E-02	8 / 9	2.3E-01
CL6(138)	ND	2.6E+00	6.8E-02	3.6E-02	8 / 9	1.0E-01
MIREX	ND	5.3E-01	1.2E-01	2.0E-02	4 / 9	1.4E-01

ND - Not Detected
Units: ug/kg wet weight

TABLE D-13
DATA SUMMARIES FOR PAH ANALYSES (BATCH 1)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	8.2E-01	3.8E+00	1.8E+00	1.1E+00	6 / 6	2.8E+00
2-methylnaphthalene	5.6E-01	1.6E+00	8.3E-01	3.8E-01	6 / 6	1.2E+00
1-methylnaphthalene	4.1E-01	8.6E-01	5.7E-01	1.8E-01	6 / 6	7.4E-01
biphenyl	3.7E-01	1.3E+00	7.6E-01	3.0E-01	6 / 6	1.1E+00
2,6-dimethylnaphthalene	2.4E-01	6.2E-01	3.6E-01	1.4E-01	6 / 6	5.0E-01
acenaphthylene	ND	1.7E+00	1.1E+00	7.8E-01	2 / 6	1.9E+00
acenaphthene	ND	1.4E+00	7.8E-01	6.8E-01	3 / 6	1.5E+00
1,6,7-trimethylnaphthalene	ND	1.5E+00	1.2E+00	5.4E-01	1 / 6	1.8E+00
fluorene	2.6E-01	7.0E-01	4.5E-01	1.5E-01	6 / 6	6.0E-01
phenanthrene	2.7E-01	1.1E+00	6.2E-01	2.9E-01	6 / 6	9.1E-01
anthracene	ND	1.3E+00	3.1E-01	5.0E-01	5 / 6	8.1E-01
1-methylphenanthrene	ND	2.3E+00	4.6E-01	9.2E-01	5 / 6	1.4E+00
fluoranthene	1.4E-01	4.2E-01	2.9E-01	1.2E-01	6 / 6	4.1E-01
pyrene	1.1E-01	2.9E-01	1.8E-01	7.7E-02	6 / 6	2.6E-01
benz[a]anthracene	ND	ND	2.7E+00	2.5E-01	0 / 6	2.9E+00
chrysene	ND	2.9E+00	1.4E+00	1.4E+00	3 / 6	2.8E+00
benzo[b]fluoranthene	ND	4.6E+00	2.3E+00	2.5E+00	3 / 6	4.8E+00
benzo[k]fluoranthene	ND	3.1E+00	1.6E+00	1.7E+00	3 / 6	3.2E+00
benzo[e]pyrene	ND	2.6E+00	1.6E+00	1.2E+00	2 / 6	2.9E+00
benzo[a]pyrene	ND	2.7E+00	2.1E+00	1.0E+00	1 / 6	3.1E+00
perylene	ND	ND	3.1E+00	2.9E-01	0 / 6	3.4E+00
indeno[1,2,3-c,d]pyrene	ND	1.5E+00	1.1E+00	5.1E-01	1 / 6	1.6E+00
dibenz[a,h]anthracene	ND	ND	1.8E+00	1.7E-01	0 / 6	2.0E+00
benzo[g,h,i]perylene	ND	2.2E+00	1.1E+00	1.1E+00	3 / 6	2.3E+00

Units in ug/kg wet weight

TABLE D-14
DATA SUMMARIES FOR PAH ANALYSES (BATCH 1)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	1.3E+00	1.3E+00	1.3E+00	NA	1 / 1	1.3E+00
2-methylnaphthalene	9.2E-01	9.2E-01	9.2E-01	NA	1 / 1	9.2E-01
1-methylnaphthalene	6.7E-01	6.7E-01	6.7E-01	NA	1 / 1	6.7E-01
biphenyl	2.9E-01	2.9E-01	2.9E-01	NA	1 / 1	2.9E-01
2,6-dimethylnaphthalene	5.6E-01	5.6E-01	5.6E-01	NA	1 / 1	5.6E-01
acenaphthylene	ND	ND	1.7E+00	NA	0 / 1	1.7E+00
acenaphthene	1.1E-01	1.1E-01	1.1E-01	NA	1 / 1	1.1E-01
1,6,7-trimethylnaphthalene	ND	ND	1.5E+00	NA	0 / 1	1.5E+00
fluorene	2.6E-01	2.6E-01	2.6E-01	NA	1 / 1	2.6E-01
phenanthrene	2.6E-01	2.6E-01	2.6E-01	NA	1 / 1	2.6E-01
anthracene	4.2E-02	4.2E-02	4.2E-02	NA	1 / 1	4.2E-02
1-methylphenanthrene	6.7E-02	6.7E-02	6.7E-02	NA	1 / 1	6.7E-02
fluoranthene	1.0E-01	1.0E-01	1.0E-01	NA	1 / 1	1.0E-01
pyrene	8.8E-02	8.8E-02	8.8E-02	NA	1 / 1	8.8E-02
benz[a]anthracene	ND	ND	2.7E+00	NA	0 / 1	2.7E+00
chrysene	ND	ND	2.8E+00	NA	0 / 1	2.8E+00
benzo[b]fluoranthene	ND	ND	4.9E+00	NA	0 / 1	4.9E+00
benzo[k]fluoranthene	ND	ND	3.3E+00	NA	0 / 1	3.3E+00
benzo[e]pyrene	ND	ND	2.5E+00	NA	0 / 1	2.5E+00
benzo[a]pyrene	ND	ND	2.6E+00	NA	0 / 1	2.6E+00
perylene	ND	ND	3.1E+00	NA	0 / 1	3.1E+00
indeno[1,2,3-c,d]pyrene	ND	ND	1.3E+00	NA	0 / 1	1.3E+00
dibenz[a,h]anthracene	ND	ND	1.8E+00	NA	0 / 1	1.8E+00
benzo[g,h,i]perylene	ND	ND	2.3E+00	NA	0 / 1	2.3E+00

