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FINAL

SUPPLEMENTAL AQUATIC SURVEY FOR WALLACE CREEK AND BEARHEAD CREEK

OPERABLE UNIT NO. 2
(SITES 6, 9, AND 82)

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0133

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Introduction

In 1992, fish and crabs were collected for chemical analysis from Wallace Creek and Bearhead Creek as part of a remedial investigation/feasibility study (RI/FS) at Operable Unit No. 2 (Sites 6, 9, and 82), Marine Corps Base (MCB), Camp Lejeune, North Carolina. This study revealed that low levels of polychlorinated biphenyls (PCBs) and pesticides were the primary contaminants of potential concern (COPCs) detected in the fish. None of the levels exceeded the U.S. Food and Drug Administration (FDA) action levels (ALs); however, consumption of the fish could potentially pose adverse risks to human health based on the conclusions of the human health risk assessment. As a result of this study, it was concluded that additional studies are warranted to better define the degree of contamination in fish and crabs from Wallace Creek and Bearhead Creek due to the limited database in which the risk assessment was based upon.

A supplemental aquatic survey of Wallace Creek and Bearhead Creek was conducted in September and October 1993. The objective of this study was to further define the degree of contamination in the edible portions of fish and crabs inhabiting Wallace Creek and Bearhead Creek. The results of the chemical analysis were compared to either USEPA screening values (SVs), or calculated risk-based levels to determine the potential risk to humans consuming the fish. In addition, the results were compared to U.S. FDA ALs, when available.

Scope of Work

A total of six different fish species and one crab species were collected as target species for this investigation. These species included: largemouth bass, southern flounder, red drum, blue crab, chain pickerel, stripped mullet, and longnose gar. The study stations included upstream and downstream locations within Wallace Creek and Bearhead Creek. The White Oak River and Hadnot Creek were recommended by the North Carolina Department of the Environment, Health, and Natural Resources (DEHNR) as reference stations. Fish and crab samples were obtained from these reference stations. The primary method for collecting the fish samples was via gill nets. Crab pots were used to collect the crab samples.

The fish samples were grouped into composite samples for chemical analysis. An attempt was made to collect three replicates of each target species in Wallace Creek and Bearhead Creek

and two replicates of each target species in Hadnot Creek. However, this was not possible for each of the target species. Only the fillets were used for the chemical analysis of the composite samples. All composite samples were analyzed for full Target Compound List (TCL) organics and Target Analyte List (TAL) inorganics.

Chemical Analysis Results

Inorganic COPCs detected in fish or crab tissue include: arsenic, cadmium, chromium, copper, manganese, mercury, and zinc. The following volatile organic compounds (VOCs) were detected: acetone, methylene chloride, 2-butanone, toluene, 1,2-dichloroethene (1,2-DCE), tetrachloroethene (PCE), and trichloroethene (TCE). 4,4-DDE, 4,4-DDD, and alpha-chlordane were the only pesticides detected in the fish samples. Aroclor-1260 was the only PCB detected.

For this study, the SVs based upon assumptions for the general adult population were used for comparisons to the contaminant concentrations in the fish and crab tissue samples. The SVs were calculated using the ingestion rates for the average fisherman (6.5 g/day) (USEPA, 1993). Arsenic was detected in all the fish and crab samples collected from Wallace Creek, Bearhead Creek, and Hadnot Creek at levels that exceeded the carcinogenic SV. For each species, the average concentration of arsenic in the Hadnot Creek samples was greater than the concentration of arsenic in the Wallace Creek and Bearhead Creek stations. It appears that the arsenic in the tissue samples collected in Wallace Creek and Bearhead Creek are within naturally occurring concentrations since they are at lower levels than fish collected from Hadnot Creek. Therefore, arsenic will not be evaluated further in this study. None of the other inorganics that were detected in the samples exceeded any of the SVs.

The largemouth bass, longnose gar, and striped mullet samples collected in Wallace Creek and Bearhead Creek contained levels of Aroclor-1260 in excess of the SV. PCBs were not detected in any of the other fish or crab samples collected from these creeks. In addition, PCBs were not detected in any of the fish or crabs collected from the reference station.

None of the SVs for any of the VOCs were exceeded for the fish or crabs collected in Wallace Creek or Bearhead Creek. Bis(2-ethylhexyl)phthalate was the only SVOC that exceeded any of the SVs. This parameter is not site-related based on previous sampling results in other media (e.g., surface water, sediment) at MCB Camp Lejeune. Bis(2-ethylhexyl)phthalate was detected in the tissue samples collected from Hadnot Creek in equal or slightly lower concentrations than those collected in Wallace Creek or Bearhead Creek. Potential sources for

contamination of phthalates include exposure to gloves used for handling the fish, plastic bags used to line the coolers, and laboratory equipment (e.g., stoppers).

None of the other fish or crab samples collected from Wallace Creek or Bearhead Creek exceeded the SVs for any of the pesticides. In addition, none of the fish or crabs collected from Hadnot Creek exceeded the SVs for any of the pesticides.

The U.S. FDA has established ALs for chemical substances in fish resulting from unavoidable environmental contamination. ALs have been established for the following contaminants that were detected in the fish samples: DDE and DDD, PCBs, and mercury (as methyl mercury).

The AL for total DDE and DDD is 5.0 mg/kg. The AL for total PCBs is 2.0 mg/kg. For methyl mercury, the AL is 1.0 mg/kg. The highest total concentration of DDE and DDD in a sample was 0.25 mg/kg, which is well below the 5.0 mg/kg AL. The highest concentration of PCBs in a sample was 0.23 mg/kg, which is well below the 2.0 mg/kg AL. Finally, the highest concentration of mercury in a sample was 0.14 mg/kg, which is well below the 1.0 mg/kg FDA AL.

Therefore, none of the contaminants detected in the fish or crabs collected from Wallace Creek or Bearhead Creek exceeded any of the FDA ALs.

Risk Assessment

The results of the screening value evaluation indicate a potential concern for the PCB levels in the fish caught in either Wallace Creek or Bearhead Creek since the average PCB level exceeded the USEPA SV. Arsenic and bis(2-ethylhexyl)phthalate were the only other contaminants detected in the fish tissue that exceeded the SVs. As discussed earlier, the arsenic and bis(2-ethylhexyl)phthalate do not appear to be site related. Therefore, only PCBs were evaluated in the risk assessment.

Recreation fishing does occur on Wallace Creek, therefore, ingestion of fish and crabs by current military and civilian personnel was assessed. In addition, future potential adult residents were assessed.

The ingestion rate was assumed to be 0.145 kg/day, which represents the USEPA Region IV default rate (Comment letter dated February 14, 1994). The fraction of fish ingested (FI) from

the source for adults was estimated to be 1.0 (100 percent) for the 90th percentile consumption rate. This assumption is very conservative since it assumes all fish intake is from fish caught in Wallace or Bearhead Creek and is always the same fish species. The exposure frequency is equal to 24 days/year. The exposure frequency of 24 days/year is based on interviews with local anglers and marinas that were conducted by the Installation Restoration Division (IRD) at MCB, Camp Lejeune, North Carolina (IRD/MCB, 1994). The exposure duration (ED) for adults was set at 30 years, and an averaging time (AT) of 70 years or 25,550 days was used for potential exposure to the potential carcinogen PCB. An averaging time of 365 days times the exposure duration (ED) was used for noncarcinogen exposure (USEPA, 1989).

Estimated incremental lifetime cancer risks (ICR) and noncarcinogenic risks for the identified adult receptor groups which could potentially be exposed to PCBs via the fish ingestion pathway were calculated. The cancer risk estimates are within the USEPA acceptable range of $10E^{-4}$ to $10E^{-6}$. In terms of noncarcinogenic risks, all the average case scenarios hazard indices were below 1.0, which is acceptable.

Summary and Conclusions

An assessment of potential human health risks associated with consumption of fish in Wallace Creek and Bearhead Creek was conducted using SVs, background comparisons, traditional human health risk assessment guidelines and comparison with fish tissue levels typically encountered in the United States. Although the FDA levels were not exceeded, results of the USEPA SV analysis indicated that PCBs may be of concern from a human health perspective. Further analysis of the data indicated that the potential risks were within USEPA's acceptable risk range of $10E^{-4}$ to $10E^{-6}$ even though a number of conservative assumptions were used in estimating the risk (e.g., all fish consumed is largemouth bass from the two creeks). The striped mullet is harvested offshore and not within the Wallace Creek area. In terms of the gar, this fish specie is not considered a game or commercial species. Therefore, it is highly unlikely that the gar would be consumed at the rates assumed in the risk assessment, if even consumed at all.

Based on the conclusions drawn throughout this study, a fish or shellfish ban is not recommended for Wallace Creek or Bearhead Creek.

1.0 INTRODUCTION

In August and September 1992, fish and crabs were collected from Wallace Creek and fish were collected from Bearhead Creek as part of a remedial investigation/feasibility study (RI/FS) at Operable Unit No. 2 (Sites 6, 9, and 82), Marine Corps Base (MCB) Camp Lejeune, North Carolina. The results of a human health risk assessment indicated that levels of contaminants of potential concern (COPCs) in the fish tissue may pose a potential risk to human health from consumption of fish taken from Wallace Creek and its tributaries. These COPCs primarily included PCBs and pesticides.

The initial sampling effort provided a screening of the waterbody to identify those sites where concentrations of the COPCs in edible portions of commonly consumed fish and shellfish indicate the potential for significant health risks to human consumers. Although the contaminant levels did not exceed U.S. Food and Drug Administration (FDA) actions levels, the elevated levels of COPCs in fish tissue did warrant additional site-intensive investigations.

According to the USEPA, Guidance for Assessing Chemical Contamination Data for use in Fish Advisories, Volume 1, Fish Sampling and Analysis (USEPA, 1993), if COPCs are detected at levels in fish or crab tissue that are potentially harmful to humans consuming the fish a more intensive study should be conducted to determine the magnitude of contamination of the edible portions of the fish and shellfish species and to establish a larger database of fish and shellfish tissue samples. Therefore, a follow-up intensive aquatic survey was conducted in September and October 1993, to collect sufficient sampling data for developing risk-based consumption advisories, if necessary. The study used composite samples to estimate mean COPC concentrations in the tissues of the fish and shellfish.

1.1 Objective

The objective of this supplemental aquatic survey was to further define the degree of contamination in the edible portions of fish and crabs inhabiting Wallace Creek and Bearhead Creek. In addition, fish and crabs were collected in the White Oak River and its tributary, Hadnot Creek, for use as reference samples for comparison to the samples collected in Wallace Creek and Bearhead Creek. The results of the chemical analysis were compared to either screening values (SVs) as established in the USEPA Guidance Manual (USEPA, 1993) or

calculated risk-based levels to determine if there was a potential risk to humans consuming the fish. The results of the chemical analysis also were compared to the U.S. FDA action level (AL) values, when available.

2.0 FIELD PROCEDURES

The following sections detail the field procedures used for collecting the fish and crab samples including the selection of target species, target analytes, station locations, sampling times, sampling methods, and number of samples collected.

2.1 Target Species

A total of six different fish species and one crab species were collected as target species for this investigation. These species included: largemouth bass (*Micropterus salmoides*), southern flounder (*Paralichthys lethostigma*), red drum (*Sciaenops ocellatus*), blue crab (*Callinectes sapidus*), chain pickerel (*Esox niger*), stripped mullet (*Mugil cephalus*), and longnose gar (*Lepisosteus osseus*). The largemouth bass, red drum, southern flounder, and blue crab are on the recommended target species list in the USEPA Guidance Manual (USEPA, 1993). The striped mullet, longnose gar and chain pickerel are not on the recommended target species list in the USEPA Guidance Manual (USEPA, 1993). However, they were collected as additional species based on their use in State and Federal contaminant monitoring programs to provide additional comparison of tissue concentrations.

2.2 Site Selection

The following sections discuss the methods used for the site selection of the study stations (Wallace Creek and Bearhead Creek) and the site selection of the reference stations (White Oak River and Hadnot Creek).

2.2.1 Study Stations

As discussed above, this intensive investigation was focused on Wallace Creek and Bearhead Creek because tissue analysis of fish and crabs previously collected from these areas indicated the presence of COPCs at concentrations that potentially posed an adverse risk to humans consuming the fish and crabs.

It was initially planned that three stations would be located in Wallace Creek (one upstream and two downstream stations) and two stations would be located in Bearhead Creek (one upstream and one downstream station). The upstream stations would be used to collect freshwater fish, while the downstream stations would be used to collect estuarine and marine

fish. As will be discussed later in this report, the salinity during this investigation was higher at the upstream stations than at similar stations in the 1992 study. Freshwater fish only were collected at the upstream station in Wallace Creek; no freshwater fish were collected in Bearhead Creek. Site access (i.e., fallen trees in the water) precluded further upstream sampling in the freshwater areas of Wallace Creek and Bearhead Creek. Because adequate numbers of estuarine and saltwater fish were collected in the downstream stations, only one downstream station was sampled in Wallace Creek. Therefore, a total of four stations were sampled in Wallace Creek and Bearhead Creek.

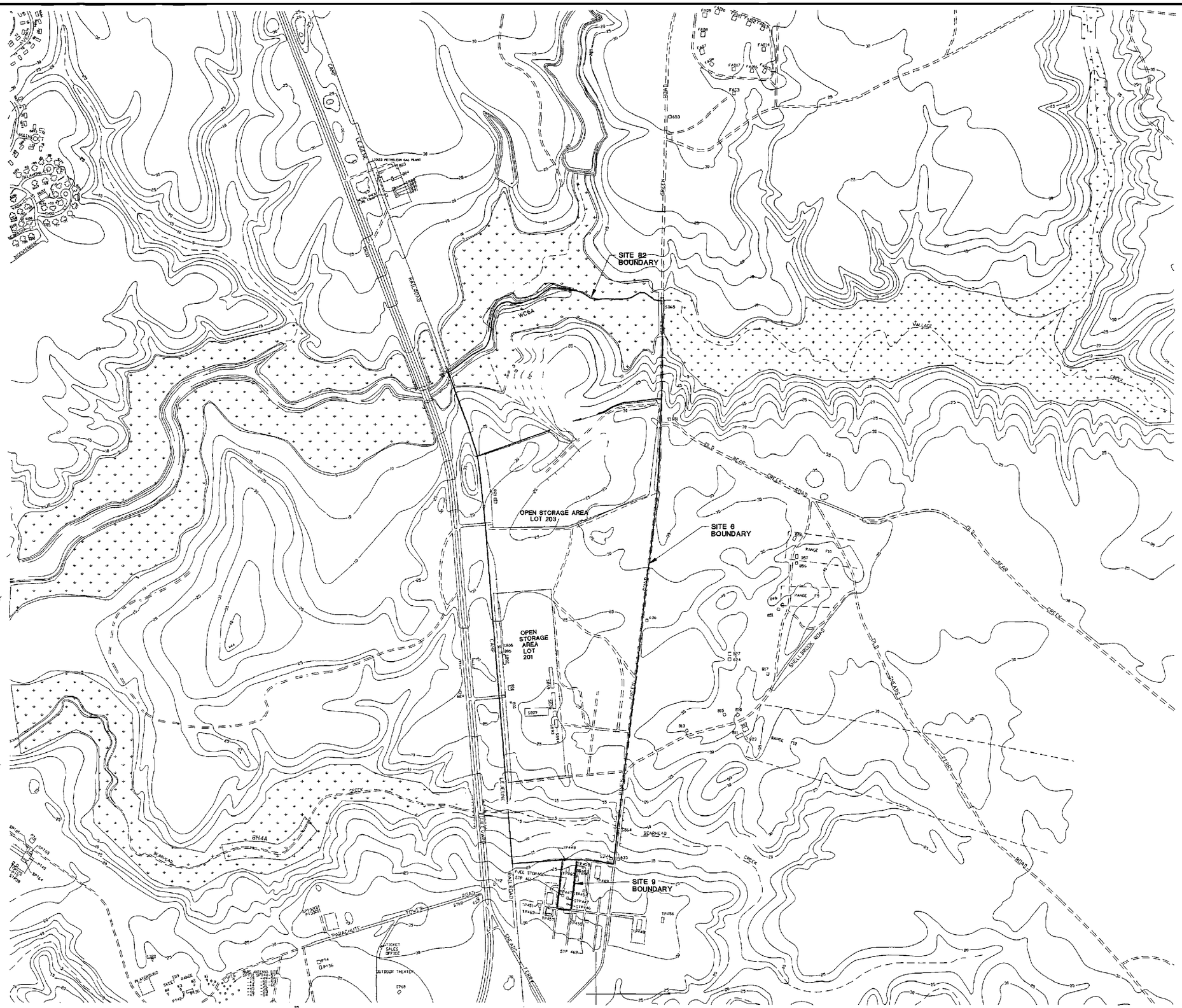
Figure 1 shows the approximate locations of the stations in Wallace Creek and Bearhead Creek. The stations are designated as WC-6A (upstream), WC-9A (downstream), BC-4A (upstream), and BC-6A (downstream).

2.2.2 Reference Stations

Based on conversations with representatives of the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR), reference stations were located in the White Oak River and in one of its tributaries, Hadnot Creek. The White Oak River basin was recommended as a reference location due to limited development within the watershed. Therefore, this basin should be representative of an aquatic system with relatively few impacts due to point and non-point pollution sources of an industrial nature similar to Camp Lejeune.

The Hadnot Creek station was selected to be representative of a freshwater/saltwater interface (i.e., salt wedge) area. However, there are reported large fluctuations in salinity in the White Oak River watershed with measured salinities varying by 10-15 parts per thousand (ppt) from week to week at a given station. Therefore, the characteristics of the fish populations could reflect the variation between a freshwater and low salinity estuarine habitat.

Initially, it was proposed that all the samples would be collected within Hadnot Creek. However, based on the lack of sampling success within the creek, a few fish were collected from the White Oak River approximately 100 feet upstream of its confluence with Hadnot Creek. In addition, crabs were collected in both Hadnot Creek and the White Oak River based on the sampling success. Gill nets in Hadnot Creek were spaced throughout the creek at locations that appeared suitable as fish collection areas.



REVISIONS	DATE NOVEMBER 1993 SCALE 1"= 500' DRAWN REL REVIEWED AMB S O # 19133-22-SRN CADD# 133001ER	NORTH		CTO-0133 MARINE CORPS BASE, CAMP LEJEUNE NORTH CAROLINA BAKER ENVIRONMENTAL, Inc Coraopolis, Pennsylvania	Baker Baker Environmental, Inc.	AQUATIC/ECOLOGICAL STATION LOCATIONS SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK OPERABLE UNIT No.2 SCALE 1"= 500' DATE NOVEMBER 1993	FIGURE No 1

SOURCE LANTDIV, FEBRUARY 1992

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Figure 2 shows the approximate locations of the stations in the White Oak River and Hadnot Creek. The remaining references in this report to samples collected from Hadnot Creek and the White Oak River will be referred to as collected from Hadnot Creek. All the fish and crabs collected from the reference station were grouped into one sample number (HC1A).

2.3 Target Analytes

The target analytes chosen for this analysis are Target Analyte List (TAL) inorganics and Target Compound List (TCL) organics. These analytes were chosen based on the results of past environmental assessments conducted in Wallace Creek and Bearhead Creek. The analysis methods used for the TAL inorganics are CLP "Statement of Work for inorganic analysis, multimedia, multiconcentration" ILM03.0, and the analysis methods used for the TCL organics are CLP "Statement of Work for organic analysis, multimedia, multiconcentration" OLM01.8.

Trip blanks for the VOCs were sent in each cooler with the fish. However, due to the low temperature of the dry ice, all the trip blanks froze and broke during transportation. Therefore, they could not be analyzed.