Units in ug/kg wet weight

TABLE D-15
DATA SUMMARIES FOR PAH ANALYSES (BATCH 2)
ESI REPORT - CAUSEWAY LANDFILL
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	8.6E+00	5.5E+02	1.3E+02	2.1E+02	6 / 6	3.4E+02
2-methylnaphthalene	ND	8.8E+01	2.4E+01	3.3E+01	5 / 6	5.7E+01
1-methylnaphthalene	ND	6.9E+01	1.7E+01	2.6E+01	5 / 6	4.3E+01
biphenyl	ND	1.1E+02	3.0E+01	3.9E+01	5 / 6	6.9E+01
2,6-dimethylnaphthalene	ND	3.8E+00	3.3E+00	4.1E-01	2 / 6	3.7E+00
acenaphthylene	ND	3.3E+00	2.6E+00	9.9E-01	3 / 6	3.6E+00
acenaphthene	ND	2.0E+01	5.9E+00	6.9E+00	4 / 6	1.3E+01
1,6,7-trimethylnaphthalene	ND	3.0E+00	2.6E+00	6.5E-01	1 / 6	3.3E+00
fluorene	ND	1.1E+01	7.3E+00	3.7E+00	4 / 6	1.1E+01
phenanthrene	1.5E+01	4.9E+01	2.8E+01	1.5E+01	6 / 6	4.3E+01
anthracene	ND	2.8E+00	2.6E+00	5.1E-01	3 / 6	3.1E+00
1-methylphenanthrene	ND	5.2E+00	3.0E+00	2.4E+00	3 / 6	5.4E+00
fluoranthene	6.3E+00	8.1E+01	2.4E+01	2.9E+01	6 / 6	5.4E+01
pyrene	1.6E+00	5.2E+02	1.0E+02	2.0E+02	6 / 6	3.1E+02
benz[a]anthracene	ND	5.4E+00	3.7E+00	2.4E+00	2 / 6	6.2E+00
chrysene	ND	6.5E+00	3.1E+00	2.7E+00	5 / 6	5.8E+00
benzo[b]fluoranthene	ND	1.4E+01	9.2E+00	4.4E+00	2 / 6	1.4E+01
benzo[k]fluoranthene	ND	1.0E+01	6.2E+00	3.2E+00	2 / 6	9.4E+00
benzo[e]pyrene	ND	5.6E+00	4.3E+00	2.0E+00	1 / 6	6.3E+00
benzo[a]pyrene	ND	5.2E+00	3.5E+00	2.5E+00	2 / 6	6.0E+00
perylene	ND	6.9E+00	5.3E+00	2.4E+00	1 / 6	7.8E+00
indeno[1,2,3-c,d]pyrene	ND	ND	2.6E+00	1.5E-01	0 / 6	2.7E+00
dibenz[a,h]anthracene	ND	ND	3.6E+00	2.2E-01	0 / 6	3.9E+00
benzo[g,h,i]perylene	ND	1.1E+01	5.1E+00	3.3E+00	2 / 6	8.4E+00

Units in ug/kg wet weight

TABLE D-16
DATA SUMMARIES FOR PAH ANALYSES (BATCH 2)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	1.0E+01	1.0E+01	1.0E+01	NA	1 / 1	1.0E+01
2-methylnaphthalene	4.2E+00	4.2E+00	4.2E+00	NA	1 / 1	4.2E+00
1-methylnaphthalene	2.3E+00	2.3E+00	2.3E+00	NA	1 / 1	2.3E+00
biphenyl	1.1E+00	1.1E+00	1.1E+00	NA	1 / 1	1.1E+00
2,6-dimethylnaphthalene	ND	ND	3.5E+00	NA	0 / 1	3.5E+00
acenaphthylene	ND	ND	3.3E+00	NA	0 / 1	3.3E+00
acenaphthene	ND	ND	3.0E+00	NA	0 / 1	3.0E+00
1,6,7-trimethylnaphthalene	ND	ND	3.0E+00	NA	0 / 1	3.0E+00
fluorene	1.1E+00	1.1E+00	1.1E+00	NA	1 / 1	1.1E+00
phenanthrene	1.3E+00	1.3E+00	1.3E+00	NA	1 / 1	1.3E+00
anthracene	ND	ND	2.8E+00	NA	0 / 1	2.8E+00
1-methylphenanthrene	ND	ND	5.2E+00	NA	0 / 1	5.2E+00
fluoranthene	7.9E-01	7.9E-01	7.9E-01	NA	1 / 1	7.9E-01
pyrene	ND	ND	5.9E+00	NA	0 / 1	5.9E+00
benz[a]anthracene	ND	ND	5.4E+00	NA	0 / 1	5.4E+00
chrysene	ND	ND	5.6E+00	NA	0 / 1	5.6E+00
benzo[b]fluoranthene	7.0E-01	7.0E-01	7.0E-01	NA	1 / 1	7.0E-01
benzo[k]fluoranthene	4.4E-01	4.4E-01	4.4E-01	NA	1 / 1	4.4E-01
benzo[e]pyrene	ND	ND	5.1E+00	NA	0 / 1	5.1E+00
benzo[a]pyrene	ND	ND	5.2E+00	NA	0 / 1	5.2E+00
perylene	ND	ND	6.3E+00	NA	0 / 1	6.3E+00
indeno[1,2,3-c,d]pyrene	ND	ND	2.6E+00	NA	0 / 1	2.6E+00
dibenz[a,h]anthracene	ND	ND	3.6E+00	NA	0 / 1	3.6E+00
benzo[g,h,i]perylene	ND	ND	4.7E+00	NA	0 / 1	4.7E+00

Units in ug/kg wet weight

TABLE D-17
DATA SUMMARIES FOR PAH ANALYSES (BATCH 3)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	9.2E-01	1.7E+00	1.2E+00	3.2E-01	4 / 4	1.6E+00
2-methylnaphthalene	4.4E-01	1.2E+00	7.3E-01	3.6E-01	4 / 4	1.1E+00
1-methylnaphthalene	3.3E-01	7.7E-01	4.6E-01	2.1E-01	4 / 4	6.7E-01
biphenyl	1.8E-01	5.1E-01	3.0E-01	1.4E-01	4 / 4	4.4E-01
2,6-dimethylnaphthalene	1.6E-01	5.0E-01	2.9E-01	1.5E-01	4 / 4	4.4E-01
acenaphthylene	ND	1.7E+00	1.3E+00	7.6E-01	1 / 4	2.1E+00
acenaphthene	ND	1.6E+00	6.8E-01	6.7E-01	3 / 4	1.4E+00
1,6,7-trimethylnaphthalene	ND	1.5E+00	1.2E+00	6.7E-01	1 / 4	1.8E+00
fluorene	2.4E-01	1.2E+00	5.3E-01	4.5E-01	4 / 4	9.8E-01
phenanthrene	4.6E-01	1.9E+00	9.1E-01	7.0E-01	4 / 4	1.6E+00
anthracene	ND	1.5E+00	1.1E+00	6.5E-01	1 / 4	1.8E+00
1-methylphenanthrene	ND	2.7E+00	1.3E+00	1.5E+00	2 / 4	2.8E+00
fluoranthene	1.4E-01	6.1E-01	2.7E-01	2.3E-01	4 / 4	5.0E-01
pyrene	7.6E-02	2.7E-01	1.4E-01	8.6E-02	4 / 4	2.3E-01
benz[a]anthracene	ND	ND	2.8E+00	2.4E-01	0 / 4	3.1E+00
chrysene	ND	2.9E+00	1.4E+00	1.6E+00	2 / 4	3.0E+00
benzo[b]fluoranthene	ND	ND	5.2E+00	4.4E-01	0 / 4	5.7E+00
benzo[k]fluoranthene	ND	ND	3.5E+00	2.9E-01	0 / 4	3.8E+00
benzo[e]pyrene	ND	ND	2.7E+00	2.2E-01	0 / 4	2.9E+00
benzo[a]pyrene	ND	ND	2.8E+00	2.3E-01	0 / 4	3.0E+00
perylene	ND	ND	3.3E+00	2.8E-01	0 / 4	3.6E+00
indeno[1,2,3-c,d]pyrene	ND	ND	1.3E+00	1.1E-01	0 / 4	1.5E+00
dibenz[a,h]anthracene	ND	ND	1.9E+00	1.6E-01	0 / 4	2.1E+00
benzo[g,h,i]perylene	ND	ND	2.5E+00	2.1E-01	0 / 4	2.7E+00

Units in ug/kg wet weight

TABLE D-18
DATA SUMMARIES FOR PAH ANALYSES (BATCH 3)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	TIDEGATE (Min)	(Max)	Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	1.1E+00	2.0E+00	1.4E+00	3.0E-01	7 / 7	1.7E+00
2-methylnaphthalene	7.6E-01	3.2E+00	1.6E+00	9.8E-01	7 / 7	2.6E+00
1-methylnaphthalene	4.7E-01	1.7E+00	8.5E-01	5.1E-01	7 / 7	1.4E+00
biphenyl	ND	2.2E+00	8.9E-01	8.5E-01	5 / 7	1.7E+00
2,6-dimethylnaphthalene	ND	1.7E+00	8.3E-01	5.9E-01	6 / 7	1.4E+00
acenaphthylene	ND	1.9E+00	1.3E+00	7.6E-01	2 / 7	2.1E+00
acenaphthene	ND	1.6E+00	7.3E-01	6.2E-01	5 / 7	1.4E+00
1,6,7-trimethylnaphthalene	ND	1.7E+00	1.0E+00	6.8E-01	3 / 7	1.7E+00
fluorene	2.3E-01	1.3E+00	5.3E-01	4.4E-01	7 / 7	9.7E-01
phenanthrene	3.9E-01	1.7E+00	8.5E-01	5.9E-01	7 / 7	1.4E+00
anthracene	ND	1.6E+00	7.2E-01	7.5E-01	4 / 7	1.5E+00
1-methylphenanthrene	ND	2.9E+00	1.2E+00	1.5E+00	4 / 7	2.7E+00
fluoranthene	1.8E-01	6.2E-01	3.5E-01	1.8E-01	7 / 7	5.4E-01
pyrene	ND	3.0E+00	5.7E-01	1.1E+00	6 / 7	1.6E+00
benz[a]anthracene	ND	ND	2.9E+00	1.6E-01	0 / 7	3.1E+00
chrysene	ND	3.2E+00	1.8E+00	1.5E+00	3 / 7	3.3E+00
benzo[b]fluoranthene	ND	5.8E+00	4.6E+00	1.9E+00	1 / 7	6.6E+00
benzo[k]fluoranthene	ND	3.8E+00	3.1E+00	1.3E+00	1 / 7	4.4E+00
benzo[e]pyrene	ND	2.9E+00	2.4E+00	1.0E+00	1 / 7	3.4E+00
benzo[a]pyrene	ND	ND	2.8E+00	1.6E-01	0 / 7	3.0E+00
perylene	ND	ND	3.4E+00	1.9E-01	0 / 7	3.6E+00
indeno[1,2,3-c,d]pyrene	ND	ND	1.4E+00	7.6E-02	0 / 7	1.5E+00
dibenz[a,h]anthracene	ND	ND	2.0E+00	1.1E-01	0 / 7	2.1E+00
benzo[g,h,i]perylene	ND	2.7E+00	1.8E+00	1.2E+00	2 / 7	3.0E+00