2.4 Sampling Methods

Prior to the sampling study, the appropriate Scientific Fish Collectors Permits were obtained by Baker. For the inland fish, a Scientific Fish Collection License No. 0559 authorizing collection under Category C was obtained from the North Carolina Wildlife Resources Commission, Division of Boating and Inland Fisheries. For the marine fish, a Scientific Collecting Permit (261A) No. SC-41-93 was obtained from the NC DEHNR, Division of Marine Fisheries.

Gill nets were the primary sampling equipment used to collect fish at each of the stations. As a supplement to the gill nets, hoop nets and trot lines were deployed and pole fishing was used in an attempt to collect bottom feeding fish (i.e., catfish, flounder). However, no fish were collected using these supplemental methods. Therefore, all the fish were collected using the gill nets, except for two or three flounder that were unintentionally caught in the crab pots. Table 2-1 summarizes the approximate times that the various sampling methods were utilized at each of the stations.

TABLE 2-1

SAMPLING METHOD LOG
BEARHEAD CREEK STATION NO: BC4A
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Date	Sampling Method	Set Time	Collection Time
10-1-93	Gill Net	1315-1345	------
10-1-93	Pole Fish	------	1345-1430
10-1-93	Gill Net	------	1715-1730
10-2-93	Gill Net	------	1055-1115
10-2-93	Trot Line	1115-1130	------
10-2-93	Gill Net	------	1525-1535

TABLE 2-1 (continued)

SAMPLING METHOD LOG
BEAR HEAD CREEK STATION NO: BC6A
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Date	Sampling Method	Set Time	Collection Time
10-1-93	Gill Nets	1215-1245	------
10-1-93	Crab Pots	1245-1300	------
10-1-93	Gill Nets	------	1630-1700
10-2-93	Gill Nets	------	0824-0900
10-2-93	Gill Nets	------	1139-1150
10-2-93	Crab Pots	------	1230-1240
10-2-93	Gill Nets	------	1543-1600
10-4-93	Gill Nets	1145	------
10-4-93	Gill Nets	------	1700
10-4-93	Crab Pots	------	1730

TABLE 2-1 (continued)

SAMPLING METHOD LOG
WALLACE CREEK STATION NO: WC6A
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Date	Sampling Method	Set Time	Collection Time
9-28-93	Hoop Net	1715-1730	------
9-28-93	Gill Net	1730-1815	1800 (a)
9-29-93	Gill Net	------	0730-0900
9-29-93	Hoop Net	------	0900-0945
9-29-93	Hoop Net	------	1615-1630
9-29-93	Gill Net	------	1630-1730
9-30-93	Hoop Net	------	1245-1300
9-30-93	Gill Net	------	1300-1345
10-1-93	Gill Net	1515-1535	------
10-1-93	Hoop Net	------	1535-1545
10-1-93	Pole Fish	------	1545-1615
10-1-93	Trot Line (b)	1900-1915	------
10-1-93	Trot Line (b)	------	0700
10-2-93	Gill Net	------	1200
10-2-93	Gill Net	------	1430-1500
10-2-93	Hoop Net	------	1500-1510
10-3-93	Trot Line (b)	------	1720-1730
10-3-93	Pole Fish	------	1730-1800

(a) - Two bass were caught immediately when deploying the nets
(b) - In Wallace Creek by Piney Green Road

TABLE 2-1 (continued)

SAMPLING METHOD LOG
WALLACE CREEK LOG STATION NO: WC9A
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Date	Sampling Method	Set Time	Collection Time
9-27-93	Gill Net	1600-1630	------
9-27-93	Crab Pots	1525-1540	------
9-27-93	Hoop Nets	1540-1600	------
9-28-93	Crab Pots	------	0900
9-28-93	Hoop Nets	------	0910-0920
9-28-93	Gill Net	------	0930-1030
9-28-93	Gill Net	------	1600-1630
9-28-93	Crab Pot	------	1630-1645
9-28-93	Hoop Nets	------	1645-1700
9-29-93	Crab Pot	------	1000
9-29-93	Crab Pot	------	1800
9-30-93	Crab Pot	------	1400
10-1-93	Crab Pot	------	1730
10-2-93	Crab Pot	------	1220
10-4-93	Gill Net	1130	------
10-4-93	Gill Net	------	1600-1700

TABLE 2-1 (continued)

SAMPLING METHOD LOG
HADNOT CREEK STATION NO: HC1A
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Date	Sampling Method	Set Time	Collection Time
9-29-93	Crab Pots	1300	------
9-29-93	Gill Nets	1315-1400	1400 (a)
9-30-93	Gill Nets	------	0800-0900
9-30-93	Gill Nets	0900-0930	------
9-30-93	Crab Pots	------	0940
9-30-93	Gill Nets	------	1630-1700
9-30-93	Crab Pots	------	1715
10-2-93	Crab Pots	1730 (b)	------
10-2-93	Gill Nets	1745-1830	------
10-3-93	Gill Nets	------	0815-0900
10-3-93	Gill Nets	0915-1030	------
10-3-93	Crab Pots	------	1100
10-3-93	Pole Fished	------	1145-1400
10-3-93	Gill Nets	------	1450-1545
10-4-93	Gill Nets	------	0800-0910
10-4-93	Crab Pots	------	0942

(a) - Immediately caught one longnose gar
(b) - These crab pots were set in the White Oak River near the pump station

The gill nets were monofilament, 50 or 100 feet in length, 6 or 8 feet in depth, and had a stretch mesh size ranging from 3 1/8 to 4 inches. The nets were deployed by either tying one end to a tree on shore and stretching the net across the channel or by weighting down both ends in the middle of a channel. At least two yellow buoys marked with "Baker Environmental" and the hotel phone number were attached to each net.

Nets were deployed either in the morning or evening, and checked the following morning or evening. Fish that were dead for an extended period of time (i.e., exhibited bloating) were discarded because of the potential for decomposition and leaching of contaminants from the organs into the edible portions of the fish.

Crab pots were used to collect blue crabs at each of the stations. The crab pots were baited with dead fish or crabs and were deployed with the pot resting on the sediment. The crab pots were checked once or twice daily.

2.5 Results of Sample Collection

The following sections contain the results of the sample collection including the physical/chemical characteristics of the water and the fish collection results.

2.5.1 Physical/Chemical Characteristics of the Water

Salinity and conductivity measurements were taken in Wallace Creek using a YSI Model 33 S-C-T meter while salinity, conductivity, dissolved oxygen, pH, and temperature measurements were taken in Hadnot Creek using either a YSI Model 33 S-C-T meter, or an ICM Water Analyzer Model 51601. The results of these measurements are contained in Table 2-2. The measurements were primarily taken to obtain the location of a salinity gradient in the creeks.

The measurements indicated that there was a significant upstream tidal influence and salt wedge on the days the measurements were conducted. The salinity at the most upstream station location measured in Wallace Creek (at the Piney Green Road crossing) ranged from 12 ppt at the surface to 28 ppt at the bottom. In addition, the salinity at the most upstream station location measured in Hadnot Creek ranged from 12-14 ppt at the surface to 32 ppt at

TABLE 2-2
FIELD WATER QUALITY MEASUREMENTS
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Date	Sample Number	Sample Location	Salinity (ppt)	Conductivity (micromho/cm)	DO (mg/l)	pH (S.U.)	Temperature (deg. C)
9-27-93	WC9A	Surface	17.5	NA	NA	NA	NA
		Bottom	17.5	NA	NA	NA	NA
9-29-93	HC1A	Surface (a)	21	NA	NA	NA	NA
		Surface	18.3	NA	NA	NA	NA
		Surface (b)	16	NA	NA	NA	NA
		Surface (c)	12-14	NA	NA	NA	NA
9-30-93	HC1A	Surface (b)	15	25000	NA	NA	NA
		Bottom	34	50000	NA	NA	NA
10-2-93	WC6A	Surface	13	NA	NA	NA	NA
		Bottom	32	NA	NA	NA	NA
10-3-93	WC6A	Surface (d)	12	19500	NA	NA	NA
		Bottom	28	42500	NA	NA	NA
10-3-93	HC1A	Surface (c)	14	18000	2.7	6.2	19.4
		Bottom	32	44000	2.3	6.49	21.4

(a) - Furthest Downstream
(b) - Near the Route 58 bridge crossing
(c) - At the furthest upstream gill net locations
(d) - By Piney Green Road
ppt - Parts per thousand
S.U. - Standard Units
NA - Not Analyzed
Sample Location - Water surface or water bottom

the bottom. An extremely turbid layer approximately six inches under the water in Wallace Creek and Bearhead Creek was observed on the last several days of the sampling study.

The turbid layer observed in the estuarine portions of Wallace Creek and Bearhead Creek was not sampled and analyzed. However, although there are many sources of turbidity in estuaries (i.e., planktonic biota, sediments, allochthonous organic debris), the major component is silt. As fresh waters encounter areas of significant salinity gradients, extremely fine particles (primarily colloidal clay minerals) often destabilize (coagulate) and agglomerate to form larger particles (flocculate). The resulting floc (larger agglomerated masses) then settles to the bottom. Flocculation occurs primarily in the upper central segments of an estuary in the areas of rapid salinity increases.

In an estuary, upstream bottom currents (tidal saltwater intrusion) often predominate over surface downstream flow (freshwater inflow) until upstream transport is counter-balanced by the downstream transport from the freshwater inflow. This "null zone" is at the head of the saline intrusion wedge and sediment deposition is extensive. The observed turbid layer probably was the upstream-flowing saltwater component of the salt wedge with a heavy load of silt at the freshwater-saltwater interface of the salt wedge. The approximately six inches of clear water probably was the downstream-flowing freshwater component of the salt wedge.

2.5.2 Fish Collection Results

Freshwater fish were only collected in Wallace Creek (at station WC6A) during the first two days of sampling, although gill nets were set at this station on other days. No freshwater fish were collected in Bearhead Creek. The most probable explanation for the low numbers of freshwater fish collected is that the salt wedge was below station WC6A on Wallace Creek during the first two days of sampling. However, the salt wedge moved up to WC6A and BC4A on Bearhead Creek after the second day of sampling. This migration of the salt wedge may have "pushed" the freshwater fish into the upstream reaches of Wallace Creek and Bearhead Creek where they could not be sampled.

Appendix 1 lists all the fish and crabs that were collected and retained for potential tissue analysis. A summary of the species and number of individuals collected at each of the stations is provided in Table 2-3.

TABLE 2-3

SUMMARY OF FISH SPECIES AND NUMBER OF INDIVIDUALS PER STATION
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Species	Station				
	WC6A	WC9A	BC4A	BC6A	HC1A
Largemouth Bass	8	0	0	0	23
Southern flounder	0	9	3	3	6
Red Drum	0	0	0	5	6
Longnose Gar	3	11	0	10	7
Stripped Mullet	19	11	1	9	1
Blue Crab	0	40	0	20	36
Chain Pickerel	3	0	0	0	0
Atlantic menhaden	0	0	0	0	3
Red ear sunfish	0	0	0	0	1
Blue gill	0	0	0	0	13

WC - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River.)

Striped mullet was the only species collected at every station. Largemouth bass were collected at stations WC6A and HC1A. Southern flounder were collected at stations WC9A, BC4A, BC6A, and HC1A. Longnose gar were collected at stations WC6A, WC9A, BC4A, BC6A, and HC1A. Red drum were collected at stations BC6A and HC1A. Blue crabs were collected at stations WC9A, BC6A, and HC1A. Chain pickerel were collected at station WC6A.

The fish samples were grouped into composite samples for chemical analysis. In most instances, the smallest individual in a composite was not less than 75 percent of the total length of the largest individual. In addition, the same number of individuals was used in each composite sample for a given target species at each sampling site. The relative difference between the average lengths of individuals within any composite sample from a given site, and the average of the average lengths of individuals in all composite samples from that site, did not exceed 10 percent.

An attempt was made to collect three replicates of each target species in Wallace Creek and Bearhead Creek and two replicates of each target species in Hadnot Creek. However, this was not possible for each of the target species.

The fish groupings for each composite sample are listed in Appendix 2. Table 2-4 contains a summary of the number and lengths of the fish in each composite sample, along with the minimum and maximum lengths, the minimum to maximum ratio, and the composite mean length. Only the fillets were used for the chemical analysis of the composite samples.

Thirteen fish composites were chemically analyzed from the samples collected in Wallace Creek and Bearhead Creek including: two Southern flounder composites (BC4A-SF and WC9A-SF), two largemouth bass composites (WC6A-LBA and WC6A-LBB), one red drum composite (BC6A-RD), three longnose gar composites (WC6A-G, WC9A-G, and BC6A-G), four stripped mullet composites (BC6A-SM, WC6A-SMA, WC6A-SMB, WC6A-SMC) and one chain pickerel composite (WC6A-CP).

Seven fish composites were chemically analyzed from the samples collected in Hadnot Creek including: one southern flounder composite (HC1A-SF), three largemouth bass composites (HC1A-LBA, HC1A-LBB, and HC1A-LBC), one red drum composite (HC1A-RD), and two longnose gar composites (HC1A-GA and HC1A-GB).

TABLE 2-4

FISH/CRAB LENGTHS FOR EACH COMPOSITE SAMPLE
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Sample	BC4A-SF (Southern Flounder) (mm)	WC9A-SF (Southern Flounder) (mm)	HC1A-SF (Southern Flounder) (mm)	BC6A-RD (Red Drum) (mm)	HC1A-RD (Red Drum) (mm)
1	266.7	279.4	292.1	412.75	406.4
2	285.75	254	330.2	438.15	558.8
3	260.35	260.35	254	419.1	387.35
4	247.65	247.65	342.9	438.15	336.55
5	241.3	273.05	260.35	387.35	374.65
6					393.7
MINIMUM	241.3	247.65	254	387.35	336.55
MAXIMUM	285.75	279.4	342.9	438.15	558.8
MINIMUM/MAXIMUM	84.44	88.64	74.07	88.41	60.23
MEAN	260.35	262.89	295.91	419.1	409.58

mm - millimeter
WL - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River)

TABLE 2-4 (continued)

FISH/CRAB LENGTHS FOR EACH COMPOSITE SAMPLE
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Sample	WC6A-LBA (Largemouth Bass) (mm)	WC6A-LBB (Largemouth Bass) (mm)	HC1A-LBA (Largemouth Bass) (mm)	HC1A-LBB (Largemouth Bass) (mm)	HC1A-LBC (Largemouth Bass) (mm)
1	336.55	304.8	317.5	336.55	317.5
2	311.15	368.3	342.9	361.95	317.5
3	374.65	330.2	355.6	336.55	393.7
4	342.9	368.3	342.9	330.2	342.9
MINIMUM	311.15	304.80	317.5	330.2	317.5
MAXIMUM	374.65	368.3	355.6	361.95	393.7
MINIMUM/MAXIMUM	83.05	82.76	89.29	91.23	80.65
MEAN	341.31	342.9	339.73	341.31	342.90

mm - millimeter
WL - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River)

TABLE 2-4 (continued)

FISH/CRAB LENGTHS FOR EACH COMPOSITE SAMPLE
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Sample	WC6A-G (Longnose Gar) (mm)	WC9A-G (Longnose Gar) (mm)	BC6A-G (Longnose Gar) (mm)	HC1A-GA (Longnose Gar) (mm)	HC1A-GB (Longnose Gar) (mm)
1	692.15	698.5	711.2	641.35	711.2
2	768.35	723.9	736.6	787.4	666.75
3	736.6	723.9	742.95	673.1	742.95
MINIMUM	692.15	698.5	711.2	641.35	666.75
MAXIMUM	768.35	723.9	742.95	787.4	742.95
MINIMUM/MAXIMUM	90.08	96.49	95.73	81.45	89.74
MEAN	732.37	715.43	730.25	700.62	706.97

mm - millimeter
WL - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River)

TABLE 2-4 (continued)

FISH/CRAB LENGTHS FOR EACH COMPOSITE SAMPLE
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Sample	BC6A-SM (Stripped Mullet) (mm)	WC6A-SMA (Stripped Mullet) (mm)	WC6A-SMB (Stripped Mullet) (mm)	WC6A-SMC (Stripped Mullet) (mm)	WC6A-CP (Chain Pickerel) (mm)
1	374.65	387.35	387.35	400.05	558.8
2	387.35	393.7	374.65	393.7	520.7
3	336.55	400.05	387.35	368.3	476.25
4	355.6	381	419.1	387.35	
5	342.9	419.1	400.05	412.75	
6	368.3	406.4	400.05	381	
7	361.95	374.65	393.7	406.4	
8	330.2	368.3	349.25	355.6	
9	336.55	361.95	368.3	387.35	
10	361.95	355.6	361.95	330.2	
MINIMUM	330.2	355.6	349.25	330.2	476.25
MAXIMUM	387.35	419.1	419.1	412.75	558.8
MINIMUM/MAXIMUM	85.25	84.85	83.33	80.00	85.23
MEAN	355.6	384.81	384.18	382.27	518.58

mm - millimeter
WL - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River)

TABLE 2-4 (continued)

FISH/CRAB LENGTHS FOR EACH COMPOSIT SAMPLE
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Sample	BC6A-BC (Blue Crab) (mm)	WC9A-BCA (Blue Crab) (mm)	WC9A-BCB (Blue Crab) (mm)	HC1A-BCA (Blue Crab) (mm)	HC1A-BCB (Blue Crab) (mm)
1	139.7	133.35	152.4	133.35	120.65
2	152.4	139.7	152.4	120.65	120.65
3	120.65	139.7	127	127	127
4	133.35	165.1	146.05	152.4	165.1
5	146.05	139.7	139.7	171.45	127
6	139.7	120.65	139.7	133.35	114.3
7	139.7	127	146.05	133.35	158.75
8	139.7	133.35	127	165.1	165.1
9	127	152.4	127	139.7	171.45
10	133.35	127	152.4	146.05	171.45

mm - millimeter
WL - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River)

TABLE 2-4 (continued)

FISH/CRAB LENGTHS FOR EACH COMPOSIT SAMPLE
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Sample	BC6A-BC (Blue Crab) (mm)	WC9A-BCA (Blue Crab) (mm)	WC9A-BCB (Blue Crab) (mm)	HC1A-BCA (Blue Crab) (mm)	HC1A-BCB (Blue Crab) (mm)
11	152.4	152.4	127	177.8	158.75
12	139.7	139.7	133.35	107.95	127
13	139.7	133.35	133.35	171.45	139.7
14	139.7	127	133.35	146.05	133.35
15	133.35	127	120.65	127	139.7
16	152.4	152.4	139.7	127	133.35
17	139.7	146.05	146.05	158.75	146.05
18	146.05	146.05	158.75	139.7	139.7
MINIMUM	120.65	120.65	120.65	107.95	114.3
MAXIMUM	152.4	165.1	158.75	177.8	171.45
MINIMUM/MAXIMUM	79.17	73.08	76.00	60.71	66.67
MEAN	139.70	138.99	138.99	143.23	142.17

mm - millimeter
WL - Wallace Creek Station
BC - Bearhead Creek Station
HC - Hadnot Creek Station (Note: Some of the fish and crabs were caught in the White Oak River)

Finally, three blue crab composites were chemically analyzed from the samples collected in Wallace Creek and Bearhead Creek (BC6A-BC, WC9A-BCA, and WC9A-BCB). Two blue crab composites were chemically analyzed from the samples collected in Hadnot Creek (HC1A-BCA and HC1A-BCB).

3.0 CHEMICAL ANALYSIS RESULTS

The following sections contains the results of the chemical analyses on the fish and crab samples.

3.1 Tissue Analysis Results

COPCs are site-related contaminants used to quantitatively estimate human exposures and associated potential health effects. The methods used for selecting COPCs are presented in detail in the Final Remedial Investigation Report for Operable Unit No. 2 (Baker, 1993).