Units in ug/kg wet weight

TABLE D-19
DATA SUMMARIES FOR PAH ANALYSES (BATCH 4)
ESI REPORT - CAUSEWAY LANDFILL
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	1.0E+01	7.9E+01	4.7E+01	2.8E+01	4 / 4	7.5E+01
2-methylnaphthalene	5.1E+00	4.0E+01	2.3E+01	1.4E+01	4 / 4	3.7E+01
1-methylnaphthalene	3.0E+00	2.6E+01	1.5E+01	9.4E+00	4 / 4	2.4E+01
biphenyl	3.6E+00	2.4E+01	1.5E+01	8.5E+00	4 / 4	2.3E+01
2,6-dimethylnaphthalene	ND	2.1E+00	1.9E+00	3.2E-01	1 / 4	2.2E+00
acenaphthylene	ND	ND	2.0E+00	3.6E-02	0 / 4	2.1E+00
acenaphthene	1.2E+00	7.9E+00	3.5E+00	3.0E+00	4 / 4	6.5E+00
1,6,7-trimethylnaphthalene	ND	1.8E+00	1.5E+00	4.8E-01	1 / 4	2.0E+00
fluorene	2.3E+00	1.2E+01	6.6E+00	3.8E+00	4 / 4	1.0E+01
phenanthrene	6.9E+00	2.3E+01	1.5E+01	6.8E+00	4 / 4	2.2E+01
anthracene	8.6E-01	6.0E+00	3.1E+00	2.1E+00	4 / 4	5.2E+00
1-methylphenanthrene	5.0E-01	5.0E+00	2.6E+00	1.8E+00	4 / 4	4.4E+00
fluoranthene	2.4E+00	9.8E+00	5.5E+00	3.2E+00	4 / 4	8.7E+00
pyrene	1.2E+00	1.1E+01	5.1E+00	4.2E+00	4 / 4	9.3E+00
benz[a]anthracene	ND	3.4E+00	3.1E+00	3.6E-01	1 / 4	3.5E+00
chrysene	5.1E-01	5.4E+00	2.7E+00	2.0E+00	4 / 4	4.7E+00
benzo[b]fluoranthene	ND	6.2E+00	6.1E+00	1.1E-01	1 / 4	6.2E+00
benzo[k]fluoranthene	ND	4.2E+00	4.0E+00	1.4E-01	1 / 4	4.1E+00
benzo[e]pyrene	ND	ND	3.1E+00	5.4E-02	0 / 4	3.2E+00
benzo[a]pyrene	ND	ND	3.2E+00	5.6E-02	0 / 4	3.2E+00
perylene	ND	ND	3.8E+00	6.7E-02	0 / 4	3.9E+00
indeno[1,2,3-c,d]pyrene	ND	ND	1.6E+00	2.7E-02	0 / 4	1.6E+00
dibenz[a,h]anthracene	ND	ND	2.2E+00	3.9E-02	0 / 4	2.3E+00
benzo[g,h,i]perylene	ND	3.2E+01	9.7E+00	1.5E+01	2 / 4	2.4E+01

Units in ug/kg wet weight

TABLE D-20
DATA SUMMARIES FOR PAH ANALYSES (BATCH 4)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	TIDEGATE (Min)	(Max)	Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	1.9E+01	4.9E+01	3.1E+01	1.1E+01	6 / 6	4.2E+01
2-methylnaphthalene	1.2E+01	2.2E+01	1.5E+01	7.3E+00	6 / 6	2.2E+01
1-methylnaphthalene	7.0E+00	1.3E+01	9.3E+00	4.7E+00	6 / 6	1.4E+01
biphenyl	5.7E+00	1.7E+01	9.2E+00	5.6E+00	6 / 6	1.5E+01
2,6-dimethylnaphthalene	3.4E+00	7.4E+00	4.5E+00	2.4E+00	6 / 6	6.9E+00
acenaphthylene	ND	ND	1.7E+00	7.7E-01	0 / 6	2.5E+00
acenaphthene	1.7E+00	2.4E+00	1.6E+00	7.7E-01	6 / 6	2.4E+00
1,6,7-trimethylnaphthalene	ND	4.1E+00	2.3E+00	1.4E+00	5 / 6	3.7E+00
fluorene	3.1E+00	8.8E+00	4.1E+00	2.6E+00	6 / 6	6.8E+00
phenanthrene	5.4E+00	2.8E+01	1.1E+01	8.6E+00	6 / 6	2.0E+01
anthracene	9.9E-01	3.4E+00	2.0E+00	1.2E+00	6 / 6	3.1E+00
1-methylphenanthrene	8.6E-01	2.5E+00	1.4E+00	8.3E-01	6 / 6	2.3E+00
fluoranthene	2.7E+00	6.1E+00	3.5E+00	1.9E+00	6 / 6	5.5E+00
pyrene	1.6E+00	4.8E+00	2.6E+00	1.6E+00	6 / 6	4.2E+00
benz[a]anthracene	ND	ND	2.8E+00	1.2E+00	0 / 6	4.0E+00
chrysene	ND	3.4E+00	1.5E+00	1.0E+00	5 / 6	2.6E+00
benzo[b]fluoranthene	ND	ND	5.1E+00	2.3E+00	0 / 6	7.4E+00
benzo[k]fluoranthene	ND	ND	3.4E+00	1.5E+00	0 / 6	5.0E+00
benzo[e]pyrene	ND	ND	2.6E+00	1.2E+00	0 / 6	3.8E+00
benzo[a]pyrene	ND	ND	2.7E+00	1.2E+00	0 / 6	3.9E+00
perylene	ND	ND	3.2E+00	1.4E+00	0 / 6	4.7E+00
indeno[1,2,3-c,d]pyrene	ND	ND	1.3E+00	5.9E-01	0 / 6	1.9E+00
dibenz[a,h]anthracene	ND	ND	1.9E+00	8.4E-01	0 / 6	2.7E+00
benzo[g,h,i]perylene	ND	2.8E+00	2.1E+00	1.3E+00	1 / 6	3.4E+00