The following sections contain the results of the tissue analysis including the samples collected from the study stations and the reference stations. The following metals were not included in the list of COPCs because the information required to generate SVs (discussed below) do not exist: aluminum, calcium, iron, lead, magnesium, potassium, and sodium. The results of the data validation are presented in Appendix 3.

3.1.1 Study Stations

Tables 3-1 through 3-7 contain the positive detections of COPCs in the fish and crab samples collected in Wallace Creek and Bearhead Creek. Each table contains the results for one fish or crab species. The tables also list the average values for the samples collected in Wallace Creek and Bearhead Creek. Appendix 4 contains the positive detections for all the contaminants detected in the fish and crabs collected in Wallace Creek and Bearhead Creek.

Of the inorganic COPCs, arsenic, cadmium, chromium, copper, manganese, mercury, and zinc were detected in the tissue samples. Volatile organic compounds (VOCs) including acetone, methylene chloride, 2-butanone, toluene, 1,2-dichloroethene (1,2-DCE), tetrachloroethene (PCE), and trichloroethene (TCE) were detected in the fish and/or crab tissues.

4,4-DDE, 4,4-DDE and alpha-chlordane were the only pesticides detected in the tissue samples, while Aroclor-1260 was the only PCB detected in the samples. Finally, the following semivolatiles (SVOCs) were detected in the tissue samples: phenol, di-n-octyl phthalate, and bis(2-ethylhexyl)phthalate.

TABLE 3-1

SCREENING VALUE COMPARISON FOR LARGEMOUTH BASS
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC6A-LBA (mg/kg)	WC6A-LBB (mg/kg)	HC1A-LBA (mg/kg)	HC1A-LBB (mg/kg)	HC1A-LBC (mg/kg)	WC Average Value (mg/kg)	HC Average Value (mg/kg)	Average Fisherman Screening Value	
								Noncarcino-genic (mg/kg)	Carcino-genic (mg/kg)
INORGANICS									
ARSENIC	0.18	0.16	0.34	0.37	0.36	0.17	0.36	3.231	0.062
CHROMIUM	0.26	0.26	0.23	0.68	0.63	0.26	0.51	10769.231	NA
COPPER	0.15	0.18	0.2	0.24	0.28	0.165	0.24	399.538	NA
MANGANESE	0.06	0.09	0.09	0.09	0.08	0.075	0.09	53.846	NA
MERCURY	0.14	0.14	0.22	0.24	0.17	0.14	0.21	0.646	NA
ZINC	3.7	4	3.9	4.4	4.6	3.85	4.30	3230.769	NA
PESTICIDES/PCBs									
4,4'-DDD	0.0062	0.005	ND	ND	ND	0.0056	ND	5.000	0.449
4,4'-DDE	0.017	0.016	ND	ND	ND	0.0165	ND	5.000	0.317
AROCLOR-1260	0.057	0.055	ND	ND	ND	0.056	ND	NA	0.014
SEMIVOLATILES									
DI-N-OCTYL PHTHALATE	0.32	0.14	0.061	ND	0.085	0.23	0.05	215.385	NA

WC - Wallace Creek Station
HC - Hadnot Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-1 (continued)

SCREENING VALUE COMPARISON FOR LARGEMOUTH BASS
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC6A-LBA (mg/kg)	WC6A-LBB (mg/kg)	HC1A-LBA (mg/kg)	HC1A-LBB (mg/kg)	HC1A-LBC (mg/kg)	WC Average Value (mg/kg)	HC Average Value (mg/kg)	Average Fisherman Screening Value	
								Noncarcino-genic (mg/kg)	Carcino-genic (mg/kg)
BIS(2-ETHYLHEXYL) PHTHALATE	14	7.6	3.6 BE	3.2 B	4.8 B	10.8	3.87	215.385	7.692
VOLATILES									
ACETONE	0.53	0.3	0.077	0.07	0.037	0.415	0.06	1076.923	NA
2-BUTANONE	0.023	0.023	ND	ND	ND	0.023	ND	6462.000	NA
1,2-DICHLOROETHENE	0.006	0.013	ND	ND	ND	0.0095	ND	96.923	NA
METHYLENE CHLORIDE	0.015	0.011	0.017	0.016	0.003	0.013	0.01	646.154	14.359
TETRACHLOROETHENE	0.003	0.008	ND	ND	ND	0.0055	ND	107.692	2.071
TRICHLOROETHENE	0.016	0.043	ND	ND	ND	0.0295	ND	64.615	NA

WC - Wallace Creek Station
HC - Hadnot Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-2

SCREENING VALUE COMPARISON FOR RED DRUM
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	BC6A-RD (mg/kg)	HC1A-RD (mg/kg)	Average Fisherman Screening Value	
			Noncarcinogenic (mg/kg)	Carcinogenic (mg/kg)
INORGANICS				
ARSENIC	0.42	0.7	3.231	0.062
COPPER	0.22	0.3	399.538	NA
MANGANESE	0.09	0.13	53.846	NA
MERCURY	0.04	0.07	0.646	NA
ZINC	4.1	5	3230.769	NA
PESTICIDES/PCBs				
4,4'-DDD	0.007	ND	5.000	0.449
4,4'-DDE	0.011	ND	5.000	0.317
ALPHA-CHLORDANE	0.0015	ND	0.646	0.083
SEMIVOLATILES				
DI-N-OCTYL PHTHALATE	0.057	ND	215.385	NA
BIS(2-ETHYLHEXYL)PHTHALATE	ND	1.1	215.385	7.692
VOLATILES				
ACETONE	0.09	0.13	1076.923	NA
METHYLENE CHLORIDE	0.012	0.041	646.154	14.359
TRICHLOROETHENE	0.001	ND	64.615	NA

BC - Bearhead Creek Station
HC - Hadnot Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-3

SCREENING VALUE COMPARISON FOR STRIPPED MULLET
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC6A-SMA (mg/kg)	WC6A-SMB (mg/kg)	WC6A-SMC (mg/kg)	BC6A-SM (mg/kg)	WC Average Value (mg/kg)	Average Fisherman Screening Value	
						Noncarcinogenic (mg/kg)	Carcinogenic (mg/kg)
INORGANICS							
ARSENIC	0.48	0.48	0.36	0.37	0.42	3.231	0.062
CHROMIUM	0.72	0.23	ND	0.65	0.40	10769.231	NA
COPPER	0.29	0.27	0.17	0.32	0.26	399.538	NA
MANGANESE	0.22	0.14	0.2	0.21	0.19	53.846	NA
MERCURY	0.01	ND	ND	0.01	0.01	0.646	NA
ZINC	6.1	6	5.6	6.5	6.05	3230.769	NA
PESTICIDES/PCBs							
4,4'-DDD	0.026	0.034	0.032	0.063	0.039	5.000	0.449
4,4'-DDE	0.038	0.047	0.048	0.12	0.063	5.000	0.317
ALPHA-CHLORDANE	ND	ND	ND	0.0075	0.002	0.650	0.080
AROCLOR-1260	0.13	0.19	0.22	0.12	0.17	NA	0.014

BC - Bearhead Creek Station
WC - Wallace Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-3 (continued)

SCREENING VALUE COMPARISON FOR STRIPPED MULLET
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC6A-SMA (mg/kg)	WC6A-SMB (mg/kg)	WC6A-SMC (mg/kg)	BC6A-SM (mg/kg)	WC Average Value (mg/kg)	Average Fisherman Screening Value	
						Noncarcinogenic (mg/kg	Carcinogenic (mg/kg)
SEMIVOLATILES							
DI-N-OCTYL PHTHALATE	0.23	0.29	0.64	2	0.79	215.385	NA
BIS(2-ETHYLHEXYL) PHTHALATE	12	16	24	ND	17.3	215.385	7.692
VOLATILES							
ACETONE	0.041	ND	0.02	0.055	0.029	1076.923	NA
2-BUTANONE	0.008	0.057	0.021	ND	0.022	6462.000	NA
1,2-DICHLOROETHENE	0.005	0.035	0.025	ND	0.016	96.923	NA
METHYLENE CHLORIDE	0.006	0.028	0.076	0.011	0.030	646.154	14.359
TETRACHLOROETHENE	0.01	0.036	0.031	ND	0.019	107.692	2.071
TOLUENE	ND	0.003	0.003	0.002	0.002	2153.846	NA
TRICHLOROETHENE	0.034	0.11	0.085	0.007	0.059	64.615	NA

BC - Bearhead Creek Station
WC - Wallace Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-4

SCREENING VALUE COMPARISON FOR SOUTHERN FLOUNDER
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC9A-SF (mg/kg)	BC4A-SF (mg/kg)	HC1A-SF (mg/kg)	WC Average Value (mg/kg)	Average Fisherman Screening Value	
					Noncarcinogenic (mg/kg)	Carcinogenic (mg/kg)
INORGANICS						
ARSENIC	0.28	0.15	0.82	0.215	3.231	0.062
CHROMIUM	1.1	0.63	ND	0.865	10769.231	NA
COPPER	0.18	0.44	0.18	0.310	399.538	NA
MANGANESE	0.23	0.59	0.38	0.410	53.846	NA
MERCURY	0.02	0.02	0.05	0.020	0.646	NA
ZINC	8.8	10.5	5	4.400	3230.769	NA
PESTICIDES/PCBs						
4,4'-DDD	ND	0.0048	ND	0.002	5.000	0.449
4,4'-DDE	0.0039	0.02	ND	0.012	5.000	0.317
ALPHA-CHLORDANE	ND	0.0018	ND	0.001	0.646	0.083

BC - Bearhead Creek Station
WC - Wallace Creek Station
HC - Hadnot Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-4 (continued)

SCREENING VALUE COMPARISON FOR SOUTHERN FLOUNDER
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC9A-SF (mg/kg)	BC4A-SF (mg/kg)	HC1A-SF (mg/kg)	WC Average Value (mg/kg)	Average Fisherman Screening Value	
					Noncarcinogenic (mg/kg)	Carcinogenic (mg/kg)
SEMIVOLATILES						
DI-N-OCTYL PHTHALATE	ND	0.037	ND	0.019	215.385	NA
BIS(2-ETHYLHEXYL)PHTHALATE	0.37	ND	0.82	0.19	215.385	7.692
VOLATILES						
ACETONE	0.063	0.066	0.056	0.065	1076.923	NA
2-BUTANONE	ND	0.081	ND	0.041	6462.000	NA
METHYLENE CHLORIDE	0.054	0.006	0.013	0.030	646.154	14.359

BC - Bearhead Creek Station
WC - Wallace Creek Station
HC - Hadnot Creek Station
ND - Not Detected
NA - Not Applicable

TABLE 3-5

STATISTICAL COMPARISON FOR CHAIN PICKEREL
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	WC6A-CP (mg/kg)	Average Fisherman Screening Value	
		Noncarcinogenic (mg/kg)	Carcinogenic (mg/kg)
INORGANICS			
ARSENIC	0.38	3.231	0.062
MANGANESE	0.13	53.846	NA
MERCURY	0.09	0.646	NA
ZINC	4.9	3230.769	NA
PESTICIDES/PCBs			
4,4'-DDE	0.0034	5.000	0.317
SEMIVOLATILES			
DI-N-OCTYL PHTHALATE	0.067	215.385	NA
BIS(2-ETHYLHEXYL)PHTHALATE	2.7	215.385	7.692
VOLATILES			
ACETONE	0.082	1076.923	NA
1,2-DICHLOROETHENE	0.008	96.923	NA
METHYLENE CHLORIDE	0.014	646.154	14.359
TETRACHLOROETHENE	0.004	107.692	2.071
TRICHLOROETHENE	0.021	64.615	NA

WC - Wallace Creek Station
NA - Not Applicable

TABLE 3-6

SCREENING VALUE COMPARISON FOR LONGNOSE GAR
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	BC6A-G (mg/kg)	WC9A-G (mg/kg)	WC6A-G (mg/kg)	HC1A-GA (mg/kg)	HC1A-GB (mg/kg)	WC Average Value (mg/kg)	HC Average Value (mg/kg)	Average Fisherman Screening Value	
								Non-carcinogenic (mg/kg)	Carcinogenic (mg/kg)
INORGANICS									
ARSENIC	0.93	0.98	1.5	2.5	3.9	1.14	3.20	3.231	0.062
CHROMIUM	ND	0.2	ND	0.32	0.21	0.07	0.27	10769.231	NA
COPPER	0.18	0.17	0.25	0.46	0.18	0.20	0.32	399.538	NA
MANGANESE	0.27	0.31	0.21	0.24	0.21	0.26	0.23	53.846	NA
MERCURY	0.06	0.07	0.1	0.22	0.14	0.08	0.18	0.646	NA
ZINC	ND	4.7	4	6.5	4.6	2.90	5.55	3230.769	NA
PESTICIDES/PCBs									
4,4'-DDD	0.042	0.07	0.045	ND	ND	0.052	ND	5.000	0.449
4,4'-DDE	0.099	0.18	0.13	0.012	0.0097	0.136	0.011	5.000	0.317
ALPHA-CHLORDANE	ND	0.0049	ND	ND	ND	0.002	ND	0.646	0.083
AROCLOR-1260	0.13	0.23	0.16	ND	ND	0.173	ND	NA	0.014

BC - Bearhead Creek Station
WC - Wallace Creek Station
HC - Hadnot Creek Station
NA - Not Applicable
ND - Not Detected

TABLE 3-6 (continued)

SCREENING VALUE COMPARISON FOR LONGNOSE GAR
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	BC6A-G (mg/kg)	WC9A-G (mg/kg)	WC6A-G (mg/kg)	HC1A-GA (mg/kg)	HC1A-GB (mg/kg)	WC Average Value (mg/kg)	HC Average Value (mg/kg)	Average Fisherman Screening Value	
								Non-carcinogenic (mg/kg)	Carcinogenic (mg/kg)
VOLATILES									
ACETONE	0.054	0.15	0.072	0.028	0.016	0.092	0.022	1076.923	NA
2-BUTANONE	ND	0.12	ND	ND	ND	0.040	ND	6462.000	NA
METHYLENE CHLORIDE	0.007	0.022	0.026	0.004	0.015	0.018	0.010	646.154	14.359
TETRACHLORO-ETHENE	ND	0.003	0.008	ND	ND	0.004	ND	107.692	2.071
TRICHLOROETHENE	0.004	0.015	0.034	ND	ND	0.018	ND	64.615	NA
SEMIVOLATILES									
PHENOL	ND	0.45	ND	ND	ND	0.15	ND	6461.538	NA
DI-N-OCTYL PHTHALATE	0.21	0.82	0.28	0.29	0.5	0.44	0.40	215.385	NA
BIS(2-ETHYLHEXYL) PHTHALATE	ND	26	12	11	17	12.7	14.0	215.385	7.692

BC - Bearhead Creek Station
WC - Wallace Creek Station
HC - Hadnot Creek Station
NA - Not Applicable
ND - Not Detected

TABLE 3-7

SCREENING VALUE COMPARISON FOR BLUE CRAB
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	BC6A-BC (mg/kg)	WC9A-BCA (mg/kg)	WC9A-BCB (mg/kg)	HC1A-BCA (mg/kg)	HC1A-BCB (mgkg)	WC Average Value (mg/kg)	HC Average Value (mg/kg)	Average Fisherman Screening Value	
								Non-carcinogenic (mg/kg)	Carcinogenic (mg/kg)
INORGANICS									
ARSENIC	0.47	0.43	0.52	0.68	0.39	0.47	0.535	3.231	0.062
BARIUM	2.9	3.6	1	ND	10.1	2.50	5.1	753.846	NA
CADMIUM	ND	ND	0.1	0.14	0.11 B	0.03	0.125	10.770	NA
CHROMIUM	ND	0.18	ND	ND	0.52	0.06	0.26	10769.231	NA
COPPER	6.8	5	5.6	7.9	5.8	5.80	6.85	399.538	NA
MANGANESE	2.7	3.8	1.1	1.8	13.6	2.53	7.7	53.846	NA
MERCURY	0.02	0.02	0.01	0.08	0.02	0.02	0.05	0.646	NA
ZINC	21.6	23.3	23.3	25	17.9	22.73	21.45	3230.769	NA
PESTICIDES/PCBs									
4,4'-DDD	0.026	0.0082	0.0093	0.0066	0.0056	0.01	0.0063	5.000	0.449
4,4'-DDE	0.033	0.0094	0.012	0.0087	0.0046	0.02	0.00665	5.000	0.317
ALPHA-CHLORDANE	0.0063	ND	ND	0.0018	0.0012	0.00	0.0015	0.646	0.083
SEMIVOLATILES									
BIS(2-ETHYLHEXYL) PHTHALATE	ND	1.8	0.83	ND	ND	0.88	ND	215.385	7.692

BC - Bearhead Creek Station
WC - Wallace Creek Station
HC - Hadnot Creek Station
ND - Not Detected

TABLE 3-7 (continued)

SCREENING VALUE COMPARISON FOR BLUE CRAB
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	BC6A-BC (mg/kg)	WC9A-BCA (mg/kg)	WC9A-BCB (mg/kg)	HC1A-BCA (mg/kg)	HC1A-BCB (mgkg)	WC Average Value (mg/kg)	HC Average Value (mg/kg)	Average Fisherman Screening Value	
								Non-carcinogenic (mg/kg)	Carcinogenic (mg/kg)
VOLATILES									
ACETONE	0.15	0.16	0.13	0.11	0.099	0.15	0.1045	1076.923	NA
METHYLENE CHLORIDE	0.037	0.019	0.018	0.011	0.022	0.02	0.0165	646.154	14.359
TRICHLOROETHENE	ND	0.002	0.002	ND	ND	0.001	ND	64.615	NA

BC - Bearhead Creek Station
WC - Wallace Creek Station
HC - Hadnot Creek Station
ND - Not Detected
NA - Not Applicable

3.1.2 Reference Station

Tables 3-1 through 3-7 contain the positive detections of COPCs in the fish and crab samples collected in Hadnot Creek. Each table contains the results for one fish or crab species. The tables also list the average values for the samples collected in Hadnot Creek. Appendix 5 contains the positive detections for all the contaminants detected in Hadnot Creek.

Of the inorganic COPCs, arsenic, antimony, cadmium, chromium, copper, manganese, mercury, nickel, and zinc were detected in the tissue samples. Antimony and nickel were not detected in the tissue samples collected from Wallace Creek or Bearhead Creek, therefore, they were not included for evaluation in this study.

Acetone, methylene chloride, and toluene were the only VOCs that were detected in the tissue samples. 4,4-DDE, 4,4-DDE and alpha-chlordane were the only pesticides detected in the tissue samples. No PCBs were detected in the tissue samples. Finally, the following semivolatiles were detected in the tissue samples: phenol, di-n-octyl phthalate, and bis(2-ethylhexyl)phthalate.

4.0 SCREENING VALUES FOR TARGET ANALYTES

The following sections contain the USEPA SVs for the target analytes including the methodology for calculating the SVs, the comparison of the SVs to the sample results, and a comparison of the FDA ALs to the sample results.

4.1 Methods for Calculating Screening Values

The USEPA Guidance Document (USEPA, 1993) contains a list of SVs for the target analytes that are defined as the concentration of contaminants in fish or shellfish tissue that are of potential public concern. These SVs are used as standards against which levels of contamination in similar tissue collected from the ambient environment can be compared. SVs have been generated for the following COPCs detected in the fish and/or crab tissue samples collected in Wallace Creek or Bearhead Creek: cadmium, mercury, total DDT, and total PCBs (USEPA, 1993). The SVs were calculated by USEPA using a risk-based procedure discussed below. Baker used this procedure to calculate SVs for the COPCs which did not have previously calculated SVs.