Units in ug/kg wet weight

TABLE D-21
DATA SUMMARIES FOR PAH ANALYSES (BATCH 5)
ESI REPORT - CAUSEWAY LANDFILL
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	6.9E-01	1.6E+00	1.0E+00	2.5E-01	9 / 9	1.3E+00
2-methylnaphthalene	5.6E-01	1.4E+00	9.3E-01	2.4E-01	9 / 9	1.2E+00
1-methylnaphthalene	3.5E-01	1.4E+00	6.1E-01	3.3E-01	9 / 9	9.5E-01
biphenyl	ND	2.3E+00	7.1E-01	7.2E-01	8 / 9	1.4E+00
2,6-dimethylnaphthalene	ND	2.0E+00	4.6E-01	5.9E-01	8 / 9	1.0E+00
acenaphthylene	ND	2.5E+00	1.2E+00	1.1E+00	4 / 9	2.3E+00
acenaphthene	ND	1.8E+00	7.2E-01	5.0E-01	8 / 9	1.2E+00
1,6,7-trimethylnaphthalene	ND	2.1E+00	8.6E-01	8.9E-01	5 / 9	1.7E+00
fluorene	2.0E-01	4.8E-01	3.2E-01	9.1E-02	9 / 9	4.1E-01
phenanthrene	3.0E-01	6.1E-01	4.2E-01	1.1E-01	9 / 9	5.3E-01
anthracene	ND	1.6E+00	2.4E-01	5.3E-01	8 / 9	7.6E-01
1-methylphenanthrene	ND	3.6E+00	8.1E-01	1.4E+00	7 / 9	2.2E+00
fluoranthene	1.8E-01	4.5E-01	2.7E-01	9.9E-02	9 / 9	3.7E-01
pyrene	1.7E-01	3.9E-01	2.4E-01	7.4E-02	9 / 9	3.1E-01
benz[a]anthracene	ND	ND	3.6E+00	5.2E-01	0 / 9	4.1E+00
chrysene	ND	3.2E+00	4.6E-01	1.0E+00	8 / 9	1.5E+00
benzo[b]fluoranthene	ND	6.9E+00	1.5E+00	2.8E+00	7 / 9	4.3E+00
benzo[k]fluoranthene	ND	4.7E+00	1.0E+00	1.9E+00	7 / 9	2.9E+00
benzo[e]pyrene	ND	4.0E+00	2.7E+00	1.5E+00	2 / 9	4.2E+00
benzo[a]pyrene	ND	4.1E+00	2.7E+00	1.5E+00	2 / 9	4.3E+00
perylene	ND	5.0E+00	3.8E+00	1.5E+00	1 / 9	5.3E+00
indeno[1,2,3-c,d]pyrene	ND	2.0E+00	1.5E+00	5.9E-01	1 / 9	2.1E+00
dibenz[a,h]anthracene	ND	ND	2.4E+00	3.5E-01	0 / 9	2.8E+00
benzo[g,h,i]perylene	ND	3.7E+00	2.8E+00	1.1E+00	1 / 9	3.9E+00

Units in ug/kg wet weight

TABLE D-22
DATA SUMMARIES FOR PAH ANALYSES (BATCH 5)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	1.2E+00	1.3E+00	1.3E+00	4.5E-02	2 / 2	1.3E+00
2-methylnaphthalene	1.7E+00	1.8E+00	1.8E+00	5.6E-02	2 / 2	1.8E+00
1-methylnaphthalene	6.5E-01	1.7E+00	1.2E+00	7.5E-01	2 / 2	1.9E+00
biphenyl	1.0E-01	2.3E-01	1.7E-01	8.8E-02	2 / 2	2.5E-01
2,6-dimethylnaphthalene	3.3E-01	3.7E-01	3.5E-01	2.9E-02	2 / 2	3.8E-01
acenaphthylene	ND	2.7E+00	1.4E+00	1.9E+00	1 / 2	3.3E+00
acenaphthene	1.8E-01	6.3E-01	4.0E-01	3.2E-01	2 / 2	7.3E-01
1,6,7-trimethylnaphthalene	ND	2.1E+00	1.1E+00	1.4E+00	1 / 2	2.5E+00
fluorene	1.5E-01	1.6E-01	1.5E-01	7.7E-03	2 / 2	1.6E-01
phenanthrene	2.1E-01	3.0E-01	2.5E-01	6.8E-02	2 / 2	3.2E-01
anthracene	ND	2.0E+00	1.0E+00	1.4E+00	1 / 2	2.4E+00
1-methylphenanthrene	4.4E-02	1.0E-01	7.4E-02	4.2E-02	2 / 2	1.2E-01
fluoranthene	1.0E-01	1.6E-01	1.3E-01	3.9E-02	2 / 2	1.7E-01
pyrene	1.1E-01	1.6E-01	1.4E-01	3.5E-02	2 / 2	1.7E-01
benz[a]anthracene	ND	ND	4.1E+00	4.4E-01	0 / 2	4.5E+00
chrysene	ND	3.9E+00	2.0E+00	2.7E+00	1 / 2	4.7E+00
benzo[b]fluoranthene	ND	ND	7.5E+00	8.2E-01	0 / 2	8.3E+00
benzo[k]fluoranthene	ND	ND	5.0E+00	5.5E-01	0 / 2	5.6E+00
benzo[e]pyrene	ND	ND	3.9E+00	4.2E-01	0 / 2	4.3E+00
benzo[a]pyrene	ND	ND	4.0E+00	4.3E-01	0 / 2	4.4E+00
perylene	ND	ND	4.8E+00	5.2E-01	0 / 2	5.3E+00
indeno[1,2,3-c,d]pyrene	ND	ND	1.9E+00	2.1E-01	0 / 2	2.1E+00
dibenz[a,h]anthracene	ND	ND	2.8E+00	3.0E-01	0 / 2	3.1E+00
benzo[g,h,i]perylene	ND	ND	3.6E+00	3.9E-01	0 / 2	3.9E+00