The general equation for calculating SVs is as follows:

$$SVm = (Pm*BW)/(CR*Xm)$$

Where:

- SVm = Screening value for chemical "m"
- Pm = Toxicologic potency factor for chemical "m"
- BW = Mean body weight for the general population or subpopulation of concern (70 kg was used for this study)
- CR = Mean daily consumption rate of the species of interest by the general population or subpopulation of concern averaged over a 70-year lifetime (6.5 mg/day was used for this study)
- Xm = Relative absorption coefficient, or the ratio of human absorption efficiency to test animal absorption efficiency for chemical "m" (1.0 was used for this study)

The only variable in this equation for different COPCs is the toxologic potency factor (Pm). For noncarcinogens, this value will be the reference dose (RfD) which is expressed in units of mg/kg body weight/day. The RfD values are based on a 70-year, lifetime exposure, and represent an approximation of a dose below which no adverse health effects would be expected even in sensitive subpopulations. The RfD is derived from the No Observed Adverse Effect Level or the Lowest Observed Adverse Effect Level by the application of uncertainty factors

(ranging from 1 to 10,000) to account for interspecies variation and sensitive human populations. For the equation above, the "Pm" should be substituted with "RfD" for calculating noncarcinogenic SVs.

It is generally assumed that carcinogenic outcomes have no threshold dose at which no adverse effects would be expected, other than no exposure. Many contaminants have been classified by the USEPA and other organizations according to the likelihood of the given chemical eliciting a carcinogenic response in humans. The USEPA's Human Health Assessment Group derives carcinogenic potency (or slope) factors (SF) for potentially carcinogenic compounds using both epidemiologic and animal studies. The potency factor is an estimate of the upper 95% confidence limit of the slope of the dose-response curve extrapolated to low doses. The SF is given in units of "mg/kg/day^{-1}", and is based upon the assumption of a lifetime average daily dose. The SVs for carcinogens are derived from the SFs and from risk levels (RLs), which is an assigned level of maximum acceptable individual lifetime risk (e.g., a RL of 10^{-5} indicates a level of risk not to exceed one excess case of cancer per 100,000 individuals exposed over a 70-year lifetime). For the equation above, the "Pm" should be substituted with "RL/SF" for calculating carcinogenic SVs.

4.2 Screening Value Comparison

For this study, the SVs based upon assumptions for the general adult population were used for comparisons to the contaminant concentrations in the fish and crab tissue samples. The SVs were calculated using the ingestion rates for the average fisherman (6.5 g/day) (USEPA, 1993). Tables 3-1 through 3-7 list the carcinogenic and noncarcinogenic SVs of each COPC for each target species. The SVs for the analytes that were not listed in the USEPA Guidance Document (USEPA, 1993) were calculated by Baker using the equation described in the previous section.

Arsenic was detected in all the fish and crab samples collected from Wallace Creek, Bearhead Creek, and Hadnot Creek at levels that exceeded the carcinogenic SV. For each species, the average concentration of arsenic in the Hadnot Creek samples was greater than the concentration of arsenic in the Wallace Creek and Bearhead Creek stations. It appears that the arsenic in the tissue samples collected in Wallace Creek and Bearhead Creek are within naturally occurring concentrations since they are at lower levels than fish collected from Hadnot Creek. In addition, the National Marine Fisheries Service's (NMFS) survey of trace

elements in the fishery resource (NMFS, 1978) found that the mean arsenic level in finfish muscle for most species was between 2.0 and 5.0 ppm and crustacea had higher levels with the largest number of species falling between 4.0 and 5.0 ppm. The present study had average values of less than 1 ppm for all species except the longnose gar, which had average values of 1.14 (Wallace Creek) and 3.2 (Hadnot Creek) but was not included in the NMFS study. Therefore, arsenic will not be evaluated further in this study. None of the other inorganics that were detected in the samples exceeded any of the SVs.

The largemouth bass, longnose gar, and striped mullet samples collected in Wallace Creek and Bearhead Creek contained levels of Aroclor-1260 in excess of the SV. PCBs were not detected in any of the other fish or crab samples collected from these creeks. In addition, PCBs were not detected in any of the fish or crabs collected from the reference station.

None of the SVs for any of the VOCs were exceeded for the fish or crabs collected in Wallace Creek or Bearhead Creek. Bis(2-ethylhexyl)phthalate was the only SVOC that exceeded any of the SVs. This parameter is not site-related based on previous sampling results in other media (e.g., surface water, sediment) at MCB Camp Lejeune. Bis(2-ethylhexyl)phthalate was detected in the tissue samples collected from Hadnot Creek in equal or slightly lower concentrations than those collected in Wallace Creek or Bearhead Creek. Potential sources for contamination of phthalates include exposure to gloves used for handling the fish, plastic bags used to line the coolers, and laboratory equipment (e.g., stoppers).

None of the other fish of crab samples collected from Wallace Creek or Bearhead Creek exceeded the SVs for any of the pesticides. In addition, none of the fish or crabs collected from Hadnot Creek exceeded the SVs for any of the pesticides.

4.3 Food and Drug Administration Action Levels

The U.S. FDA has established ALs for chemical substances in fish resulting from unavoidable environmental contamination. ALs have been established for the following contaminants that were detected in the fish samples: DDE and DDD, PCBs, and mercury (as methyl mercury).

The AL for total DDE and DDD is 5.0 mg/kg. The AL for total PCBs is 2.0 mg/kg. For methyl mercury, the AL is 1.0 mg/kg. The highest total concentration of DDE and DDD in a sample was 0.25 mg/kg, which is well below the 5.0 mg/kg AL. The highest concentration of PCBs in a

sample was 0.23 mg/kg, which is well below the 2.0 mg/kg AL. Finally, the highest concentration of mercury in a sample was 0.14 mg/kg, which is well below the 1.0 mg/kg FDA AL. Therefore, none of the contaminants detected in the fish or crabs collected from Wallace Creek or Bearhead Creek exceeded any of the FDA ALs.

5.0 RISK ASSESSMENT

5.1 Introduction

The results of the SV evaluation indicate a potential concern for the PCB levels in the fish caught at the site (i.e., the PCB fish levels exceed the USEPA SVs). Arsenic and bis(2-ethylhexyl)phthalate were the only other contaminants detected in the fish tissue that exceeded the SVs. As discussed earlier in this report, the arsenic and bis(2-ethylhexyl)phthalate do not appear to be site related. Therefore, only PCB will be evaluated in this risk assessment. In order to evaluate the potential human health risks associated with the PCB levels in fish, a focused risk assessment was conducted. The following sections present the results of the risk assessment conducted for the PCB levels detected in the composites for the gar, striped mullet, and largemouth bass.

The risk assessment for OU No. 2 was conducted in accordance with current USEPA's Risk Assessment Guidance (USEPA, December 1989 and March 25, 1991).

The components of the focused risk assessment include:

- Identification of potential contaminants of concern;
- The exposure assessment;
- The toxicity assessment;
- Risk characterization; and,
- Uncertainty analysis.

This risk assessment is divided into five sections, including the Introduction. Section 5.2 discusses the exposure assessment. Section 5.3 presents the toxicity assessment. Section 5.4 discusses the risk characterization. Section 5.5 discusses the sources of uncertainty in the risk assessment.

5.2 Exposure Assessment

This section details the potential human exposure pathways at OU No. 2 and the rationale for its evaluation.

5.2.1 Exposure Pathways

This section describes the potential fish ingestion exposure pathway associated with each potential human receptor group, then qualitatively evaluates each pathway for further consideration in the quantitative risk analysis.

5.2.1.1 Biota

Current military personnel (including civilian employees) and future potential adult residents could catch and consume fish from Wallace Creek, thereby being exposed to PCBs accumulated in the edible portions of fish.

Recreational fishing does occur on Wallace Creek, therefore, ingestion of fish by current and future fisher persons is retained for quantitative evaluation.

5.2.2 Calculation of Chronic Daily Intakes

In order to numerically estimate the risks for current and future human receptors at OU No. 2., a chronic daily intake (CDI) must be estimated for PCBs in each fish species caught at the site.

The following paragraphs present the general equations and input parameters used in the calculation of CDIs for each potential exposure pathway. Input parameters are taken from USEPA's default exposure factors guidelines where available and applicable. All inputs not defined by USEPA are derived from USEPA documents concerning exposure or best professional judgement.

Carcinogenic risks are calculated as an incremental lifetime risk, and therefore incorporate terms describing to represent the exposure duration (years) over the course of a lifetime (70 years, or 25,550 days).

Noncarcinogenic risks, on the other hand, were estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. In general, noncarcinogenic risks for many exposure routes (e.g. soil

ingestion) are greater for children than for adults because of the differences in body weights and similar or higher ingestion rates.

Current and future exposure scenarios consider an adult weighing 70 kg on average. Assumption of an adult receptor is conservative since exposure is assumed over 30 years.

5.2.2.1 Fish Ingestion

The chronic daily intake associated with the potential ingestion of fish taken from Wallace Creek and Bearhead Creek was expressed using the following general equation:

$$CDI = \frac{C \times IR \times Fi \times EF \times ED}{BW \times AT}$$

Where:
- C = Contaminant concentration in fish (mg/kg)
- IR = Ingestion rate (kg/day)
- Fi = Fraction ingested (dimensionless)
- EF = Exposure frequency (events/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (days)

The ingestion rate was assumed to be 0.145 kg/day, which represents the USEPA Region IV default rate (USEPA, 1994). The fraction of fish ingested (FI) from the source for adults was estimated to be 1.0 (100 percent) for the 90th percentile consumption rate. This assumption is very conservative since it assumes all fish intake is from fish caught in Wallace or Bearhead Creek and is always the same fish species. The exposure frequency of 24 days/year is based on interviews with local anglers and marinas that were conducted by the Installation Restoration Division (IRD) at MCB, Camp Lejeune, North Carolina (IRD/MCB, 1994). The exposure frequency is equal to 24 days/year. The exposure duration (ED) for adults was set at 30 years, and an averaging time (AT) of 70 years or 25,550 days was used for potential exposure to the potential carcinogen PCB. An averaging time of 365 days times the exposure duration (ED) was used for noncarcinogen exposure (USEPA, 1989a).

Table 5-1 presents a summary of the exposure factors used for the fish ingestion scenario.

TABLE 5-1

EXPOSURE ASSESSMENT SUMMARY - FISH INGESTION
SUPPLEMENTAL AQUATIC SURVEY OF WALLACE CREEK AND BEARHEAD CREEK
OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Fish Ingestion - Adult			
Input Parameter	Description	Value	Rationale
C	Exposure Concentration	Maximum Concentration per Species (mg/kg)	USEPA, December 1989a
IR	Ingestion Rate	0.145 kg/day	EPA Region IV default rate (USEPA, 1994)
Fi	Fraction Ingested from Contaminated Source	1.0	90th Percentile Consumption Rate
EF	Exposure Frequency	24 days/yr	Based on site-specific data (IRD/MCB, 1994)
ED	Exposure Duration	30 years	90th percentile at one residence (USEPA, December 1989a)
BW	Body Weight	70 kg	USEPA, December 1989a
AT_c	Averaging Time Carcinogen	25,550 days	USEPA, December 1989a
AT_{nc}	Averaging Time Noncarcinogen	10,950 days	USEPA, December 1989a

5.3 Toxicity Assessment

Section 5.2 identified potential exposure pathways and potentially affected populations for this risk assessment. This section will review the available toxicological information for PCBs.

5.3.1 Toxicological Evaluation

The purpose of this section is to define the toxicological values used to evaluate the potential exposure to the PCBs. A toxicological evaluation characterizes the inherent toxicity of a compound. It consists of the review of scientific data to determine the nature and extent of the potential human health and environmental effects associated with potential exposure to various contaminants.

Human data from occupational exposures are often insufficient for determining quantitative indices of toxicity because of uncertainties in exposure estimates, and inherent difficulties in determining causal relationships established by epidemiological studies. For this reason, animal bioassays are conducted under controlled conditions and their results are extrapolated to humans. There are several stages to this extrapolation. First, to account for species differences, conversion factors are used to extrapolate from test animals to humans. Second, the relatively high doses administered to test animals must be extrapolated to the lower doses more typical of human exposures. For potential noncarcinogens, safety factors and modifying factors are applied to animal results when developing acceptable human doses. For potential carcinogens, mathematical models are used to extrapolate effects at high doses to effects at lower doses. Epidemiological data can be used for inferential purposes to establish the credibility of the experimentally derived indices.

The available toxicological information indicates that exposure to PCBs could potentially elicit carcinogenic health effects in humans and/or experimental animals. Additionally, data are available for evaluating the noncarcinogenic risks, to Aroclor-1016. The reference dose (RfD) for Aroclor-1016 will be conservatively applied in this assessment to estimate non-cancer risks. Although the PCBs may potentially cause adverse health impacts, dose-response relationships and the potential for exposure must be evaluated before the risk to receptors can be determined. Dose-response relationships correlate the magnitude of the dose with the probability of toxic effects, as discussed in the following section.

5.3.2 Dose-Response Evaluation

An important component of the risk assessment is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse health effects resulting from the exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. The published information on doses and responses is used in conjunction with information on the nature and magnitude of exposure to develop an estimate of risk.

A standard carcinogenic slope factor has been developed for PCBs. Also, a verified RfD is available for evaluating Aroclor-1016. This RfD will be conservatively applied to estimate non-cancer risks. This section provides a brief description of these parameters.

5.3.2.1 Carcinogenic Slope Factor (CSF)

Carcinogenic slope factors are used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen (USEPA, 1989a). This factor is generally reported in units of $(mg/kg/day)^{-1}$ and is derived through an assumed low-dosage linear multistage model and an extrapolation from high to low dose-responses determined from animal studies. The value used in reporting the slope factor is the upper 95th percent confidence limit.

These slope factors are also accompanied by USEPA weight-of-evidence (WOE) classifications which designate the strength of the evidence that PCBs are a potential human carcinogen.

In assessing the carcinogenic potential of a chemical, the Human Health Assessment Group (HHAG) of USEPA classifies the chemical into one of the following groups, according to the weight of evidence from epidemiologic and animal studies:

Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans)

Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)

Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)

Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)

Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

5.3.2.2 Reference Dose (RfD)

The RfD is developed for chronic and/or subchronic human exposure to chemicals and is based solely on the noncarcinogenic effects of chemical substances. It is defined as an estimate of a daily exposure level for the human population, including sensitive populations, that is likely to be without an appreciable risk of adverse effects during a lifetime. The RfD is usually expressed as dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a no-observed-(adverse)-effect-level (NOAEL or NOEL) or a lowest observed-adverse-effect-level (LOAEL) for the critical toxic effect by an appropriate "uncertainty factor (UF)." Effect levels are determined from laboratory or epidemiological studies. The uncertainty factor is based on the availability of toxicity data.

Uncertainty factors usually consist of multiples of 10, where each factor represents a specific area of uncertainty naturally present in the extrapolation process. These uncertainty factors are presented below and were taken from the "Risk Assessment Guidance Document for Superfund, Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989a):

- A UF of 10 is to account for variation in the general population and is intended to protect sensitive populations (e.g., elderly, children).

- A UF of 10 is used when extrapolating from animals to humans. This factor is intended to account for the interspecies variability between humans and other mammals.

- A UF of 10 is used when a NOAEL derived from a subchronic instead of a chronic study is used as the basis for a chronic RfD.

- A UF of 10 is used when a LOAEL is used instead of a NOAEL. This factor is intended to account for the uncertainty associated with extrapolating from LOAELs to NOAELs.

In addition to UFs, a modifying factor (MF) is applied to each reference dose and is defined as:

- An MF ranging from >0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire data base for the chemical not explicitly addressed by the preceding uncertainty factors. The default for the MF is 1.

Thus, the RfD incorporates the uncertainty of the evidence for chronic human health effects. Even if applicable human data exist, the RfD still maintains a margin of safety so that chronic human health effects are not underestimated.

The slope factor for PCBs is 7.7 $(mg/kg/day)^{-1}$ as determined by the USEPA. Based on the available toxicological and epidemiological data for PCBs, the USEPA has assigned a weight-of-evidence of Group B2-probable human carcinogen. The reference dose of 0.00007 mg/kg/day for Aroclor-1016 was conservatively assumed for the PCBs.

5.4 Risk Characterization

This section presents and discusses the estimated incremental lifetime cancer risks (ICR) and noncarcinogenic risks for identified potential adult receptor group which could be exposed to PCBs via the fish ingestion exposure pathway presented in Section 5.2.

These quantitative risk calculations for potentially carcinogenic compounds estimate incremental lifetime cancer risk levels for an individual in a specified population. This unit risk refers to the cancer risk that is over and above the background cancer risk in unexposed individuals. For example, an incremental lifetime cancer risk level (ICR) of $10E^{-6}$ indicates that, for a lifetime exposure, one additional case of cancer may occur per one million exposed individuals.

The incremental lifetime potential cancer risk level to individuals is estimated from the following relationship:

$$ICR = \sum_{i=1}^{n} CDI_i \, x \, CSF_i$$

where CSF_i is the cancer slope [(mg/kg/day)$^{-1}$] for contaminant i, and CDI_i is the chronic daily intake (mg/kg/day) for compound i. The cancer slope factor is defined in most instances as an upper 95th percentile confidence limit of the probability of a carcinogenic response based on experimental animal data and the CDI is defined as the exposure expressed as a mass of a substance contracted per unit body weight per unit time, averaged over a period of time (i.e., six years to a lifetime). The above equation was derived assuming that cancer is a non-threshold process and that the potential excess risk level is proportional to the cumulative intake over a lifetime.

In contrast to the above approach for potentially carcinogenic effects, quantitative risk calculations for noncarcinogenic compounds assume that a threshold toxicological effect exists. Therefore, the potential for noncarcinogenic effects are calculated by comparing chronic daily intake levels with threshold levels (reference doses).

Noncarcinogenic effects are estimated by calculating the Hazard Index (HI) which is defined as:

$$HI = HQ_1 + HQ_2 + \ldots HQ_n$$

$$= \sum_{i=1}^{n} HQ_i$$

$$where \; HQ_i = CDI_i / RfD_i$$

HQ_i is the hazard quotient for contaminant i, CDI_i is the chronic daily intake (mg/kg/day) of contaminant i, and RfD_i is the reference dose (mg/kg/day) of the contaminant i over a prolonged period of exposure.

Estimated incremental cancer risks will be compared to the target risk range of 1.0E^{-4} to 1.0E^{-6} which the USEPA considers to be safe and protective of public health (USEPA, 1989a). A value of 1.0 is used for examination of the HI. The hazard index calculated by comparing estimated chronic daily intakes with threshold levels below which, noncarcinogenic health

effects are not expected to occur. Any HI equal to or exceeding 1.0 suggests that noncarcinogenic health effects are possible.

5.4.1 Human Health Effects

The following paragraph presents the quantitative results of the human health evaluation for potential fish ingestion at OU No. 2.

5.4.1.1 Fish Ingestion

ICR values and hazard indices are presented in Table 5-2. The cancer risk estimates are within the USEPA acceptable range of $10E^{-4}$ to $10E^{-6}$. In terms of the non-cancer risk, the hazard indices are below the acceptable level of 1.0.

5.5 Sources of Uncertainty

Uncertainties are encountered throughout the process of performing the risk assessment. This section discusses the sources of uncertainty involved with the following:

- Analytical data
- Exposure Assessment
- Toxicity Assessment

Uncertainties associated with this risk assessment are discussed in detail below.

5.5.1 Analytical Data

The development of a risk assessment depends on the reliability of and uncertainties with the analytical data available to the risk assessor. Analytical data are limited by the precision and accuracy of the analytical method of analysis. For example, contract laboratory program (CLP) methods have, in general, a precision of about plus or minus 50 percent depending on the sample media and the presence of interfering compounds. A value of 100 µg/kg could be as high as 150 µg/kg or as low as 50 µg/kg. In addition, the statistical methods used to compile and analyze the data (mean concentration, standard deviation, and detection frequencies) are subject to the uncertainty in the ability to acquire data.

TABLE 5-2

INCREMENTAL LIFETIME CANCER RISK AND
HAZARD INDEX VALUES ASSOCIATED WITH
POTENTIAL CURRENT AND FUTURE EXPOSURES TO FISH
WALLACE CREEK AND BEARHEAD CREEK
SUPPLEMENTAL AQUATIC SURVEY OF OPERABLE UNIT NO. 2
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant of Concern	Fish Species	Noncancer Risk	Cancer Risk
PCBs (Aroclor 1260)	Gar	0.19	$1.0E^{-4}$
PCBs (Aroclor 1260)	Largemouth Bass	0 05	$2.6E^{-5}$
PCBs (Aroclor 1260)	Striped Mullet	0.18	$9.9E^{-5}$

Data validation serves to reduce some of the inherent uncertainty associated with the analytical data by establishing the usability of the data to the risk assessor who may or may not choose to include the data point in the estimation of risk.

Data qualified as "J," "K," "L," or "P" (estimated) are retained for the estimation of risk at OU No. 2. Data can be qualified as estimated for many reasons including initial and continuing calibration exceedances, high or low surrogate recovery, or intra sample variability. Data qualified "B" (detected in blank) or "R" (unreliable) are not used in the estimation of risk due to the unusable nature of the data. Due to the comprehensive sampling and analytical program at OU No. 2, the loss of some data points qualified "B" or "R" does not significantly increase the uncertainty in the estimation of risk.

5.5.2 Exposure Assessment

In performing exposure assessments, uncertainties arise from two main sources. First, the chemical concentration to which a receptor may be exposed must be estimated for every medium of interest. Second, uncertainties arise in the estimation of contaminant intakes resulting from contact by a receptor with a particular medium.

Estimating the contaminant concentration in a given medium to which a human receptor could potentially be exposed can be as simple as deriving the 95th percent upper confidence limit of the mean for a data set. More complex methods of deriving the contaminant concentration is necessary when exposure to PCBs in a given medium occur subsequent to release from another medium and analytical data are not available to characterize the release. In this case, actual maximum fish concentrations employed to estimate the potential human exposure.

To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of contaminants by the receptor. Exposure factors, have been generated by the scientific community and have undergone review by the USEPA. Regardless of the validity of these exposure factors, they have been derived from a range of values generated by studies of limited number of individuals. In all instances, values used in the risk assessment, scientific judgements, and conservative assumptions agree with those of the USEPA. Conservative assumptions designed not to underestimate daily intakes were employed throughout the risk assessment and should err on conservatively, thus

adequately protecting human health and allowing the establishment of reasonable clean-up goals.

5.5.3 Toxicity Assessment

In making quantitative estimates of the toxicity of varying dosage of a compound to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are available at all. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used and new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental animals, high doses of a compound are used over a relatively short time period. In this situation, a high dose means that experimental animal exposures are much greater than human environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at the high doses must be extrapolated to approximate effects at lower doses.

In extrapolating effects from animals to humans and high doses to low doses, scientific judgement and conservative assumptions are employed. In selecting animal studies for use in dose response calculations, the following factors are considered:

- Studies are preferred where the animal closely mimics human pharmacokinetics.
- Studies are preferred where dose intake most closely mimics the intake route and duration for humans.
- Studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens) safety factors are employed in the extrapolation of effects from animals to humans, and from high to low doses.

The use of conservative assumptions results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects, but may overestimate these effects by an order of magnitude or more.

6.0 CONCLUSIONS

None of the contaminants detected in the fish or crabs collected from Wallace Creek or Bearhead Creek exceeded any of the FDA ALs. Three fish species collected from Wallace Creek and Bearhead Creek had contaminant concentrations exceeding the target analyte SVs including largemouth bass, longnose gar, and striped mullet. Other fish and crab species were collected in Wallace Creek and Bearhead Creek, however, no PCBs were detected in these fish and crabs at levels that exceeded the SVs.

The determination of whether a fish advisory is recommended, as per USEPA Guidance Document (Figure 2-1), is based on the exceedance of the target analyte screening values by any target species and the conduct of a risk assessment to evaluate the need for issuance of a fish consumption advisory. Because the target analyte screening value for PCB was exceeded, a risk assessment was conducted. The incremental lifetime cancer risk estimated for fish ingestion was within the USEPA acceptable range of $10E^{-4}$ to $10E^{-6}$ for each of the three species of concern. However, the actual risk to humans varies depending upon the parameters used in the risk assessment exposure equations. The following paragraphs discuss the fish consumption rates used in the risk assessment and why the calculated risk are considered protective of recreation fisherman.

The largemouth bass was the only species of these three that was recommended as a target species according to the USEPA Guidance Document (USEPA, 1993). The bass are freshwater fish, therefore, they will primarily be found in the upper reaches of Wallace Creek. As a result, the parameters of 145 g/day for the consumption rate and 24 days/year for the number of days the fish are consumed in a year, should provide a reasonable factor of safety for the recreational fisherman primarily because it is doubtful that any one person would consume or be exposed to these rates.

The USEPA Exposure Factors Handbook contains a list of the mean total fish consumption rates by species (USEPA, 1989). The consumption rates were based on responses to a survey conducted by NPD Research Inc. in which the respondents were asked to report the species and the amount consumed during the survey. Longnose gar was not included on the list. Mullet had a mean consumption rate of 0.029 g/day, compared to a mean consumption rates of 1.179 and 0.258 g/day for flounder and bass, respectively. These rates include both recreationally caught and commercially purchased fish, and therefore would not represent consumption rates for recreational fishermen. However, they may be used to obtain a relative proportion of fish

species making up the human diet. Therefore, gar does not appear to be a fish that is normally consumed in large quantities, if at all, so the estimated increased risk appears to overestimate the risk.

Striped mullet, which are harvested for commercial and recreational purposes are widely consumed throughout coastal North Carolina. However, the vast majority of these are harvested offshore and in salt marshes adjacent to the Atlantic Intercoastal Waterway (IRD, MCB, 1994). Wallace Creek is not utilized for commercial harvest. Since the population of these fish increases dramatically from July through October, the majority of the harvesting occurs offshore during this time.

According to the USEPA National Study of Chemical Residues in Fish (NSCRF, 1992), the mean PCB concentration of fish in industrial/urban sites ranged from 0.0025 to 12.027 mg/kg with a mean value of 2.46 mg/kg and a median value of 0.213 mg/kg. Therefore, the levels of PCBs detected in most of the fish collected in Wallace Creek and Bearhead Creek were less than the median value. All the PCB levels detected in fish were less than mean value.

Finally, the USEPA Guidance Document (USEPA, 1993) recognizes that the 0.010 mg/kg SV for PCBs will result in widespread exceedances in waterbodies throughout the country which will drive virtually all the fish and shellfish monitoring programs into the risk assessment phase for PCBs. These exceedances of SVs result from a combination of the conservative methodology for estimating the values (e.g., 365 days per year exposure over 70 years) and the relatively high cancer slope factor for PCBs [7.7 $(mg/kg/day)^{-1}$].

In summary, an assessment of potential human health risks associated with consumption of fish in Wallace Creek and Bearhead Creek was conducted using SVs, background comparisons, traditional human health risk assessment guidelines and comparison with fish tissue levels typically encountered in the United States. Although the FDA levels were not exceeded, results of the USEPA SV analysis indicated that PCBs may be of concern from a human health perspective. Further analysis of the data indicated that the potential risk were within USEPA's acceptable risk range of $10E^{-4}$ to $10E^{-6}$ even though a number of conservative assumptions were used in estimating the risk (e.g., all fish consumed is large mouth bass from the two creeks). The striped mullet is harvested offshore and not within the Wallace Creek area. In terms of the gar this fish specie is not considered a game or commercial species. Therefore, it is highly unlikely that the gar would be consumed at the rates assumed in the risk assessment, if even consumed at all.

Based on the conclusions drawn throughout this study, a fish or shellfish ban is not recommended for Wallace Creek or Bearhead Creek.

7.0 REFERENCES

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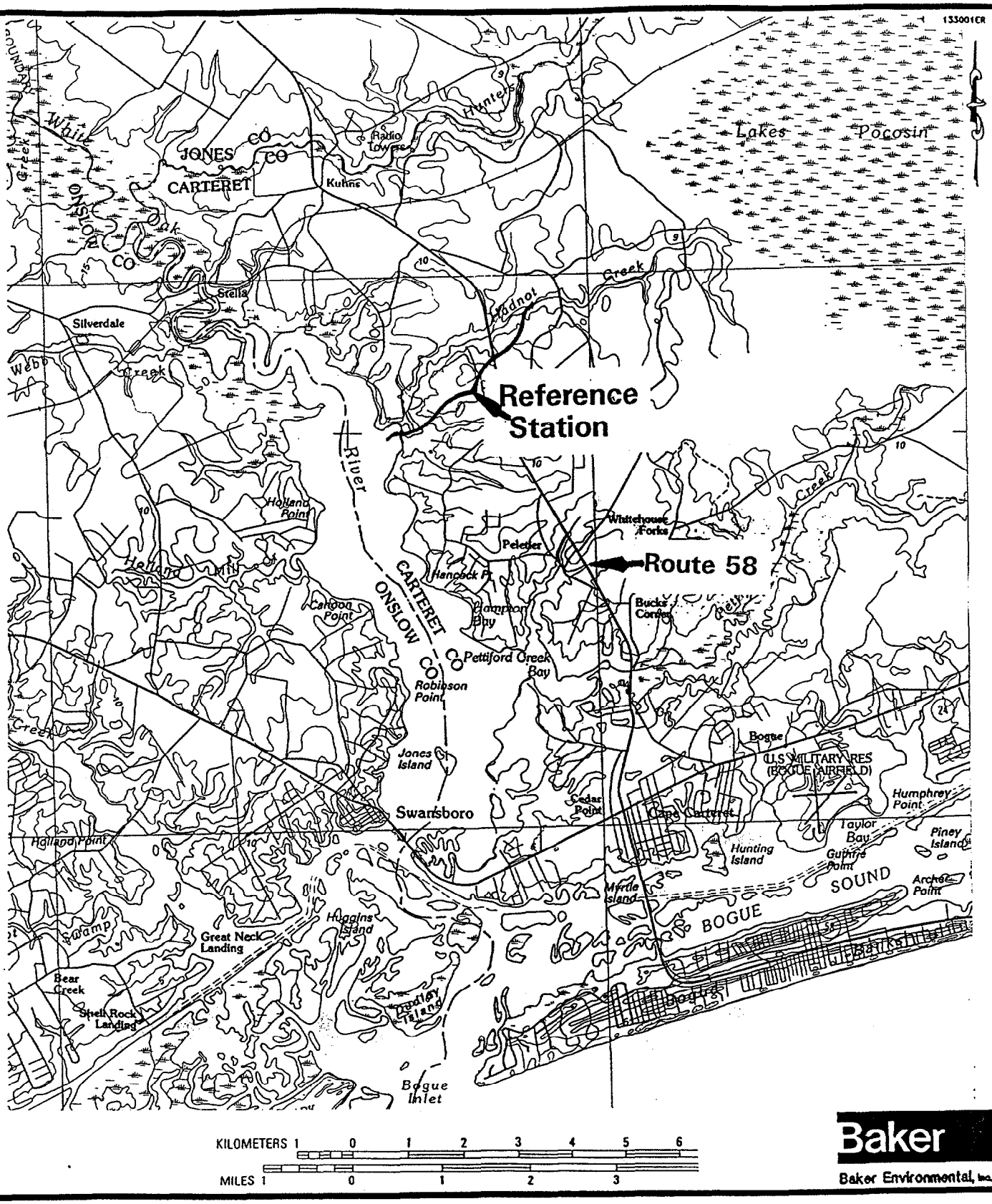
Appendix 1
Fish and Crab Collection Log



SOURCE: U.S. GEOLOGIC SURVEY
NEW RIVER, 1:100,000 SCALE
TOPOGRAPHIC MAP, #34077-E1-TM-100.
1991

FIGURE 2
FISH AND CRAB SAMPLING
LOCATIONS IN HADNOT CREEK
CTO-0133
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. WC6A
Fish Species: Long-nosed gar

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-29-93	830	WC6A-G01	27.25	692.15
9-29-93	830	WC6A-G02	30.25	768.35
10-2-93	1500	WC6A-G03	29	736.6

Station No. WC9A
Fish Species: Long-nosed gar

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-28-93	930	WC9A-G01	36.5	927.1
9-28-93	930	WC9A-G02	27.5	698.5
9-28-93	930	WC9A-G03	34.5	876.3
9-28-93	930	WC9A-G04	28.5	723.9
9-28-93	930	WC9A-G05	32.25	819.15
9-28-93	930	WC9A-G06	28.5	723.9
9-28-93	930	WC9A-GO7	28.5	723.9
9-28-93	930	WC9A-G08	28.5	723.9
9-28-93	930	WC9A-G09	31.25	793.75
9-28-93	930	WC9A-G10	26.75	679.45
10-4-93	1700	WC9A-G11	37	939.8

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. BC6A
Fish Species: Long-nosed gar

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
10-1-93	1700	BC6A-G01	26.5	673.1
10-1-93	1700	BC6A-G02	29.5	749.3
10-1-93	1700	BC6A-G03	28	711.2
10-1-93	1700	BC6A-G04	29	736.6
10-1-93	1700	BC6A-G05	29.5	749.3
10-1-93	1700	BC6A-G06	27	685.8
10-2-93	900	BC6A-G07	29.25	742.95
10-2-93	900	BC6A-G08	31.75	806.45
10-2-93	900	BC6A-G09	30.5	774.7
10-2-93	900	BC6A-G10	27	685.8

Station No. HC1A
Fish Species: Long-nosed gar

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-29-93	1400	HC1A-G01	25.25	641.35
9-30-93	800	HC1A-G02	31	787.4
9-30-93	800	HC1A-G03	26.5	673.1
9-30-93	800	HC1A-G04	28	711.2
9-30-93	800	HC1A-G05	26	660.4
10-4-93	800	HC1A-G06	26.25	666.75
10-4-93	800	HC1A-G07	29.25	742.95

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. BC4A
Fish Species: Southern flounder

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
10-2-93	1055	BC4A-SF01	10.5	266.7
10-2-93	1055	BC4A-SF02	8.25	209.55
10-2-93	1055	BC4A-SF03	11.25	285.75

Station No. BC6A
Fish Species: Southern flounder

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
10-1-93	1700	BC6A-SF01	10.25	260.35
10-2-93	900	BC6A-SF02	9.75	247.65
10-4-93	1700	BC6A-SF03	9.5	241.3

Station No. WC9A
Fish Species: Southern flounder

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-28-93	930	WC9A-SF01	11	279.4
9-28-93	930	WC9A-SF02	10	254
9-28-93	930	WC9A-SF03	10.25	260.35
9-28-93	930	WC9A-SF04	8.5	215.9
9-28-93	1600	WC9A-SF05	9.25	234.95
9-28-93	1600	WC9A-SF06	9.75	247.65
10-4-93	1700	WC9A-SF07	8	203.2
10-4-93	1700	WC9A-SF08	9.5	241.3
10-4-93	1700	WC9A-SF09	10.75	273.05

Station No. HC1A
Fish Species: Southern flounder

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-30-93	800	HC1A-SF01	11.5	292.1
10-3-93	1000	HC1A-SF02	13	330.2
10-3-93	1000	HC1A-SF03	10	254
10-4-93	800	HC1A-SF04	13.5	342.9
10-4-93	800	HC1A-SF05	21.25	539.75
10-4-93	800	HC1A-SF06	10.25	260.35

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. BC6A
Fish Species: Red drum

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
10-1-93	1700	BC6A-RD01	16.25	412.75
10-1-93	1700	BC6A-RD02	17.25	438.15
10-2-93	900	BC6A-RD03	16.5	419.1
10-2-93	900	BC6A-RD04	17.25	438.15
10-2-93	900	BC6A-RD05	15.25	387.35

Station No. HC1A
Fish Species: Red drum

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-30-93	800	HC1A-RD01	16	406.4
10-3-93	900	HC1A-RD02	22	558.8
10-3-93	900	HC1A-RD03	15.25	387.35
10-3-93	900	HC1A-RD04	13.25	336.55
10-4-93	800	HC1A-RD05	14.75	374.65
10-4-93	800	HC1A-RD06	15.5	393.7

Station No. WC6A
Fish Species: Chain pickerel

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-29-93	830	WC6A-CP01	22	558.8
9-29-93	830	WC6A-CP02	20.5	520.7
9-30-93	1400	WC6A-CP03	18.75	476.25

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. BC6A and BC4A
Fish Species: Stripped mullet

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
10-1-93	1700	BC6A-SM01	14.75	374.65
10-1-93	1700	BC6A-SM02	15.25	387.35
10-1-93	1700	BC6A-SM03	13.25	336.55
10-1-93	1700	BC6A-SM04	14	355.6
10-1-93	1700	BC6A-SM05	13.5	342.9
10-2-93	900	BC6A-SM06	14.5	368.3
10-2-93	900	BC6A-SM07	14.25	361.95
10-2-93	900	BC6A-SM08	13	330.2
10-2-93	900	BC6A-SM09	13.25	336.55
10-1-93	1730	BC4A-SM01	14.25	361.95

Station No. WC6A
Fish Species: Stripped mullet

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-29-93	830	WC6A-SM00	15.25	387.35
9-28-93	1800	WC6A-SM01	14.75	374.65
9-29-93	830	WC6A-SM02	15.75	400.05
9-29-93	830	WC6A-SM03	15.25	387.35
9-29-93	830	WC6A-SM04	15.5	393.7
9-29-93	830	WC6A-SM05	15.25	387.35
9-29-93	830	WC6A-SM06	16.5	419.1
9-29-93	830	WC6A-SM07	15.5	393.7
9-29-93	830	WC6A-SM08	15.75	400.05
9-29-93	830	WC6A-SM09	15.75	400.05
9-29-93	830	WC6A-SM10	14.5	368.3
9-29-93	830	WC6A-SM11	15.25	387.35
9-29-93	830	WC6A-SM12	16.25	412.75
9-29-93	830	WC6A-SM13	15.75	400.05
9-29-93	830	WC6A-SM14	15	381
9-29-93	830	WC6A-SM15	15	381
9-29-93	1700	WC6A-SM16	15.5	393.7
9-29-93	1700	WC6A-SM17	16	406.4
9-30-93	1400	WC6A-SM18	16.5	419.1
9-30-93	1400	WC6A-SM19	16	406.4

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. WC9A
Fish Species: Stripped mullet

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-28-93	930	WC9A-SM01	14	355.6
9-28-93	930	WC9A-SM02	17.25	438.15
9-28-93	930	WC9A-SM03	13.75	349.25
9-28-93	930	WC9A-SM04	14.75	374.65
9-28-93	930	WC9A-SM05	15.25	387.35
9-28-93	930	WC9A-SM06	14.5	368.3
9-28-93	930	WC9A-SM07	14.25	361.95
9-28-93	930	WC9A-SM08	13	330.2
9-28-93	930	WC9A-SM09	14.5	368.3
9-28-93	930	WC9A-SM10	14.25	361.95
9-28-93	930	WC9A-SM11	14	355.6

Station No. HC1A
Fish Species: Stripped mullet

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-30-93	800	HC1A-SM01	16.5	419.1

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. WC6A
Fish Species: Largemouth bass