Units in ug/kg wet weight

TABLE D-23
DATA SUMMARIES FOR PAH ANALYSES (BATCH 6)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	8.0E-01	2.4E+00	1.5E+00	5.4E-01	7 / 7	2.0E+00
2-methylnaphthalene	6.1E-01	1.4E+00	9.0E-01	2.6E-01	7 / 7	1.2E+00
1-methylnaphthalene	3.9E-01	9.9E-01	5.7E-01	2.1E-01	7 / 7	7.8E-01
biphenyl	1.8E-01	6.2E-01	4.4E-01	1.5E-01	7 / 7	5.9E-01
2,6-dimethylnaphthalene	2.4E-01	4.0E-01	3.2E-01	6.7E-02	7 / 7	3.9E-01
acenaphthylene	ND	6.7E-01	5.1E-01	1.8E-01	1 / 7	6.9E-01
acenaphthene	ND	5.4E-01	3.5E-01	2.0E-01	3 / 7	5.5E-01
1,6,7-trimethylnaphthalene	ND	ND	5.1E-01	4.5E-02	0 / 7	5.6E-01
fluorene	1.4E-01	2.7E-01	2.0E-01	5.3E-02	7 / 7	2.5E-01
phenanthrene	2.8E-01	7.6E-01	4.9E-01	1.6E-01	7 / 7	6.5E-01
anthracene	4.7E-02	3.0E-01	1.4E-01	8.1E-02	7 / 7	2.2E-01
1-methylphenanthrene	6.2E-02	1.2E-01	9.1E-02	2.0E-02	7 / 7	1.1E-01
fluoranthene	2.9E-01	1.2E+00	5.4E-01	2.9E-01	7 / 7	8.3E-01
pyrene	2.1E-01	8.8E-01	4.3E-01	2.2E-01	7 / 7	6.5E-01
benz[a]anthracene	ND	ND	9.4E-01	8.2E-02	0 / 7	1.0E+00
chrysene	1.0E-01	3.4E-01	1.8E-01	7.7E-02	7 / 7	2.6E-01
benzo[b]fluoranthene	5.2E-02	2.1E-01	1.1E-01	5.3E-02	7 / 7	1.6E-01
benzo[k]fluoranthene	4.1E-02	1.3E-01	7.5E-02	2.7E-02	7 / 7	1.0E-01
benzo[e]pyrene	ND	9.1E-01	7.6E-01	2.8E-01	1 / 7	1.0E+00
benzo[a]pyrene	ND	9.4E-01	4.3E-01	4.3E-01	4 / 7	8.6E-01
perylene	ND	1.1E+00	3.5E-01	4.8E-01	5 / 7	8.2E-01
indeno[1,2,3-c,d]pyrene	ND	ND	4.4E-01	3.9E-02	0 / 7	4.8E-01
dibenz[a,h]anthracene	ND	ND	6.3E-01	5.5E-02	0 / 7	6.9E-01
benzo[g,h,i]perylene	ND	8.4E-01	6.9E-01	2.8E-01	1 / 7	9.7E-01

Units in ug/kg wet weight

TABLE D-24
DATA SUMMARIES FOR PAH ANALYSES (BATCH 7)
ESI REPORT - CAUSEWAY LANDFILL
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	POND Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	5.8E-01	1.1E+00	7.6E-01	1.8E-01	8 / 8	9.4E-01
2-methylnaphthalene	7.6E-01	1.4E+00	1.1E+00	2.3E-01	8 / 8	1.3E+00
1-methylnaphthalene	3.7E-01	7.0E-01	5.4E-01	1.1E-01	8 / 8	6.6E-01
biphenyl	1.7E-01	3.1E-01	2.2E-01	5.0E-02	8 / 8	2.7E-01
2,6-dimethylnaphthalene	4.4E-01	7.2E-01	5.9E-01	9.2E-02	8 / 8	6.9E-01
acenaphthylene	ND	9.5E-01	3.1E-01	3.9E-01	6 / 8	7.0E-01
acenaphthene	3.3E-01	6.7E-01	4.4E-01	1.1E-01	8 / 8	5.5E-01
1,6,7-trimethylnaphthalene	ND	8.2E-01	2.5E-01	2.3E-01	7 / 8	4.8E-01
fluorene	3.5E-01	5.5E-01	4.5E-01	6.2E-02	8 / 8	5.1E-01
phenanthrene	1.5E+00	2.2E+00	1.8E+00	2.5E-01	8 / 8	2.1E+00
anthracene	1.7E-01	4.2E-01	2.8E-01	8.5E-02	8 / 8	3.6E-01
1-methylphenanthrene	2.3E-01	5.4E-01	3.3E-01	9.9E-02	8 / 8	4.3E-01
fluoranthene	3.0E+00	1.1E+01	5.2E+00	3.1E+00	8 / 8	8.3E+00
pyrene	1.3E+00	6.2E+00	2.7E+00	1.9E+00	8 / 8	4.6E+00
benz[a]anthracene	2.8E-01	2.1E+00	8.4E-01	6.5E-01	8 / 8	1.5E+00
chrysene	9.1E-01	3.1E+00	1.5E+00	7.6E-01	8 / 8	2.3E+00
benzo[b]fluoranthene	ND	2.8E+00	1.1E+00	7.9E-01	7 / 8	1.9E+00
benzo[k]fluoranthene	ND	1.9E+00	4.8E-01	5.8E-01	7 / 8	1.1E+00
benzo[e]pyrene	1.8E-01	8.7E-01	4.0E-01	2.4E-01	8 / 8	6.4E-01
benzo[a]pyrene	ND	1.6E+00	5.4E-01	6.2E-01	6 / 8	1.2E+00
perylene	5.9E-02	3.2E-01	1.4E-01	8.5E-02	8 / 8	2.3E-01
indeno[1,2,3-c,d]pyrene	ND	8.9E-01	3.9E-01	3.5E-01	5 / 8	7.4E-01
dibenz[a,h]anthracene	ND	1.1E+00	5.5E-01	5.4E-01	4 / 8	1.1E+00
benzo[g,h,i]perylene	6.0E-02	7.8E-01	2.0E-01	2.4E-01	8 / 8	4.4E-01