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-28-93	1800	WC6A-LB01	12	304.8
9-28-93	1800	WC6A-LB02	13.25	336.55
9-29-93	830	WC6A-LB03	14.5	368.3
9-29-93	830	WC6A-LB04	12.25	311.15
9-29-93	830	WC6A-LB05	13	330.2
9-29-93	830	WC6A-LB06	14.75	374.65
9-29-93	1700	WC6A-LB07	14.5	368.3
9-29-93	1700	WC6A-LB08	13.5	342.9

Station No. HC1A
Fish Species: Largemouth bass

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-30-93	800	HC1A-LB01	12.5	317.5
9-30-93	800	HC1A-LB02	11.75	298.45
9-30-93	800	HC1A-LB03	12.25	311.15
9-30-93	800	HC1A-LB04	12.5	317.5
9-30-93	800	HC1A-LB05	12.5	317.5
9-30-93	800	HC1A-LB06	15.5	393.7
9-30-93	800	HC1A-LB07	13.5	342.9
9-30-93	800	HC1A-LB08	13.25	336.55
9-30-93	800	HC1A-LB09	14	355.6
9-30-93	800	HC1A-LB10	12	304.8
9-30-93	800	HC1A-LB11	13.5	342.9
9-30-93	1700	HC1A-LB12	13	330.2
9-30-93	1700	HC1A-LB13	12	304.8
9-30-93	1700	HC1A-LB14	12	304.8
9-30-93	1700	HC1A-LB15	13.5	342.9
9-30-93	1700	HC1A-LB16	13	330.2
10-3-93	1100	HC1A-LB17	16.25	412.75
10-3-93	1100	HC1A-LB18	14.25	361.95
10-3-93	1100	HC1A-LB19	13.25	336.55
10-3-93	1200	HC1A-LB20	16	406.4
10-3-93	1200	HC1A-LB21	10.25	260.35
10-3-93	1200	HC1A-LB22	13	330.2
10-3-93	1200	HC1A-LB23	11.75	298.45

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. BC6A
Fish Species: Blue crab

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
10-2-93	1230	BC6A-BC01	5.5	139.7
10-2-93	1230	BC6A-BC02	6	152.4
10-2-93	1230	BC6A-BC03	4.75	120.65
10-2-93	1230	BC6A-BC04	5.25	133.35
10-2-93	1230	BC6A-BC05	5.75	146.05
10-2-93	1230	BC6A-BC06	4.5	114.3
10-4-93	1730	BC6A-BC07	5.5	139.7
10-4-93	1730	BC6A-BC08	5.5	139.7
10-4-93	1730	BC6A-BC09	5.5	139.7
10-4-93	1730	BC6A-BC10	5	127
10-4-93	1730	BC6A-BC11	5.25	133.35
10-4-93	1730	BC6A-BC12	6	152.4
10-4-93	1730	BC6A-BC13	5.5	139.7
10-4-93	1730	BC6A-BC14	5.5	139.7
10-4-93	1730	BC6A-BC15	5.5	139.7
10-4-93	1730	BC6A-BC16	5.25	133.35
10-4-93	1730	BC6A-BC17	4.75	120.65
10-4-93	1730	BC6A-BC18	6	152.4
10-4-93	1730	BC6A-BC19	5.5	139.7
10-4-93	1730	BC6A-BC20	5.75	146.05

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. WC9A
Fish Species: Blue crab

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-28-93	900	WC9A-BC01	5.25	133.35
9-28-93	900	WC9A-BC02	5.5	139.7
9-28-93	900	WC9A-BC03	6	152.4
9-28-93	900	WC9A-BC04	6	152.4
9-28-93	900	WC9A-BC05	5.5	139.7
9-28-93	1630	WC9A-BC06	6.5	165.1
9-28-93	1630	WC9A-BC07	5.5	139.7
9-29-93	1000	WC9A-BC08	5	127
9-29-93	1000	WC9A-BC9	4.25	107.95
9-29-93	1000	WC9A-BC10	4.75	120.65
9-29-93	1000	WC9A-BC11	5	127
9-29-93	1000	WC9A-BC12	5.25	133.35
9-29-93	1000	WC9A-BC13	6	152.4
9-29-93	1000	WC9A-BC14	4.5	114.3
9-29-93	1800	WC9A-BC15	5.75	146.05
9-29-93	1800	WC9A-BC16	5.5	139.7
9-29-93	1800	WC9A-BC17	5.5	139.7
9-29-93	1800	WC9A-BC18	4.5	114.3
9-29-93	1800	WC9A-BC19	5	127
9-29-93	1800	WC9A-BC20	4.5	114.3
9-29-93	1800	WC9A-BC21	5.75	146.05
9-29-93	1800	WC9A-BC22	5	127
9-29-93	1800	WC9A-BC23	5	127
9-30-93	1400	WC9A-BC24	6	152.4
9-30-93	1400	WC9A-BC25	6	152.4
9-30-93	1400	WC9A-BC26	5.5	139.7
9-30-93	1400	WC9A-BC27	5	127
9-30-93	1400	WC9A-BC28	5.25	133.35
9-30-93	1400	WC9A-BC29	5.25	133.35
9-30-93	1400	WC9A-BC30	5	127
10-1-93	1730	WC9A-BC31	5.25	133.35
10-1-93	1730	WC9A-BC32	5.25	133.35
10-1-93	1730	WC9A-BC33	5	127
10-1-93	1730	WC9A-BC34	4.75	120.65
10-1-93	1730	WC9A-BC35	5.5	139.7
10-2-93	1200	WC9A-BC36	6	152.4
10-2-93	1200	WC9A-BC37	5.75	146.05
10-2-93	1200	WC9A-BC38	6.25	158.75
10-2-93	1200	WC9A-BC39	5.75	146.05
10-2-93	1200	WC9A-BC40	5.75	146.05

Appendix 1

Fish and Crab Collection Log
Supplemental Aquatic Survey of Wallace Creek and Bearh
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Station No. HC1A
Fish Species: Blue crab

Date	Collection Time	Sample Number	Length (inches)	Length (mm)
9-30-93	940	HC1A-BC01	4.75	120.65
9-30-93	940	HC1A-BC02	5.25	133.35
9-30-93	940	HC1A-BC03	4.75	120.65
9-30-93	940	HC1A-BC04	5.5	139.7
9-30-93	940	HC1A-BC05	5	127
9-30-93	940	HC1A-BC06	4.75	120.65
9-30-93	940	HC1A-BC07	6.5	165.1
9-30-93	940	HC1A-BC08	5	127
9-30-93	1700	HC1A-BC09	6	152.4
9-30-93	1700	HC1A-BC10	5	127
10-3-93	1100	HC1A-BC11	6.75	171.45
10-3-93	1100	HC1A-BC12	5.25	133.35
10-3-93	1100	HC1A-BC13	5.25	133.35
10-3-93	1100	HC1A-BC14	4.5	114.3
10-3-93	1100	HC1A-BC15	6.5	165.1
10-3-93	1100	HC1A-BC16	6.25	158.75
10-3-93	1100	HC1A-BC17	5.5	139.7
10-3-93	1100	HC1A-BC18	5.75	146.05
10-3-93	1100	HC1A-BC19	6.5	165.1
10-3-93	1100	HC1A-BC20	6.75	171.45
10-3-93	1100	HC1A-BC21	6.75	171.45
10-3-93	1100	HC1A-BC22	6.25	158.75
10-3-93	1100	HC1A-BC23	5	127
10-3-93	1100	HC1A-BC24	7	177.8
10-3-93	1100	HC1A-BC25	4.25	107.95
10-3-93	1100	HC1A-BC26	6.75	171.45
10-3-93	1100	HC1A-BC27	5.5	139.7
10-3-93	1100	HC1A-BC28	5.25	133.35
10-3-93	1100	HC1A-BC29	5.5	139.7
10-4-93	942	HC1A-BC30	5.75	146.05
10-4-93	942	HC1A-BC31	5.25	133.35
10-4-93	942	HC1A-BC32	5	127
10-4-93	942	HC1A-BC33	5	127
10-4-93	942	HC1A-BC34	6.25	158.75
10-4-93	942	HC1A-BC35	5.75	146.05
10-4-93	942	HC1A-BC36	5.5	139.7

Appendix 2
Field Record for Fish Contamination Monitoring Program - Intensive Study

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SRN Sampling Dates: Sept 28,93 – Oct 4,93

SITE LOCATION

Site Name/Number: Camp Lejeune - Site 6.9082
County/Parish: Onslow Lat./Long:
Waterbody Name/Segment Number: New River Basin - Wallace Creek, Beachead Creek
Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY
Site Description:

Collection Method: Gill Nets
Collector Name: Aaron Bernhardt, Michael Musolin, Bill Jeffords
(print and sign)
Agency: Phone: (___)
Address:

FISH COLLECTED

Species Name: Southern Flounder Replicate Number: 1/2
Composite Sample #: BC4A-SF Number of Individuals: 5

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
BC4A-SF01	266.7				
BC4A-SF03	285.75				
BC6A-SF01	260.35				
BC6A-SF02	247.65				
BC6A-SF03	241.3				

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 84.4 ≥ 75% Composite Mean Length 254 mm

Notes (e.g., morphological anomalies);

Species Name: Southern Flounder Replicate Number: 2/2
Composite Sample #: WC9A-SF Number of Individuals:

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC9A-SF01	279.4				
" -SF02	254				
" -SF03	260.35				
" -SF06	247.65				
" -SF09	273.05				

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 90.7 ≥ 75% Composite Mean Length 260.4 mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAN Sampling Dates: Sept 30, 93 → Oct 4, 93

SITE LOCATION

Site Name/Number: Reference Station For Camp Lejeune
County/Parish: _____ Lat./Long: _____
Waterbody Name/Segment Number: White Oak River Basin - Hadnot Creek
Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY
Site Description: _____

Collection Method: Gill Nets
Collector Name: AMB, WJJ, MGM
(print and sign)
Agency: _____ Phone: (___) _____
Address: _____

FISH COLLECTED

Species Name: Southern Flounder Replicate Number: 1
Composite Sample #: HC1A - SF Number of Individuals: 5

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC1A - SF01	292.1				
SF02	330.2				
SF03	254.0				
SF04	342.9				
SF06	260.35				

Minimum Length / Maximum Length x 100 = 74.1 ≥ 75% Composite Mean Length 300.0 mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____
Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

Minimum Length / Maximum Length x 100 = _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SRN Sampling Dates: Sept 28.93 - Sept 29.93

SITE LOCATION

Site Name/Number: Camp Lejeune, Site 6. 9+82
County/Parish: Onslow Lat./Long:
Waterbody Name/Segment Number: New River Basin: Wallace Creek, Beachead Creek
Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY
Site Description:

Collection Method: Gill Nets
Collector Name: AMB, WJT, MGM
(print and sign)
Agency: Phone: ( )
Address:

FISH COLLECTED

Species Name: Largemouth Bass Replicate Number: 1/2
Composite Sample #: WC6A-LBA Number of Individuals: 4

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC6A-LB02	336.55				
LB04	311.15				
LB06	374.65				
LB08	342.9				

Minimum Length / Maximum Length x 100 = 83.1 ≥ 75% Composite Mean Length 342.9 mm

Notes (e.g., morphological anomalies);

Species Name: Largemouth Bass Replicate Number: 2/2
Composite Sample #: WC6A-LBB Number of Individuals: 4

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC6A-LB01	304.8				
LB03	368.3				
LB05	330.2				
LB07	368.3				

Minimum Length / Maximum Length x 100 = 82.8 ≥ 75% Composite Mean Length 347.1 mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAV Sampling Dates: Sept 30, 93 - Oct 3. 93

SITE LOCATION

Site Name/Number: Reference Station For Camp Lejeune

County/Parish: _____ Lat./Long: _____

Waterbody Name/Segment Number: White Oak River Basin - Hadnot Creek

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description: _____

Collection Method: _____

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: _____ Phone: (___) _____

Address: _____

FISH COLLECTED

Species Name: Largemouth Bass Replicate Number: 1/3

Composite Sample #: HC1A-LBA Number of Individuals: 4

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC1A-LB05	317.5				
LB07	342.9				
LB09	355.6				
LB11	342.9				

Minimum Length / Maximum Length x 100 = 89.3 ≥ 75% Composite Mean Length 336.7 mm

Notes (e.g., morphological anomalies); _____

Species Name: Largemouth Bass Replicate Number: 2/3

Composite Sample #: HC1A-LBB Number of Individuals: 4

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC1A-LB08	336.55				
LB18	361.95				
LB19	336.55				
LB22	330.2				

Minimum Length / Maximum Length x 100 = 91.2 ≥ 75% Composite Mean Length 340.8 mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY (Cont.)
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAN Sampling Dates: Sept 30, 93 - Oct 3, 93

SITE LOCATION

Site Name/Number: Reference station For Camp Lejeune

County/Parish: _____ Lat./Long: _____

FISH COLLECTED

Species Name: Largemouth Bass Replicate Number: 3/3

Composite Sample #: HC1A-LBC Number of Individuals: 4

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC1A-LB01	317.5				
LB04	317.5				
LB06	393.7				
LB15	342.9				

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 80.7 ≥ 75% Composite Mean Length 351.37 mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAN Sampling Dates: Sept 29, 93 - Sept 30, 93

SITE LOCATION

Site Name/Number: Camp Lejeune - Site 6, 9, 82

County/Parish: Onslow Lat./Long:

Waterbody Name/Segment Number: New River Basin - Wallace Creek

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description:

Collection Method: Gill Nets

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: Phone: (___) ___

Address:

FISH COLLECTED

Species Name: Chain Pickerel Replicate Number: 1/1

Composite Sample #: WC6H-CP Number of Individuals: 3

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC6H-CP01	558.8				
-CP02	520.7				
-CP03	476.25				

Minimum Length / Maximum Length x 100 = 91.5 ≥ 75% Composite Mean Length 498.48 mm

Notes (e.g., morphological anomalies);

Species Name: Replicate Number:

Composite Sample #: Number of Individuals:

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

Minimum Length / Maximum Length x 100 = ___ ≥ 75% Composite Mean Length ___ mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAN Sampling Dates: Sept 29.93 - Oct 4.93

SITE LOCATION

Site Name/Number: Camp Lejeune, Site 6, 9 & 82
County/Parish: Onslow Lat./Long:
Waterbody Name/Segment Number: New River Basin & Wallace Creek and Beaverdam Creek
Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY
Site Description:

Collection Method: Gill Nets
Collector Name: AMB, WJJ, MGM
(print and sign)
Agency: Phone: ( )
Address:

FISH COLLECTED

Species Name: Long-nosed gar Replicate Number: 1/3
Composite Sample #: WC6H-G Number of Individuals: 3

	Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC6A-	G01	692.15				
↓	G02	768.35				
	G03	736.6				

Minimum Length / Maximum Length x 100 = 90.1 ≥ 75% Composite Mean Length 730.3 mm

Notes (e.g., morphological anomalies);

Species Name: Long-nosed gar Replicate Number: 2/3
Composite Sample #: WC9H-G Number of Individuals: 3

	Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC9H-	G02	698.5				
↓	G04	723.9				
	G06	723.9				

Minimum Length / Maximum Length x 100 = 96.5 ≥ 75% Composite Mean Length 711.2 mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY (Cont.)
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAM Sampling Dates: Sept 29.93 - Oct 4.93

SITE LOCATION

Site Name/Number: Camp Lejeune, Site 6, 9087

County/Parish: Onslow Lat./Long: _____

FISH COLLECTED

Species Name: Long-nosed Gar Replicate Number: 3/3

Composite Sample #: BC6A-G Number of Individuals: 3

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
BC6A-G03	711.2				
-G04	736.6				
-G07	742.95				

Minimum Length / Maximum Length x 100 = 95.7 ≥ 75% Composite Mean Length 727.1 mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

Minimum Length / Maximum Length x 100 = _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish.#	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

Minimum Length / Maximum Length x 100 = _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SMM Sampling Dates: Sept 28,93 - Oct 2,93

SITE LOCATION

Site Name/Number: Camp Lejeune - Site 6,9,87

County/Parish: Onslow Lat./Long:

Waterbody Name/Segment Number: New River Basin - Wallace Creek

Waterbody Type: ☑ RIVER ☐ LAKE ☐ ESTUARY

Site Description:

Collection Method: Crab Pots

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: Phone: (___) ___

Address:

SHELLFISH COLLECTED

Species Name: Blue Crab Replicate Number: 3/3

Composite Sample #: WL9A - BCB Number of Individuals: 18

Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex
WL9A - BC03	152.4		WL9A-BC38	158.75				
BC04	152.4							
BC08	127							
BC15	146.05							
BC16	139.7							
BC17	139.7							
BC21	146.05							
BC22	127							
BC23	127							
BC25	152.4							
BC27	127							
BC29	133.35							
BC31	133.35							
BC32	133.35							
BC34	120.65							
BC35	139.7							
BC37	146.05							

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 76.0 ≥ 75% Composite Mean Length 139.0 mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAV Sampling Dates: Sept 29, 93 - Oct 4, 93

SITE LOCATION

Site Name/Number: Reference Station for Camp Lejeune

County/Parish: _____ Lat./Long: _____

Waterbody Name/Segment Number: White Oak River Basin.

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description: _____

Collection Method: Gill Nets

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: _____ Phone: (___) _____

Address: _____

FISH COLLECTED

Species Name: Long-nosed gar Replicate Number: 1/2

Composite Sample #: HC1A-GA Number of Individuals: 3

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC1A-G01	641.35				
G02	787.4				
G03	673.1				

Minimum Length / Maximum Length x 100 = 81.5 ≥ 75% Composite Mean Length 714.4 mm

Notes (e.g., morphological anomalies); _____

Species Name: Long-nosed gar Replicate Number: 2/2

Composite Sample #: HC1A-GB Number of Individuals: 3

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC1A-G04	711.2				
G06	666.75				
G07	742.95				

Minimum Length / Maximum Length x 100 = 89.7 ≥ 75% Composite Mean Length 704.9 mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SRN Sampling Dates: Oct 1,93 - Oct 2,93

SITE LOCATION

Site Name/Number: Camp Lejeune - Site 6, 9, 82

County/Parish: Onslow Lat./Long: _____

Waterbody Name/Segment Number: New River Basin - Bearhead Creek

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description: _____

Collection Method: Gill Nets

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: _____ Phone: (___) _____

Address: _____

FISH COLLECTED

Species Name: Red drum Replicate Number: 1/1

Composite Sample #: BC6H-RD Number of Individuals: 5

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
BC6H-RD01	412.75				
RD02	438.15				
RD03	419.1				
RD04	438.15				
RD05	387.35				

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 88.4 ≥ 75% Composite Mean Length 412.8 mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAN Sampling Dates: Sept 30,93 – Oct 4,93

SITE LOCATION

Site Name/Number: Reference station For Camp Lejeune

County/Parish: _____ Lat./Long: _____

Waterbody Name/Segment Number: White Oak River Basin - Hadnot Creek

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description: _____

Collection Method: Gill nets

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: _____ Phone: (___) _____

Address: _____

FISH COLLECTED

Species Name: Red drum Replicate Number: 1/1

Composite Sample #: HC14-RD Number of Individuals: 6

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
HC14-RD01	406.4		HC14-RD06	393.7	
RD02	558.8				
RD03	387.35				
RD04	336.53				
RD05	374.65				

Minimum Length / Maximum Length x 100 = 60.2 ≥ 75% Composite Mean Length 400.1 mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

Minimum Length / Maximum Length x 100 = _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SIRM Sampling Dates: Sept 28.93 - Oct 2.93

SITE LOCATION

Site Name/Number: Camp Lejeune - Site 6.9082

County/Parish: Onslow Lat./Long: .