Units in ug/kg wet weight

TABLE D-25
DATA SUMMARIES FOR PAH ANALYSES (BATCH 7)
CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

ANALYTE	(Min)	(Max)	TIDEGATE Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
naphthalene	3.4E-01	1.4E+00	6.3E-01	3.0E-01	9 / 9	9.3E-01
2-methylnaphthalene	7.6E-01	1.4E+00	4.8E-01	3.3E-01	9 / 9	8.1E-01
1-methylnaphthalene	3.7E-01	7.0E-01	3.1E-01	2.3E-01	9 / 9	5.4E-01
biphenyl	1.7E-01	3.1E-01	1.6E-01	1.3E-01	9 / 9	2.9E-01
2,6-dimethylnaphthalene	4.4E-01	7.2E-01	2.4E-01	1.2E-01	9 / 9	3.6E-01
acenaphthylene	ND	ND	7.2E-01	3.1E-02	0 / 9	7.5E-01
acenaphthene	ND	6.7E-01	1.6E-01	2.0E-01	8 / 9	3.6E-01
1,6,7-trimethylnaphthalene	ND	8.2E-01	4.6E-01	2.6E-01	3 / 9	7.1E-01
fluorene	3.5E-01	5.5E-01	1.9E-01	4.8E-02	9 / 9	2.3E-01
phenanthrene	1.5E+00	2.2E+00	5.3E-01	1.2E-01	9 / 9	6.6E-01
anthracene	1.7E-01	4.2E-01	9.5E-02	5.9E-02	9 / 9	1.5E-01
1-methylphenanthrene	2.3E-01	5.4E-01	1.1E-01	5.8E-02	9 / 9	1.7E-01
fluoranthene	3.1E+00	1.1E+01	9.7E-01	2.8E-01	9 / 9	1.2E+00
pyrene	1.3E+00	6.2E+00	5.8E-01	1.8E-01	9 / 9	7.6E-01
benz[a]anthracene	ND	2.1E+00	8.5E-01	4.5E-01	3 / 9	1.3E+00
chrysene	9.1E-01	3.1E+00	3.4E-01	9.8E-02	9 / 9	4.4E-01
benzo[b]fluoranthene	ND	2.8E+00	4.5E-01	6.2E-01	8 / 9	1.1E+00
benzo[k]fluoranthene	ND	1.9E+00	2.7E-01	4.3E-01	8 / 9	7.0E-01
benzo[e]pyrene	1.8E-01	8.7E-01	8.8E-02	3.1E-02	9 / 9	1.2E-01
benzo[a]pyrene	ND	1.6E+00	5.4E-01	5.6E-01	4 / 9	1.1E+00
perylene	5.9E-02	3.2E-01	9.6E-02	2.9E-02	9 / 9	1.3E-01
indeno[1,2,3-c,d]pyrene	ND	8.9E-01	2.2E-01	2.5E-01	5 / 9	4.7E-01
dibenz[a,h]anthracene	ND	ND	7.9E-01	3.4E-02	0 / 9	8.2E-01
benzo[g,h,i]perylene	ND	7.8E-01	5.0E-01	5.0E-01	5 / 9	1.0E+00

Units in ug/kg wet weight

TABLE D-26
DATA SUMMARIES FOR MERCURY ANALYSES

CAUSEWAY LANDFILL, MCRD
PARRIS ISLAND, SOUTH CAROLINA

POND

BATCH #	(Min)	(Max)	Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
1	4.1E-02	6.9E-02	5.5E-02	1.0E-02	6 / 6	6.6E-02
2	3.5E-02	4.2E-01	1.1E-01	1.5E-01	6 / 6	2.7E-01
3	2.3E-03	6.4E-03	3.8E-03	1.8E-03	4 / 4	5.6E-03
4	4.0E-02	1.5E-01	7.5E-02	5.3E-02	4 / 4	1.3E-01
5	1.1E-02	3.2E-02	2.2E-02	6.1E-03	9 / 9	2.8E-02
6			NS			
7	7.9E-03	1.3E-02	1.1E-02	2.0E-03	8 / 8	1.3E-02

TIDEGATE

BATCH #	(Min)	(Max)	Arithmetic average	Standard error	Detection Frequency	Mean + 1 se
1	5.8E-02	5.8E-02	5.8E-02	NA	1 / 1	5.8E-02
2	7.1E-02	7.1E-02	7.1E-02	NA	1 / 1	7.1E-02
3	1.1E-03	1.1E-02	4.5E-03	3.3E-03	7 / 7	7.8E-03
4	3.6E-02	8.9E-02	6.1E-02	2.2E-02	6 / 6	8.3E-02
5	4.2E-02	5.6E-02	4.9E-02	9.8E-03	2 / 2	5.9E-02
6	3.8E-03	9.6E-03	6.4E-03	1.8E-03	7 / 7	8.2E-03
7	6.9E-03	1.1E-02	8.3E-03	1.3E-03	9 / 9	9.6E-03

NOTES:

NA - Not applicable (only one sample)

APPENDIX E

ECOLOGY OF COLLECTED SPECIES

ECOLOGY OF TARGET SPECIES

Striped Mullet. Adult mullet (*Mugil cephalus*) are described as herbivorous, detritivorous, and interface feeders. Their diet varies with location, but the major food consumed is either epiphitic and benthic microalgae, macrophytic detritus, or inorganic sediment particles (Collins, 1985). Although sediment particles function primarily as a grinding paste in the gizzard-like pyloric portion of the stomach, some small particles are rich in microorganisms and are selectively ingested for their food value.

Mullet commonly feed by sucking up the top layer of sediment, which is rich in detritus and microalgae, primarily diatoms, and by grazing on epiphytes and epifauna from seagrasses and other substrates. They also ingest surface scum when large concentrations of microalgae are present at the air water interface. As a result of their feeding behavior, mullet are exposed to any sediment contamination directly or indirectly through consumption of contaminated food items (i.e., bioaccumulation).

Mullet are schooling fish that are generally found in the more saline areas of estuaries and occasionally in freshwater as well. Mature mullet move offshore to spawn in the fall and winter and return to estuarine areas in the spring. Mullet may be resident in the tidal creek and pond areas near the causeway on a seasonal basis for periods of 6 to 9 months. On the tidal creek side, mullet may move with tidal exchange and are probably resident for shorter periods of time.

Summer Flounder. The summer flounder (*Paralithys dentatus*) are found along the shores of bays, sounds, and lagoons in comparatively shallow water along the south Atlantic and Gulf coasts.

Summer flounders are highly predaceous, feeding on both benthic and pelagic fish and crustaceans. As adults, they are primarily tertiary consumers and capture prey equally well on the bottom or in the water column (Enge and Mulholland, 1985). Larger southern flounder tend to prey proportionally more on fish than other types of prey but also feed on penaeid shrimp and portunid crabs. In flounders over 150 millimeters (6 inches), fish constituted about 70 percent of the food items, penaeid shrimp were the most frequent invertebrates, followed by blue crabs (Rogers and Van Den Avyle, 1983). Fish commonly eaten by the summer flounder include anchovy, mullet, menhaden, Atlantic croaker, and pinfish. Three of the original target species: shrimp, crabs, and mullet are thus primary diet items of the summer flounder.

As top carnivores or tertiary consumers in the aquatic food web and potentially resident in the pond area for 8 to 9 months, summer flounder provide a good candidate for examining potential concentration of contaminants at the top of the aquatic food web in the vicinity of the Causeway Landfill. They are probably resident for shorter periods in the tidal creeks moving in and out during tidal changes and only incidentally returning to the same creek.

Blue Crab. The blue crab (*Callinectes sapidus*) is a decapod crustacean that is common in estuarine waters along the Atlantic and Gulf coasts. Adults inhabit shallow bays and reaches of creeks during most of the year, frequently migrating to somewhat deeper, warmer waters during the winter. Females migrate to higher

salinity waters, after mating in lower estuaries, sounds, and nearshore spawning areas (Van Den Avyle and Fowler, 1984).

Blue crabs are omnivorous and feed on benthic macroinvertebrates, small fish, aquatic vegetation (and its associated fauna), and dead organisms. As such, they span the range from primary through tertiary consumers. As mostly secondary and tertiary consumers in their adult stage, crabs provide a mid-level indicator in the aquatic food web. Although blue crabs are highly mobile and good swimmers, they are generally benthic feeders.

Blue crabs are often buried in the sediment for cover either during molting (shedding of hard carapace) when they are more vulnerable to predation, or when overwintering.

Exposure routes for contaminants would include direct exposure to sediment as well as dietary exposures. Blue crabs may migrate to deeper waters during winter periods, depending on water temperatures; however, they may reside in the pond area for relatively long periods of time (sometimes up to 9 months). It is not clear from available data whether winter temperatures would permit overwintering in the pond. Blue crabs grow quickly and do not usually live more than 3 years.

Almost all of the large crabs for this study caught were caught on the pond side, which due to limited tidal exchange was somewhat warmer during the initial part of the survey. Most of the crabs caught were males; females may have already migrated offshore to more saline waters for spawning. The reduced numbers captured on the tide gate side may be due to declining temperatures; however, this is uncertain. Crabs generally inhabit shallow nearshore waters during the summer and warm fall months and, after temperature declines, may move offshore into deeper waters for overwintering.

Hard Clam. Hard clams (*Mercenaria mercenaria*) are common in intertidal and subtidal estuarine habitats along the Atlantic and Gulf coasts in salinity ranges from about 12.5 parts per thousand (ppt) to full salt water (35 ppt) and in a wide variety of substrate types. Optimal salinity range for adult hard clams is 20 to 30 ppt.

The apparent limited distribution of clams on the pond side of the causeway may be related to a combination of environmental factors or the distribution of predators, particularly the blue crab which, based on catch-per-unit-effort, was considerably more abundant on the pond side of the causeway. The habitat suitability index (HSI) model for the hard clam (Mulholland, 1984) includes water quality (salinity, dissolved oxygen, and temperature) and substrate-suspended solids components (percent silt-clay, current, and suspended solids). With the possible exception of salinity, these parameters did not appear to be limiting factors at the Causeway Landfill site. Other water quality factors such as pH may be a reason for the absence or reduced abundance of clams on the pond side. Calabrese (1972) observed that successful recruitment of *M. mercenaria* requires that the pH of estuarine waters not fall below 7.0.

Adult hard clams are suspension feeding bivalves that obtain food by filtering plankton and microorganisms (Mulholland, 1984) and absorbing organic material from the water (Eversole, 1987). Clams are primarily infaunal planktivores/omnivores. Adult hard clams are capable of withstanding temporary adverse environmental conditions by closing their shells. Adults are sedentary making

them good biological indicators of changing environmental conditions at a site. Sessile species, such as clams and oysters, provide a means of interpreting temporal variations in exposure to contaminants.

American Oyster. The American or eastern oyster (*Crassostrea virginica*) occurs in nearshore estuarine ecosystems from Canada to Mexico. The location and distribution of oysters in a salt marsh-estuarine system results from the interaction of many biological, chemical, geological, and physical processes (Bahr and Lanier, 1981). The normal salinity range for American oysters is 10 to 30 ppt, but they can survive in salinities from 5 to 40 ppt.

The primary limiting factor controlling the distribution of oysters in the vicinity of the Causeway landfill was probably substrate quality. The oyster requires firm or stable substrate conditions to attach, survive, and proliferate. Ideal bottom substrate consists of
shell (reef) materials or mud-sand-shell mixtures that are firm enough to support the weight of large oysters without burial.

The intertidal distribution of oysters sampled on the tide gate side was limited by the soft mud substrate. Distribution was limited to rock substrate at the tide gate and to outer curves in the tidal creek where faster flowing water reduced soft silt deposition resulting in firmer substrate. Subtidal distribution of oysters on the pond side was limited by the more sandy pond bottom. The oysters were essentially restricted to the deposited hard substrate sections of the Causeway Landfill itself. On more sandy bottoms, oysters are either buried or their gills are unable to function in filter feeding and respiration (Galtsoff, 1964).

Oysters are filter feeding planktivores and omnivores. These primary consumers also ingest a large assortment of small waterborne particles including diatoms, flagellates, and bacteria (nanoplankton), detritus and silt, and dissolved molecules such as glucose (Galtsoff 1964). Adult oysters feed primarily on phytoplankton. At optimum conditions of temperature and salinity, an oyster pumps water at a rate of 15 liters per hour. The daily volume of water filtered by intertidal oysters would be less than subtidal oysters due to exposure (Burrell, 1986). As a sessile benthic mollusk, like the hard clam, the American oyster is also a good indicator of environmental conditions within estuarine habitats. Because of its commercial importance, the oyster is widely studied and comparative data from other areas is readily available.