Waterbody Name/Segment Number: New River Basin - Wallace Creek, Beachead Creek

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description: _____

Collection Method: Gill Nets

Collector Name: AMB, WJJ, MFM
(print and sign)

Agency: _____ Phone: (___) _____

Address: _____

FISH COLLECTED

Species Name: Stripped Mullet Replicate Number: 1/4

Composite Sample #: BC6A - SM Number of Individuals: 10

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
BC6A-SM01	374.65		BC6A SM06	368.3	
SM02	387.35		SM07	361.95	
SM03	336.55		SM08	330.2	
SM04	355.6		SM09	336.55	
SM05	342.9		BC4A SM01	361.95	

Minimum Length / Maximum Length x 100 = 85.3 ≥ 75% Composite Mean Length 352.8 mm

Notes (e.g., morphological anomalies); _____

Species Name: Stripped Mullet Replicate Number: 2/4

Composite Sample #: WC6A - SM4 Number of Individuals: 10

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)
WC6A-SM03	387.35		WC6A-SM19	406.4	
SM04	393.7		WC4A-SM04	374.65	
SM09	400.05		SM06	368.3	
SM14	381		SM07	361.95	
SM18	419.1		SM11	355.6	

Minimum Length / Maximum Length x 100 = 84.9 ≥ 75% Composite Mean Length 382.4 mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY (Cont.)
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAN Sampling Dates: Sept 28, 93 - Oct 2, 93

SITE LOCATION

Site Name/Number: Camp Lejeune, Site 6, 9682

County/Parish: Onslow Lat./Long: _____

FISH COLLECTED

Species Name: Stripped mullet Replicate Number: 3/4

Composite Sample #: WC6A-SM13 Number of Individuals: 10

	Fish #	Length (mm)	Sex (M, F, or I)		Fish #	Length (mm)	Sex (M, F, or I)
WC6A-	SM00	387.35		WC6A	SM13	400.05	
↓	SM01	374.65		↓	SM16	393.7	
	SM05	387.35		WC9A-	SM03	349.25	
	SM06	419.1			SM09	368.3	
	SM08	400.05		↓	SM10	361.95	

Minimum Length / Maximum Length x 100 = 83.3 ≥ 75% Composite Mean Length 384.5 mm

Notes (e.g., morphological anomalies); _____

Species Name: Stripped mullet Replicate Number: 4/4

Composite Sample #: WC6A-SM0 Number of Individuals: 10

	Fish #	Length (mm)	Sex (M, F, or I)		Fish #	Length (mm)	Sex (M, F, or I)
WC6A-	SM02	400.05		WC6A-	SM15	381	
↓	SM07	393.7		↓	SM17	406.4	
	SM10	368.3		WC9A	SM01	355.6	
	SM11	387.35			SM05	387.35	
	SM12	412.75		↓	SM08	330.2	

Minimum Length / Maximum Length x 100 = 80.0 ≥ 75% Composite Mean Length 378.2 mm

Notes (e.g., morphological anomalies); _____

Species Name: _____ Replicate Number: _____

Composite Sample #: _____ Number of Individuals: _____

Fish #	Length (mm)	Sex (M, F, or I)	Fish #	Length (mm)	Sex (M, F, or I)

Minimum Length / Maximum Length x 100 = _____ ≥ 75% Composite Mean Length _____ mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAM Sampling Dates: Sept 28, 93 - Oct 2. 93

SITE LOCATION

Site Name/Number: Camp Lejeune, Site 6, 9187
County/Parish: Onslow Lat./Long:
Waterbody Name/Segment Number: New River Basin - Wallace Creek
Waterbody Type: ☑ RIVER ☐ LAKE ☐ ESTUARY
Site Description:

Collection Method: Crab Pots
Collector Name: AMB, WJT, MGM
(print and sign)
Agency: Phone: (___)
Address:

SHELLFISH COLLECTED

Species Name: Blue Crab Replicate Number: 2/3
Composite Sample #: WC9A-BC9A Number of Individuals: 20

Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex
WC9A-BC01	133.35		WC9A BC46	146.05				
BC02	139.7							
BC05	139.7							
BC06	165.1							
BC07	139.7							
BC10	120.65							
BC11	127							
BC12	133.35							
BC13	152.4							
BC19	127							
BC24	152.4							
BC26	139.7							
BC28	133.35							
BC30	127							
BC33	127							
BC36	152.4							
BC39	146.05							

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 73.1 ≥ 75% Composite Mean Length 139.0 mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SAV Sampling Dates: Oct 2, 93 - Oct 4, 93

SITE LOCATION

Site Name/Number: Camp Lejeune - Sta 6, 9, 67
County/Parish: Onslow Lat./Long:
Waterbody Name/Segment Number: New River Basin - Wallace Creek, Beaufort Creek
Waterbody Type: ☑ RIVER ☐ LAKE ☐ ESTUARY
Site Description:

Collection Method: Crab Pots
Collector Name: AMB, WTT, MGM
(print and sign)
Agency: Phone: (___) ___
Address:

SHELLFISH COLLECTED

Species Name: Blue Crab Replicate Number: 1/3
Composite Sample #: BC6A - BC Number of Individuals: 18

Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex
BC6A-BC01	139.7		BC6A-BC18	152.4				
BC02	152.4							
BC03	120.65							
BC04	133.35							
BC05	146.05							
BC20	146.05							
BC07	139.7							
BC08	139.7							
BC09	139.7							
BC10	127							
BC11	133.35							
BC12	152.4							
BC13	139.7							
BC14	139.7							
BC15	139.7							
BC16	133.35							
BC19	139.7							

Minimum Length / Maximum Length x 100 = 79.2 ≥ 75% Composite Mean Length 139.7 mm

Notes (e.g., morphological anomalies);

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-52-SRN Sampling Dates: Sept 30, 93 - Oct 4, 93

SITE LOCATION

Site Name/Number: Reference station for Camp Lejeune

County/Parish: _____ Lat./Long: _____

Waterbody Name/Segment Number: White Oak River

Waterbody Type: ☒ RIVER ☐ LAKE ☐ ESTUARY

Site Description: _____

Collection Method: Crab Pots

Collector Name: AMB, WJJ, MGM
(print and sign)

Agency: _____ Phone: (___) _____

Address: _____

SHELLFISH COLLECTED

Species Name: Blue Crab Replicate Number: 1/2

Composite Sample #: HC14 - BC4 Number of Individuals: 16

Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex
HC14 - BC02	133.35	___	HC14 - BC04	139.7	___	___	___	___
BC06	120.65 *	___	___	___	___	___	___	___
BC08	127	___	___	___	___	___	___	___
BC09	152.4	___	___	___	___	___	___	___
BC11	171.45	___	___	___	___	___	___	___
BC12	133.35	___	___	___	___	___	___	___
BC13	133.35	___	___	___	___	___	___	___
BC15	165.1	___	___	___	___	___	___	___
BC17	139.7	___	___	___	___	___	___	___
BC18	146.05	___	___	___	___	___	___	___
BC24	177.8	___	___	___	___	___	___	___
BC25	107.95	___	___	___	___	___	___	___
BC26	171.45	___	___	___	___	___	___	___
BC30	146.05	___	___	___	___	___	___	___
BC32	127	___	___	___	___	___	___	___
BC33	127	___	___	___	___	___	___	___
BC34	158.75	___	___	___	___	___	___	___

$\frac{\text{Minimum Length}}{\text{Maximum Length}} \times 100 =$ 60.7 ≥ 75% Composite Mean Length 143.2 mm

Notes (e.g., morphological anomalies); _____

FIELD RECORD FOR FISH CONTAMINANT MONITORING PROGRAM - INTENSIVE STUDY
MCB CAMP LEJEUNE, NORTH CAROLINA

Project Number: 19133-92-SAN Sampling Dates: Sept 30,93 - Oct 4,93

SITE LOCATION

Site Name/Number: Reference station For Camp Lejeune
County/Parish: _____ Lat./Long: _____
Waterbody Name/Segment Number: White Oak River
Waterbody Type: ☑ RIVER ☐ LAKE ☐ ESTUARY
Site Description: _____

Collection Method: Crab Pots
Collector Name: AMB, WJJ, MGM
(print and sign)
Agency: _____ Phone: (___) _____
Address: _____

SHELLFISH COLLECTED

Species Name: Blue Crab Replicate Number: 2/2
Composite Sample #: HL1A - BCB Number of Individuals: 18

Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex	Shellfish #	Size (mm)	Sex
HL1A - BC 01	120.65		HL1A - BC 36	139.7				
BC 03	120.65							
BC 05	127							
BC 07	165.1							
BC 10	127							
BC 14	114.3							
BC 16	158.75							
BC 19	165.1							
BC 20	171.45							
BC 21	171.45							
BC 22	158.75							
BC 23	127							
BC 27	139.7							
BC 28	133.35							
BC 29	139.7							
BC 31	133.35							
BC 35	146.05							

Minimum Length / Maximum Length x 100 = 66.7 ≥ 75% Composite Mean Length 142.2 mm

Notes (e.g., morphological anomalies); _____

Appendix 3
Data Validation Reports

InterOffice Memorandum

Baker

To:	Ray Wattras	**Date:**	December 30, 1993
From:	Rich Hoff R.H.	**Subject:**	CTO 133, SDG# BC6A-G Fish tissue organic data validation

This data validation report presents the validated data for 32 fish samples taken September 29th through October 10th, 1993. These samples were analyzed for volatile organics, semivolatile organics, pesticides and PCBs by the CLP Statement of Work. Samples evaluated in this report are:

BC6A-G	HC1A-SF
BC4A-SF	OP1A-BGA
BC6A-BC	OP1A-BGB
BC6A-RD	OP1A-RDA
BC6A-SM	OP1A-RDB
HC1A-AM	WC9A-G
HC1A-BCM	WC6A-G
HC1A-BCB	WC6A-CP
HC1A-BGA	WC6A-LBA
HC1A-BGB	WC6A-LBB
HC1A-GA	WC6A-SMA
HC1A-GB	WC6A-SMB
HC1A-LBA	WC6A-SMC
HC1A-LBB	WC9A-SF
HC1A-LBC	WC9A-BCA
HC1A-RD	WC9A-BCB

Data were reviewed using the Laboratory Data Validation Functional Guidelines For Evaluating Organic Analysis, 1991 and the CLP Statement of Work for Organic Analysis. Because of the nature of the media, professional judgement was also used in the validation.

Miscellaneous

Two of three volatile system monitoring compounds (SMCs) were beyond the specified contract required QC limits. Toluene-d8 (139%) and bromofluorobenzene (57%) were out of compliance in sample WC6A-SMC. Because these exceedances were slight, no action was taken.

The matrix spike duplicate result for trichloroethene (61%) fell just below the QC recovery limit of 62% in sample BC6A-G and the corresponding relative percent difference (RPD) for the matrix spike/matrix spike duplicate (48%) exceeded its QC limit of 24%. Because the matrix spike recovery was 100% no action is necessary.

Pesticide surrogate percent recoveries for tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB) were beyond the advisory QC limits in samples HC1A-AM, HC1A-GB, HC1A-LBA, HC1A-LBC, HC1A-RD, HC1A-SF, OP1A-BGA, OP1A-RDA, WC6A-CP, WC6A-G, WC6A-LBA, WC6A-LBB, WC6A-SMA, WC6A-SMB, WC6A-SMC, WC9A-BCA, and WC9A-BCB. Exceedances were associated primarily TCX on the first column and DCB on both first and second columns. Surrogate recoveries also exceeded criteria in PBLK04 (high TCX and DCB, both columns). PBLK05 and PBLK06 also had surrogate recovery exceedances. DCB was particularly low when analyzed on both first and second columns. However, recovery values are advisory in nature and fish samples are particularly complex, therefore, no action was taken.

Matrix spike duplicate percent recoveries for trichloroethene (61%) were slightly below the minimum recovery value of 62 percent. No action was taken.

The matrix spike for gamma-BHC (28%) and the matrix spike duplicate for gamma-BHC (30%), heptachlor (29%), aldrin (26%), dieldrin (24%) and endrin (27%) were slightly below recovery criteria. Because of the complex matrix, no action was taken.

The presence of di-n-octyl phthalate in fish samples could be present as a result of laboratory induced contamination. Di-n-octyl phthalate was not, however, detected in any blank samples and no action could be taken by the validator. In general, the occurrence of di-n-octyl phthalate and its prevalence in fish tissue samples apparently increases proportionally to the presence of bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate is discussed in detail in subsequent paragraphs of this memo. The data user should consider further the relationship between the occurrence of these two phthalates.

Minor Issues

Laboratory "J" qualifiers were removed from positive results which were flagged for being below the CRQL. Values below the CRQL are considered to be estimated results and should be considered as such by the data user. Therefore, these results were qualified "J" by the data validator

Matrix spike, matrix spike duplicate percent recoveries for 2,4-dinitrotoluene were well below minimum recovery criteria. Associated sample results and nondetect values for 2,4-dinitrotoluene were qualified as "J" estimated.

Blank samples contained the constituents bromomethane, methylene chloride and 2-hexanone. The common laboratory contaminant methylene chloride was qualified as "B" if sample concentrations were within 10 times of the maximum detected blank result. Methylene chloride present in samples, but not qualified by the validator, should be used with caution by the data user. 2-Hexanone was qualified as "B" if sample concentrations were within 5 times of the maximum detected blank concentrations. Bromomethane was not detected in fish tissue samples and no further action was necessary.

Bis (2-ethylhexyl)phthalate was detected in laboratory blanks at concentrations ranging from 78 ug/Kg (SBLKDR) to 840 ug/Kg (SBLKDP). The detected concentration in SBLKDP exceeded its respective CRDL by approximately 25 times. Therefore, bis(2-ethylhexyl)phthalate results in associated samples (HC1A-GA, HC1A-GB, HC1A-LBA, HC1A-LBB, HC1A-LBC, HC1A-RD, HC1A-SF, OP1A-BGA,

OP1A-BGB, OP1A-RDA, OP1A-RDB and WC9A-G) were qualified as "R" rejected. Because of the presence of bis(2-ethylhexyl)phthalate in other blanks, all results less than 8400 ug/Kg will be qualified as "B" laboratory or sampling related contamination. Samples containing concentrations in excess of 8400 uk/Kg without validator qualification should be used with caution, because the presence of this chemical is probably laboratory related.

Bis(2-ethylhexyl)phthalate was detected in samples HC1A-GA, HC1A-GB, OP1A-BGA, OP1A-BGB, OP1A-RD, WC6A-G, WC6A-LBA, WC6A-SMA, WC6A-SMB, WC6A-SMC and WC9A-G at levels which exceed linear range of instrument working calibration. Samples were not reanalyzed by the laboratory at dilutions which would put bis(2-ethylhexyl)phthalate within the working range. Therefore, reported results were qualified as "J" estimated. Again, the data user should be aware of the potential for laboratory or sampling related phthalate contamination.

Volatile internal standard areas were below their lower 12 hour area limit in samples HC1A-LBA (chlorobenzene-d5), OP1A-RDA (1,4-difluorobenzene, chlorobenzene-d5), WC6A-LBA (chlorobenzene-d5), and WC9A-G (chlorobenzene-d5), WC6A-SMB (bromochloromethane, 1,4-difluorobenzene, chlorobenzene-d5), BC6A-G (chlorobenzene-d5), WC6A-G (bromochloromethane, 1,4-difluorobenzene, chlorobenzene-d5), BC6A-SM (chlorobenzene-d5), HC1A-AM (chlorobenzene-d5), HC1A-BGB and (bromochloromethane, 1,4-difluorobenzene, chlorobenzene-d5). Associated chemicals in affected samples were qualified as "J" or "UJ" estimated.

Semivolatile internal standard areas were below the lower 12 hour area limit in samples: HC1A-BGA, HC1A-RD, BC4A-SF, WC6A-LBA and WC9A-SF (perylene-d12); HC1A-AM, WC9A-BCB HC1A-GA, HC1A-GB, WC6A-G, BC6A-BC, BC6A-RD, OP1A-BGA, OP1A-BGB, WC6A-LBB, WC6A-SMA, WC6A-SMB (chrysene-d12, perylene-d12); HC1A-LBA (phenanthrene-d10, perylene-d12); and BC6A-SM (phenanthrene-d10, chrysene-d12, perylene-d12). Associated chemicals in affected samples were qualified as "J" or "UJ" estimated.

The Percent Relative Standard Deviation (%RSD) for acetone (32%) exceeded initial calibration criteria of 25% for SDG BC6A-G. All associated positive results and nondetect values were qualified as "J" or "UJ" estimated.

Continuing calibration Percent Difference (%D) values for chloromethane, vinyl chloride, chloroethane, methylene chloride, 1,1-dichloroethene, and 2-butanone (10/28/93) exceeded continuing calibration criteria of 25%. All associated results were qualified as either "J" or "UJ" estimated.

Continuing calibration %D values for 2,2'-oxybis(1-chloropropane), 2-nitrophenol, 2,6-dinitrotoluene, 4-nitrophenol, pentachlorophenol, di-n-octyl phthalate and benzo(g,h,i)perylene exceeded the 25% criteria on November 7, 1993. 4-Nitrophenol, 4,6-dinitro-2-methylphenol, pentachlorophenol, butylbenzylphthalate, bis(2-ethylhexyl)phthalate and di-n-octylphthalate exceeded %D values on November 9, 1993. The compounds 2-nitrophenol, 4-chloroaniline, hexachlorocyclopentadiene, 3-nitroaniline, 2,4-dinitrophenol, 4-nitrophenol, 4-nitroaniline, 4,6-dinitro-2-methylphenol, di-n-butylphthalate and 3,3'-dichlorobenzidine exceeded %D values on November 4, 1993. 2,2'-Oxybis(1-chloropropane), n-nitroso-di-n-propylamine, 3-nitroaniline, 2,4-dinitrophenol, 4-nitrophenol, 4-nitroaniline, 3,3'-dichlorobenzidine and benzo(k)fluoranthene exceeded %D criteria on November 5, 1993. Finally, 2,2'-oxybis(1-chloropropane),n-nitroso-di-n-propylamine,isphorone,hexachlorocyclopentadiene,2,4,5-trichlorophenol,

3-nitroaniline, 2,4-dinitrotoluene, 4-nitrophenol, 4-nitroaniline and 3,3'-dichlorobenzidine exceeded %D criteria on November. All associated results were qualified as either "J" or "UJ", respectively.

The percent breakdown of 4,4'-DDT and the combined endrin/4,4'-DDT breakdown exceeded method specified criteria on November 10 1993. Because 4,4'-DDT was responsible for the majority of the breakdown, only the DDT series (4,4'-DDT, DDE, DDD) pesticides will be qualified "J" or "UJ" estimated. Endrin results were not qualified.

Second column confirmation results exceeding 25 percent difference (%D) from first column results should be qualified as "P". Because of the complex nature of tissue samples, analytical results for pesticides analyzed on first and second columns with %Ds exceeding 50% were qualified "P". These samples are BC6A-B, BC6A-RD, BC6A-SM, HC1A-AM, HC1A-BGA, HC1A-LBC, WC6A-G, WC6A-LBA, WC6A-LBB, WC6A-SMA, WC6A-SMB, WC6A-SMC AND WC9A-G.

Conclusions

All samples were successfully analyzed by the laboratory and data are useable for any intended purpose within the limits of validation qualification. Qualifiers used in this validation, qualified data and support documentation are presented in the following attachments.

RAH/nd
Attachments

cc: Tom Biksey, letter only
Matt Bartman, letter only

GLOSSARY OF DATA QUALIFIER CODES

CODES RELATED TO IDENTIFICATION

(confidence concerning presence or absence of compounds)

U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.

B = Unreliable result because of potential laboratory or field induced contamination. Analyte is probably not a site related contaminant.

CODES RELATED TO QUANTITATION

(used for positive results and sample quantitation limits):

J = Analyte present. Reported value may not be accurate or precise without an indication of potential bias.

K = Analyte present. Reported value may be biased high. Actual value is potentially lower than the reported value.

L = Analyte present. Reported value may be biased low. Actual value is potentially higher than the reported value.

UJ = Not detected, quantitation limit may be inaccurate or imprecise without an indication of potential bias.

UL = Not detected, quantitation limit is probably higher than the reported limit.

P = First and second column results do not agree within specified criteria. Reported value may not be accurate or precise.

InterOffice Memorandum

Baker

To:	Ray Wattras	**Date:**	January 3, 1994
From:	Rich Hoff R.H.	**Subject:**	CTO-0133, SDG# BC6A-G Fish tissue inorganic data validation

This data validation report presents the validated data for 32 fish samples taken September 29th through October 10th, 1993. These samples were analyzed for inorganic analytes by the CLP Statement of Work (SOW) ILM03.0. Fish samples were digested according to the procedures for conducting Marine Environmental Sampling and Analysis (Method ERL-N SOP 2.03.006, Rev 0, January 1991). Samples evaluated in this report are:

BC6A-G	HC1A-SF
BC4A-SF	OP1A-BGA
BC6A-BC	OP1A-BGB
BC6A-RD	OP1A-RDA
BC6A-SM	OP1A-RDB
HC1A-AM	WC9A-G
HC1A-BCM	WC6A-G
HC1A-BCB	WC6A-CP
HC1A-BGA	WC6A-LBA
HC1A-BGB	WC6A-LBB
HC1A-GA	WC6A-SMA
HC1A-GB	WC6A-SMB
HC1A-LBA	WC6A-SMC
HC1A-LBB	WC9A-SF
HC1A-LBC	WC9A-BCA
HC1A-RD	WC9A-BCB

Data were reviewed using the Laboratory Data Validation Functional Guidelines For Evaluating Inorganic Analysis, 1993 and the 1993 Statement of Work for Inorganic Analysis. Because of the nature of the media, professional judgement was also used in the validation.

Miscellaneous

Duplicate sample analytical results (samples BC6A-Gdup, HC1A-LBCdup and WC6A-CPdup) for several analytes fell outside soil percent difference criteria (plus or minus 35%). Because of the complexity of the fish tissue matrix duplicate sample results did not warrant action by the data validator.

The percent recovery criteria (%R) for selenium (82%) fell slightly below the 90% criteria established by the SOW. Subsequent continuing calibration %R values were successful, therefore, no action was taken.

Vanadium displayed two high %R results and one low result %R result in ICP interference check samples (ICSs). Inconsistencies in these results were identified in the case narrative by the laboratory. In

general, vanadium did not display reoccurring problems with ICS recoveries throughout the SDG, therefore, no action was taken.

Minor Issues

Analytes qualified as"B" by the laboratory were qualified "J", estimated, by the data validator. Laboratory "B" qualifiers indicate that the detected analyte was present in the sample above instrument detection limits, but below contact quantitation limits. For the purposes of this validation, values below the contract quantitation limit were considered estimated values and were qualified as such.

CRDL standard %R values for antimony, cadmium, chromium, lead, silver, nickel and arsenic fell outside of SOW specified values. Associated positive results and CRDLs were qualified as "UL" and "L" biased low in appropriate samples.

Initial calibration, continuing calibration and preparation blanks contained low levels of aluminum, antimony, barium, magnesium, calcium, iron, lead, potassium, sodium, selenium, vanadium and zinc. Because of the prevalence of the analytes in blanks run throughout the SDG, sample results were qualified as "U" not detected if they failed to exceed 5 times the maximum blank concentration adjusted to represent the tissue matrix.

The following concentrations represent 5 times the maximum detected blank concentration on a mass/mass basis:

aluminum	22 mg/Kg
barium	5.7 mg/Kg
antimony	31.9 mg/Kg
calcium	14 mg/Kg
lead	0.13 mg/Kg
magnesium	24.4 mg/Kg
potassium	13.2 mg/Kg
sodium	11.2 mg/Kg
iron	29.2 mg/Kg
selenium	4.9 mg/Kg
silver	3.2 mg/Kg
vanadium	5.2 mg/Kg
zinc	1.3 mg/Kg

Lead results were below %R criteria in several ICS samples throughout the SDG. Lead was, therefore, qualified as "L" or "UL" in all associated samples.

Spike sample results for arsenic, chromium, mercury, selenium, silver, thallium and zinc fell outside of the specified 75% to 125% recovery range specified by the SOW. Positive sample results associated with high %R values were qualified "K" biased high. No action was taken for nondetect results. Positive and nondetect sample results associated with spike %R values greater than 30% but less than 75% were

qualified either "L" or "UL" respectively. Sample results associated with %R values below 30% were qualified "L" and nondetect results were qualified "R" rejected.

Conclusions

All samples were successfully analyzed by the laboratory and data are useable for any intended purpose within the limits of validation qualification. Qualifiers used in this validation, qualified data and support documentation are presented in the following attachments.

RAH/nd
Attachments

GLOSSARY OF DATA QUALIFIER CODES

CODES RELATED TO IDENTIFICATION

(confidence concerning presence or absence of compounds)

U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.

B = Unreliable result because of potential laboratory or field induced contamination. Analyte is probably not a site related contaminant.

CODES RELATED TO QUANTITATION

(used for positive results and sample quantitation limits):

J = Analyte present. Reported value may not be accurate or precise without an indication of potential bias.

K = Analyte present. Reported value may be biased high. Actual value is potentially lower than the reported value.

L = Analyte present. Reported value may be biased low. Actual value is potentially higher than the reported value.

UJ = Not detected, quantitation limit may be inaccurate or imprecise without an indication of potential bias.

UL = Not detected, quantitation limit is probably higher than the reported limit.

P = First and second column results do not agree within specified criteria. Reported value may not be accurate or precise.

Appendix 4
Positive Detections for Samples Collected in Wallace Creek and Bearhead Creek

APPENDIX 4
Positive Detections for Samples Collected in Wallace Creek and Bearhead Creek
Supplemental Aquatic Survey of Wallace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Parameter	BC6A-RD (Red drum) (mg/kg)		BC4A-SF (Southern flounder) (mg/kg)		WC9A-SF (Southern flounder) (mg/kg)	
INORGANICS						
ARSENIC	0.42		0.15	J	0.28	L
CADMIUM						
CALCIUM	217		3460		1540	
CHROMIUM			0.63	L	1.1	
COPPER	0.22	J	0.44	J	0.18	J
LEAD						
MAGNESIUM	269		329		288	
MANGANESE	0.09	J	0.59		0.23	J
MERCURY	0.04		0.02	J	0.02	
POTASSIUM	3760		3980		3890	
SODIUM	740		734		890	
ZINC	4.1		10.5		8.8	
PESTICIDES/PCBs						
4,4'-DDD	0.007		0.0048	P		
4,4'-DDE	0.011		0.02		0.0039	
ALPHA-CHLORDANE	0.0015	P	0.0018			
AROCLOR-1260						
SEMIVOLATILES						
PHENOL						
DI-N-OCTYL PHTHALATE	0.057	J	0.037	J		
DI-N-BUTYLPHTHALATE						
BIS(2-ETHYLHEXYL)PHTHALATE					0.37	B
VOLATILES						
ACETONE	0.09	J	0.066	J	0.063	J
2-BUTANONE			0.081	J		
1,2-DICHLOROETHENE						
METHYLENE CHLORIDE	0.012	B	0.006	B	0.054	B
TETRACHLOROETHENE						
TOLUENE						
TRICHLOROETHENE	0.001	J				
XYLENES, TOTAL						

APPENDIX 4
Positive Detections for Samples Collected in Wallace Creek and Bearhead Creek
Supplemental Aquatic Survey of Wallace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Parameter	WC6A-LBA (Largemouth bass) (mg/kg)		WC6A-LBB (Largemouth bass) (mg/kg)		WC6A-CP (Chain pickerel) (mg/kg)	
INORGANICS						
ARSENIC	0.18	L	0.16	L	0.38	L
CADMIUM						
CALCIUM	1390		1890		1000	
CHROMIUM	0.26		0.26			
COPPER	0.15	J	0.18	J		
LEAD						
MAGNESIUM	271		285		284	
MANGANESE	0.06	J	0.09	J	0.13	J
MERCURY	0.14		0.14		0.09	L
POTASSIUM	3380		3530		3650	
SODIUM	539		569		673	
ZINC	3.7		4		4.9	
PESTICIDES/PCBs						
4,4'-DDD	0.0062	P	0.005	P		
4,4'-DDE	0.017		0.016		0.0034	
ALPHA-CHLORDANE						
AROCLOR-1260	0.057		0.055			
SEMIVOLATILES						
PHENOL						
DI-N-OCTYL PHTHALATE	0.32	J	0.14	J	0.067	J
DI-N-BUTYLPHTHALATE						
BIS(2-ETHYLHEXYL)PHTHALATE	14	J	7.6	B	2.7	B
VOLATILES						
ACETONE	0.53	J	0.3	J	0.082	J
2-BUTANONE	0.023	B	0.023	B		
1,2-DICHLOROETHENE	0.006	J	0.013		0.008	J
METHYLENE CHLORIDE	0.015	B	0.011	B	0.014	B
TETRACHLOROETHENE	0.003	J	0.008	J	0.004	J
TOLUENE						
TRICHLOROETHENE	0.016		0.043		0.021	
XYLENES, TOTAL						

APPENDIX 4
Positive Detections for Samples Co llected in Wallace Creek and Bearhead Creek
Supplemental Aquatic Survey of W allace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolin a

Parameter	BC6A-G (Longnose gar) (mg/kg)		WC6A-G (Longnose gar) (mg/kg)		WC9A-G (Longnose gar) (mg/kg)	
INORGANICS						
ARSENIC	0.93		1.5	L	0.98	L
CADMIUM						
CALCIUM	980		469		1160	
CHROMIUM					0.2	L
COPPER	0.18	J	0.25	J	0.17	J
LEAD						
MAGNESIUM	295		292		331	
MANGANESE	0.27	J	0.21	J	0.31	J
MERCURY	0.06	L	0.1		0.07	
POTASSIUM	3130		3370		3090	
SODIUM	427		515		829	
ZINC			4		4.7	
. ESTICIDES/PCBs						
4,4'-DDD	0.042	P	0.045	JP	0.07	
4,4'-DDE	0.099		0.13	J	0.18	
ALPHA-CHLORDANE					0.0049	P
AROCLOR-1260	0.13	J	0.16		0.23	P
SEMIVOLATILES						
PHENOL					0.45	
DI-N-OCTYL PHTHALATE	0.21		0.28	J	0.82	
DI-N-BUTYLPHTHALATE						
BIS(2-ETHYLHEXYL)PHTHALATE			12	J	26	J
VOLATILES						
ACETONE	0.054	J	0.072	J	0.15	J
2-BUTANONE					0.12	
1,2-DICHLOROETHENE			0.011	J		
METHYLENE CHLORIDE	0.007	B	0.026	B	0.022	B
TETRACHLOROETHENE			0.008	J	0.003	J
TOLUENE						
TRICHLOROETHENE	0.004	J	0.034	J	0.015	
'LENES, TOTAL						

APPENDIX 4
Positive Detections for Samples Collected in Wallace Creek and Bearhead Creek
Supplemental Aquatic Survey of Wallace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Parameter	BC6A-SM (Stripped mullet) (mg/kg)		WC6A-SMA (Stripped mullet) (mg/kg)		WC6A-SMB (Stripped mullet) (mg/kg)		WC6A-SMC (Stripped mullet) (mg/kg)	
INORGANICS								
ARSENIC	0.37		0.48	L	0.48	L	0.36	L
CADMIUM								
CALCIUM	1190		992		723		1360	
CHROMIUM	0.65		0.72		0.23	J		
COPPER	0.32	J	0.29	J	0.27	J	0.17	J
LEAD								
MAGNESIUM	290		294		283		297	
MANGANESE	0.21	J	0.22	J	0.14	J	0.2	J
MERCURY	0.01		0.01	J				
POTASSIUM	3840		3850		3830		3790	
SODIUM	903		564		538		592	
ZINC	6.5		6.1		6		5.6	
STICIDES/PCBs								
,4'-DDD	0.063	P	0.026	JP	0.034	JP	0.032	J
4,4'-DDE	0.12		0.038	J	0.047	J	0.048	J
ALPHA-CHLORDANE	0.0075	P						
AROCLOR-1260	0.12		0.13	J	0.19		0.22	
SEMIVOLATILES								
PHENOL								
DI-N-OCTYL PHTHALATE	2	J	0.23	J	0.29	J	0.64	
DI-N-BUTYLPHTHALATE							0.1	
BIS(2-ETHYLHEXYL)PHTHALATE			12	J	16	J	24	J
VOLATILES								
ACETONE	0.055	J	0.041	J			0.02	J
2-BUTANONE			0.008	B	0.057	J	0.021	B
1,2-DICHLOROETHENE			0.005	J	0.035	J	0.025	
METHYLENE CHLORIDE	0.011	B	0.006	B	0.028	B	0.076	
TETRACHLOROETHENE			0.01		0.036	J	0.031	
TOLUENE	0.002	J			0.003	J	0.003	J
TRICHLOROETHENE	0.007	J	0.034		0.11	J	0.085	
XYLENES, TOTAL								

APPENDIX 4
Positive Detections for Samples Collected in Wallace Creek and Bearhead Creek
Supplemental Aquatic Survey of Wallace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolina

Parameter	BC6A-BC (Blue crab) (mg/kg)		WC9A-BCA (Blue crab) (mg/kg)		WC9A-BCB (Blue crab) (mg/kg)	
INORGANICS						
ARSENIC	0.47		0.43	L	0.52	L
CADMIUM					0.1	L
CALCIUM	15900		4340		4800	
CHROMIUM			0.18	J		
COPPER	6.8		5		5.6	
LEAD					0.59	L
MAGNESIUM	1120		1270		604	
MANGANESE	2.7		3.8		1.1	
MERCURY	0.02		0.02	J	0.01	J
POTASSIUM	2380		2380		2260	
SODIUM	3930		4130		4000	
ZINC	21.6		23.3		23.3	
PESTICIDES/PCBs						
4,4'-DDD	0.026		0.0082		0.0093	
4,4'-DDE	0.033		0.0094		0.012	
ALPHA-CHLORDANE	0.0063					
AROCLOR-1260						
SEMIVOLATILES						
PHENOL						
DI-N-OCTYL PHTHALATE						
DI-N-BUTYLPHTHALATE						
BIS(2-ETHYLHEXYL)PHTHALATE			1.8	B	0.83	B
VOLATILES						
ACETONE	0.15	J	0.16	J	0.13	J
2-BUTANONE						
1,2-DICHLOROETHENE						
METHYLENE CHLORIDE	0.037	B	0.019	B	0.018	B
TETRACHLOROETHENE						
TOLUENE						
TRICHLOROETHENE			0.002	J	0.002	J
XYLENES, TOTAL						

Appendix 5
Positive Detections for Samples Collected in Hadnot Creek

APPENDIX 5

)sitive Detections for Samples Co llected in the White Oak River and Hadnot
Supplemental Aquatic Survey of W allace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolin a

Parameter	HC1A-RD (Red drum) (mg/kg)		HC1A-SF (Southern flounder) (mg/kg)	
INORGANICS				
ALUMINUM				
ARSENIC	0.7	L	0.82	
BARIUM				
CADMIUM				
CALCIUM	154		271	
CHROMIUM	0.38	L		
COPPER	0.3	J	0.18	J
IRON				
LEAD				
MAGNESIUM	285		254	
MANGANESE	0.13		0.38	
MERCURY	0.07		0.05	
CKEL				
OTASSIUM	3930		3700	
SODIUM	1060		607	
ZINC	5		5	
PESTICIDES/PCBs				
4,4'-DDD				
4,4'-DDE				
ALPHA-CHLORDANE				
AROCLOR-1260				
SEMIVOLATILES				
PHENOL			0.46	
DI-N-OCTYL PHTHALATE				
BIS(2-ETHYLHEXYL)PHTHALATE	1.1	B	0.82	B
VOLATILES				
ACETONE	0.13	J	0.056	J
METHYLENE CHLORIDE	0.041		0.013	B

APPENDIX 5

sitive Detections for Samples Co llected in the White Oak River and Hadnot Creek
Supplemental Aquatic Survey of W allace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolin a

Parameter	HC1A-LBA (Largemouth bass) (mg/kg)		HC1A-LBB (Largemouth bass) (mg/kg)		HC1A-LBC (Largemouth bass) (mg/kg)	
INORGANICS						
ALUMINUM			36.5			
ARSENIC	0.34	L	0.37	L	0.36	K
BARIUM						
CADMIUM						
CALCIUM	528		684		1170	
CHROMIUM	0.23	L	0.68	L	0.63	L
COPPER	0.2	J	0.24	J	0.28	J
IRON						
LEAD						
MAGNESIUM	298		292		319	
MANGANESE	0.09	J	0.09	J	0.08	J
MERCURY	0.22		0.24		0.17	K
CKEL						
. OTASSIUM	3740		3610		4040	
SODIUM	505		580		529	
ZINC	3.9		4.4		4.6	L
PESTICIDES/PCBs						
4,4'-DDD						
4,4'-DDE						
ALPHA-CHLORDANE					0.00017	P
AROCLOR-1260						
SEMIVOLATILES						
PHENOL			2.1		1.6	
DI-N-OCTYL PHTHALATE	0.061	J			0.085	
BIS(2-ETHYLHEXYL)PHTHALATE	3.6	B	3.2	B	4.8	B
VOLATILES						
ACETONE	0.077	J	0.07	J	0.037	J
METHYLENE CHLORIDE	0.017	B	0.016	B	0.003	B

APPENDIX 5

sitive Detections for Samples Co llected in the White Oak River and Hadnot Creek
Supplemental Aquatic Survey of W allace Creek and Bearhead Creek
Operable Unit No. 2
MCB Camp Lejeune, North Carolin a

Parameter	HC1A-BCA (Blue crab) (mg/kg)		HC1A-BCB (Blue crab) (mg/kg)		HC1A-GA (Longnose gar) (mg/kg)		HC1A-GB (Longnose gar) (mg/kg)	
INORGANICS								
ALUMINUM								
ARSENIC	0.68		0.39		2.5		3.9	L
BARIUM			10.1					
CADMIUM	0.14		0.11	J				
CALCIUM	4480		32200		493		520	
CHROMIUM			0.52	L	0.32	L	0.21	L
COPPER	7.9		5.8		0.46	J	0.18	J
IRON								
LEAD								
MAGNESIUM	591		1800		286		300	
MANGANESE	1.8		13.6		0.24	J	0.21	J
MERCURY	0.08		0.02	J	0.22		0.14	
CKEL					0.45	L		
OTASSIUM	2170		1860		3410		3270	
SODIUM	4060		4270		623		523	
ZINC	25		17.9		6.5		4.6	
PESTICIDES/PCBs								
4,4'-DDD	0.0066		0.0056					
4,4'-DDE	0.0087		0.0046		0.012		0.0097	
ALPHA-CHLORDANE	0.0018		0.0012					
AROCLOR-1260								
SEMIVOLATILES								
PHENOL								
DI-N-OCTYL PHTHALATE					0.29	J	0.5	J
BIS(2-ETHYLHEXYL)PHTHALATE					11	J	17	J
VOLATILES								
ACETONE	0.11	J	0.099	J	0.028	J	0.016	J
METHYLENE CHLORIDE	0.011	B	0.022	B	0.004	B	0.015	B